EVALUATION OF ANTIOXIDANT PROPERTIES AND SENSORY PROFILE OF PURPLE BRAZILIAN CHERRY BEVERAGES

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Abstract

This study aimed to develop and evaluate the sensory acceptability of Brazilian cherry beverages, and analyze their chemical and physicochemical characteristics and antioxidant properties. The beverages were formulated with 15, 25 and 35% of pulp for refreshment, nectar and tropical juice, respectively. Analysis of pH, titratable acidity, soluble solids, total and reducing sugars, color, ascorbic acid, anthocyanins, total carotenoids, total extractable polyphenols, antioxidant activity, microbiological analyses and sensory evaluation were performed. The refreshment, nectar and tropical juice differed with regard to ascorbic acid, total carotenoids, anthocyanins, total extractable polyphenols and total antioxidant activity, with the highest values observed in the beverage with the highest concentration of pulp (tropical juice). Sensory evaluation revealed that refreshment, nectar and tropical juice presented mean scores ranging between acceptance and indifference in the acceptance testing and purchase intent, with higher scores for nectar and refreshment.

Palavras-chave:
Eugenia uniflora *L.; Pitanga; Sensory evaluation; Development of fruit products.*

Resumo

Este trabalho teve como objetivo desenvolver e avaliar a aceitação sensorial de bebidas formuladas com pitanga roxa, e analisar suas características químicas e físico-químicas e propriedades antioxidantes. As bebidas foram formuladas com 15; 25 e 35% de polpa para refresco, néctar e suco tropical, respectivamente. Foram realizadas análises de pH, acidez titulável, sólidos solúveis, açúcares totais e redutores, cor, ácido ascórbico, antocianinas, carotenóides totais, polifenóis extraíveis totais, atividade antioxidante, análises microbiológicas e avaliação sensorial. O refresco, o néctar e o suco tropical diferiram entre si quanto ao teor de ácido ascórbico, carotenóides totais, antocianinas totais, polifenóis extraíveis totais e atividade antioxidante total, sendo os valores maiores observados na bebida com maior concentração de polpa (suco tropical). A avaliação sensorial revelou que o refresco, o néctar e o suco tropical adoçado apresentaram escores médios entre a faixa de aceitação e indiferença para os testes de aceitação e intenção de compra, com maiores notas para o néctar e o refresco.

Keywords:
Eugenia uniflora *L.; Pitanga; Avaliação sensorial; Desenvolvimento de produtos de frutas.*

INTRODUCTION

Eugenia uniflora L. is a member of the Mirtaceae family which is a widely found tree in South American countries, mainly in Brazil, Argentina, Uruguay and Paraguay[1]. This plant is found in homegardens in Brazilian Amazon, being used in food and for medicinal purposes[2]. Pitanga, also known as Brazilian cherry or Suriname cherry, is an outstanding source of ascorbic acid, carotenoids and phenolic compounds, mainly flavonoids, with high antioxidant activities[3,4]. Epidemiological studies have shown that the consumption of fruit and vegetables imparts many health benefits and their antioxidant activities are directly related to slowing of the ageing process[5] and the prevention of diseases such as cancer[6]. Therefore, pitanga is a promising fruit and its pulp production has high economic potential because the product has both consumer appeal and a high concentration of antioxidant compounds[7].

The processing of fruits as juices, purées and other products is an alternative use of production surpluses, therefore enabling the integral use of fruits and avoiding problems related to seasonality[8]. Moreover, the overall aim of processing fruits is to add value to the product and this has been so well accomplished that the market for industrialized fruit products is much larger than that for *in natura* fruits[9].

There is a wide variety of beverages made from fruit pulp, such as nectars, soft drinks, juices and refreshment. According to Brazilian legislation, non-alcoholic fruit beverages are classified using as the main parameter the pulp content, specifying a minimum percentage of fruit pulp in its preparation. The acidity, flavor intensity and content of the pulp are the main parameters that determine the amount of pulp used in the preparation of refreshment, nectars and tropical juices[10]. Several works have addressed the sensorial acceptance of juices prepared with cherries[11,12], however, there are no works in the literature about the acceptance of Brazilian cherry juice.

Given the high perishability of Brazilian cherries and the great consumer demand for tropical fruit beverages, this study aimed to develop and evaluate the sensory acceptability of Brazilian cherry beverages, and analyze their chemical and physicochemical characteristics and antioxidant properties.

MATERIAL AND METHODS

Descrition of fruits and beverages

The fruits used in this experiment were purple Brazilian cherries from the city of Gandu/Bahia, harvested at the mature stage and packed in plastic bags. The fruits were then frozen and transported by air to the laboratory where they were washed and sanitized in hypochlorite solution (100 ppm for 15 minutes). The seed was separated from the pulp with the aid of knives, the pulp was whisked in a domestic centrifuge. Part of the extracted pulp was frozen for later laboratorial analyses.

The beverages were prepared using 35% of pulp for the tropical juice, 25% of pulp for the nectar and 15% of pulp for the refreshment. The soluble solids content was fixed at 11°Brix by adding commercial sucrose. The decision on the content of soluble solids was made based on Brazilian law which establishes a minimum value for tropical juice and Brazilian cherry nectar of 11°Brix, with no reference value for refreshment[13]. After the addition of commercial sucrose, the homogenization of beverages in a household blender was performed for the correction of soluble solids. There were no added flavors in the juice. The beverages were pasteurized at 90°C for 60 seconds, followed by hot filling in glass bottles closed with plastic caps and cooled in an ice bath with chlorinated water with a concentration of 100 ppm, until the final temperature of 37°C was obtained.

Chemical and physicochemical characterization of the pulp and the Brazilian cherry beverages

The pH was determined by direct reading on potentiometer (Digimed, model DMF, NTC). The titratable acidity was determined by titration of the samples with a 0.1 N NaOH solution, using a potentiometer as an indicator of turning as described in the standards of the Adolfo Lutz Institute[13]. The soluble solids content of the samples was determined by direct reading on a refractometer (Atago, model POCKET PAL-1)[13]. The total sugars were determined by the anthrone method using 0.5 mL of purple Brazilian Cherry beverage diluted in 245 mL of water. The quantification of total sugars was performed with the anthrone solution (200 mg of anthrone in 200 mL of sulfuric acid) using glucose as standard solution as described by Yemn and Willis[14] in spectrophotometer (Shimadzu UV-1800), at a wavelength of 620 nm and the reducing sugars were determined according to the technique described by Miller[15] using 3,5 - dinitro salicylic (DNS) and the reading in spectrophotometer (Shimadzu UV-1800) at 540 nm. The color measurements of the samples were evaluated using the CIE L*, a* and b* using a Minolta colorimeter (Chroma Meter-CR 200b, Osaka, Japan) model CR 10, calibrated with white ceramic plate, using illuminant D65. All analyses were performed in triplicate.

Bioactive compounds and antioxidant activity of the pulp and the Brazilian cherry beverages

The ascorbic acid content was determined by Tillman's titration method based on the reduction of the indicator 2,6-dichloro-phenol-indophenol (DFI) according to the methodology described by Strohecker and Henninng[16]. The analysis of anthocyanins was performed according to Francis[17], using the extraction solution of ethanol:HCl 1.5 N (85:15, v/v) and the reading of the absorbance, at 535 nm, was performed in a spectrophotometer (Shimadzu, Model UV-1800).

The total carotenoids content was analyzed according to the methodology described by Higby[18]. For the extraction of total carotenois, 5 mL of purple Brazilian Cherry beverage, 15 mL of isopropyl alcohol and 5 mL of hexane were homogenized on a magnetic stirrer for 1 minute. The aqueous phase was removed and the organic phase containing the carotenoids was filtered through cotton with anhydrous sodium sulfate for a amber volumetric flask of 25 mL, adding 2.5 mL of acetone and measuring the flask with hexane. The reading was performed in a spectrophotometer (Shimadzu, Model UV-1800) at 450 nm. The extract to determine the total extractable polyphenols (TEP) and the antioxidant activity was prepared according to the methodology described by Larrauri et al.[19]. The quantification of TEP was conducted using the Folin-Ciocalteu with the standard curve prepared with gallic acid, according to methodology described by Obanda and Owuor[20]. The reading was performed in a spectrophotometer (Shimadzu, Model UV-1800) at 700 nm. The total antioxidant activity was determined by 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS•+) free radical, using a standard curve of trolox 2 mM solution according to the methodology described by Re et al.[21]. The reading was performed in a spectrophotometer (Shimadzu, Model UV-1800) at 734 nm.

Microbiological analyses

The beverages prepared with the purple Brazilian cherry pulp were analyzed for coliforms at 45°C, *Salmonella*, molds and yeasts, according to the methodology recommended by Apha[22]. The results of the analysis of coliforms were visualized in a table of most probable number (MPN) and are expressed in MPN.mL^{-1}. For *Salmonella*, molds and yeast, the results were expressed as colony forming unit (CFU) per milliliter of sample.

Sensory evaluation

The beverages were subjected to sensory evaluation by 60 panelists. The panelists answered a questionnaire about the frequency of their consumption of fruit juice, and the frequency of consumption of pitanga juice. The samples were presented in individual cabins, in monadic randomized form, in plastic cups coded with three digits, with approximately 25 mL of the beverage at refrigeration temperature (4 ± 1°C). The evaluations were performed using a structured hedonic scale of nine points ranging from 1 - extremely dislike to 9 - extremely like and by testing the consumer's purchase intention[23]. The attributes evaluated were color, appearance, aroma, sweetness, flavor, overall impression and purchase intent. The sensory evaluation of products was approved by the *Comitê de Ética em Pesquisa* (COMEPE) of the *Universidade Federal do Ceará*, with Protocol number 232/11. The procedures used in this experiment were in accordance with the ethical standard of COMEPE.

Statistical Analysis

The experiment was conducted with three replications and the data obtained from the chemical, physicochemical and sensory analysis were subjected to analysis of variance (ANOVA) and Tukey's test for comparison of means at 5% probability ($p \leq 0{,}05$), using the statistical program SAS version 9.1.

RESULTS AND DISCUSSION

Analyses of the purple Brazilian cherry pulp

The purple Brazilian cherry pulp had low pH values (3.08 ± 0.01) (Table 1) lying within the range established by the Brazilian law for this fruit, which establishes values ranging from 2.5 to 3.4[10]. Bagetti et al.[24] evaluated the physicochemical characteristics of Brazilian cherries from Rio Grande do Sul and observed pH values of 3.38.

Table 1 — Results of chemical and physicochemical analysis of the purple Brazilian cherry pulp (n=4)

Characteristics		Average ± standard deviation
pH		3.08 ± 0.01
Titratable acidity (g citric acid 100 mL-1 of pulp)		2.09 ± 0.03
Soluble solids (°Brix)		10.0 ± 0.26
Total sugar (g 100 mL-1)		9.03 ± 0.39
Reducing sugar (g 100 mL-1)		7.40 ± 0.23
	L*	30.00 ± 1.43
Color	**a***	3.57 ± 1.54
	b*	1.78 ± 0.57

The titratable acidity observed in the Brazilian cherry pulp was quite high (2.09 ± 0.03 g citric acid 100 mL^{-1} of pulp) (Table 1), with values within those established by law, which requires a minimum of 0.92 g citric acid 100 mL^{-1}, and there is no maximum value for this variable. Prado[25] and Santos et al.[26] observed values below those of the present study, finding averages of titatrable acidity of 1.24 and 1.57 g citric acid 100 mL^{-1} in the red Brazilian cherry pulp, respectively. The difference between the present study and the other studies may be due to cultivation conditions and the variety of Brazilian cherry studied.

The soluble solid values found in the present study are within the ranges required by Brazilian law which establishes a minimum of 6°Brix for Brazilian cherry pulp[10]. Dias[27], evaluating 50 genotypes of Brazilian cherry tree in the city of Bahia, obtained values of this variable ranging from 9 to 15.3°Brix. The differences found in this determination can be explained by the influence of climatic and geographical conditions on the chemical composition of fruits from different regions.

Brazilian cherry pulp presented values of total and reducing sugars of 9.03% ± 0.39 and 7.40 ± 0.23 g 100 mL^{-1}, respectively. Dias[27] obtained a percentage of total sugars higher than that found in the present study (8.41 g 100 mL^{-1}), and a lower percentage of reducing sugars (4.71 g 100 mL^{-1}). The differences between the results may be related to different genotypes, ripeness and environmental conditions of the location where the fruits were farmed.

The L* parameter measures the brightness of the sample, ranging from 0 for black to 100 for white. L* values close to 0 indicate darker, while values close to 100 indicate lighter color. Positive values of the coordinate a* measure the degree of red, while negative values measure the degree of green color. The positive b* parameter is a measure of the yellow and negative values of b* is a measure of blue. In the purple Brazilian cherry pulp values of L*, a* and b* of 30.00 ± 1.43, 3.57 ± 1.54 and 1.78 ± 0.57, respectively, were observed (Table 1), featuring a fruit dark red in color with little presence of yellow color. Lopes et al.[28] analyzing the red Brazilian cherry from the city of Valinhos/Sao Paulo, found a value for the parameter L* of 37.54, close to this particular study. However, the values obtained by the same authors for a* and b* parameters were well above, with 20.67 and 15.62 for the parameters a* and b*, respectively. The results obtained in the present study can be explained by the influence of geographical differences on the coloration, as the fruit used in this study was from a different region and climate.

Ascorbic acid is a water soluble nutrient involved in many biological functions, possessing antioxidant activity[29] and anti-cancer action[30]. Brazilian cherry pulp had ascorbic acid content of 41.20 ± 0.35 mg 100 mL^{-1} (Table 2). This result is relatively low compared to other tropical fruits such as acerola and guava that have values of 1191.9 and 175.5 mg 100 mL^{-1}, respectively, depending on the variety and growing conditions[31,32]. However, the Brazilian cherry provides ascorbic acid near to the recommended daily intake (RDI) for an adult which is 45 mg, based on a 2000 calorie diet[33].

Table 2 — Bioactive compounds and antioxidant activity of the purple Brazilian cherry pulp (n=4)

Characteristics	Average ± standard deviation
Ascorbic acid (mg 100 mL^{-1})	41.20±0.35
Total anthocyanins (mg 100 mL^{-1})	32.40±0.34
Total carotenoids (mg 100 mL^{-1})	1.26±0.34
Total extractable polyphenols (mg GA 100 mL^{-1})	449.81± 38.56
ABTS$^{\bullet +}$ (μMtrolox mL^{-1})	17.55 ± 3.38

The values found in this study for ascorbic acid are similar to those observed by Santos et al.[26], who obtained a content of 38.35 mg 100 mL^{-1} in the Brazilian cherry. Oliveira et al.[34] obtained values of ascorbic acid in the purple Brazilian cherry pulp lower than those found in the present study, with 13.42 mg 100 mL^{-1}. Variations in ascorbic acid can be explained by several factors such as climate and cultivation, harvest, handling and processing, among others.

Anthocyanins are the pigments responsible for the color of many fruits, with colors ranging from purple to orange, and are the pigments responsible for the color of the purple Brazilian cherry. The purple Brazilian cherry pulp presented an anthocyanin content of 32.40 ± 0.34 mg 100 mL^{-1}(Table 2). Lower values than those found in this work were reported by Lima et al.[35] who evaluated the stability of anthocyanins in Brazilian cherry, which initially had 16.23 mg 100 mL^{-1} and after 35 days this value decreased to 8.78 mg.100 mL^{-1} for extracts exposed to light and 10.01 mg 100 mL^{-1} for extracts protected from light. Teixeira et al.[36], quantified the total anthocyanins in several fruits, obtained values close to those found in the present study for açai (*Euterpe oleracea*) (21.63 mg 100 mL^{-1}) and higher values for jabuticaba (*Plinia cauliflora*) (641.01 mg 100 mL^{-1}).

Carotenoids are natural pigments that contribute to the color of many fruits and vegetables. The average of total carotenoids found in the present study was 1.26 ± 0.34 mg 100 mL^{-1} (Table 2). Jacques et al.[4] observed values of carotenoids of 9 mg 100 mL^{-1} in Brazilian cherry pulp.

In Brazilian cherry pulp a TEP content of 449.81 ± 38.56 mg of galic acid (GA) 100 mL^{-1} (Table 2) was observed, similar to that observed by Bagetti et al.[24] (463 mg GA 100 mL^{-1}) and by Jaques et al.[4] (420.8 mg GA 100 mL-1).

The total antioxidant activity of the purple Brazilian cherry pulp was 17.55 ± 3.38 μM trolox mL^{-1} (Table 2). This antioxidant activity is possibly related to the high concentration of phenolic compounds and ascorbic acid. According to Pereira[37], there is a direct correlation between antioxidant activity and total phenolic compounds, considered to be the most representative bioactive compounds with antioxidant activity. Prado[25], evaluating the antioxidant potential of tropical fruits, noted that the red Brazilian cherry pulp has a value of total antioxidant activity, as found by ABTS$^{\bullet +}$ method, higher than that found in guava, passion fruit, mango, pineapple and melon.

Analysis of beverages prepared with the purple Brazilian cherry pulp

The pH values determined in the present study for the refreshment (3.11), nectar (3.05) and tropical juice (3.04) were low (Table 3), contributing to the stability of the product, since the pH of the drinks becomes a limiting factor for the growth of pathogenic and deteriorative microorganisms. The significant difference ($p<0.05$) observed among the three types of beverages is due to the different amounts of pulp used which directly influence the amount of organic acid present in the beverage. Thus, the highest pH is observed in the beverage with the smallest amounts of pulp.

Table 3 — Chemical and physicochemical properties of tropical juice, nectar and refreshment prepared with the purple Brazilian cherry pulp (n=4)

Beverages	pH	Titratable acidity (g citric acid 100 mL^{-1})	Total sugar (g 100 mL^{-1})	Reducing sugars (g 100 mL-1)	Color		
					L*	a*	b*
Tropical juice	3.04 ± 0.01^{c}	0.50 ± 0.03 ^{a}	11.06 ± 0.44^{b}	3.02 ± 0.09^{a}	33.15 ± 0.79^{b}	33.15 ± 0.79^{b}	3.15 ± 0.61^{b}
Nectar	3.05 ± 0.01^{b}	0.40 ± 0.02^{b}	11.29 ± 0.21^{ab}	2.02 ± 0.06^{b}	33.63 ± 0.50^{b}	33.63 ± 0.50^{b}	3.33 ± 0.67^{b}
Refreshment	3.11 ± 0.01^{a}	0.30 ± 0.00^{c}	11.57 ± 0.23^{a}	1.29 ± 0.10^{c}	37.93 ± 1.66^{a}	37.93 ± 1.66^{a}	6.42 ± 0.72^{a}

* Means followed by different letters in the same column are statistically differ ($p < 0.05$) by the Tukey test.

With regard to the pH, there was a significant difference ($p<0.05$) between the three formulated beverages in terms of the titratable acidity (Table 3). The highest value was observed in tropical juice (the beverage formulated with higher pulp content). These results are consistent with those observed in pH where a higher titratable acidity causes a greater reduction in pH value. According to the Standards of Identity and Quality, the tropical juice and the nectar are within the standards established by legislation which requires minimum values of 0.30 and 0.20 g of citric acid 100 mL^{-1}, respectively[13].

Regarding the total sugar content, the refreshment had the highest percentage (11.57 g 100 mL^{-1}), followed by the nectar (11.29 g 100 mL^{-1}) and tropical juice (11.06 g 100 mL^{-1}) (Table 3), which can be explained by the higher commercial sucrose adding to the °Brix correction in the beverage with lower content of pulp. The minimum values of total sugars established by law are 6.0 and 7.0 g 100 mL^{-1} for nectar and tropical juice, respectively[13], meaning that the beverages prepared in this study are in accordance with the current legislation.

The beverages had low values of reducing sugars compared with the pulp (7.4 g 100 mL^{-1}). This result was due to the dilution of the pulp in the formulation of beverages, as shown by the fact that the highest content of reducing sugar is in tropical juice, the product with the highest concentration of pulp.

The parameters L*, a* and b* of refreshment significantly differ ($p<0.05$) from the results from nectar and tropical juice. The highest value found for the L* parameter was observed for refreshment, which showed 37.93 of brightness, as can be seen in Table 3. This fact can be explained by dilution in water in the preparation of the beverages, causing a higher luminosity. The highest values of the a* parameter (red) relative to the b* parameter (yellow) indicates a predominance of red coloration in nectar and tropical juice. The proximity of these two parameters and the value of a significantly higher b* ($p < 0.05$) shows a tendency for the refreshment to have an orange color compared to the other beverages.

For all the bioactive compounds studied and the antioxidant activity, a significant difference ($p<0.05$) was observed between the three types of beverages studied, with the highest values observed in the tropical juice, which can be explained by the higher content of pulp present in this formulation.

The ascorbic acid was highest in tropical juice (15.83 mg 100 mL^{-1}) (Table 4), as was expected, due to the highest concentration of pulp (35%) used in this formulation. A 200 mL portion of the prepared beverages provides a significant amount of ascorbic acid since the RDI for an adult is 45 mg[33].

Table 4 — Ascorbic acid (AA), total anthocyanins (Anthoc.), total carotenoids (TC), total extractable polyphenols (TEP) and antioxidant activity of the tropical juice, nectar and refreshment prepared with the purple Brazilian cherry pulp (n=4)

Beverages	AA (mg 100 mL^{-1})	Anthoc. (mg 100 mL^{-1})	TC (mg 100 mL^{-1})	TEP (mg GA 100 mL^{-1})	ABTS$^{\bullet+}$(μM trolox mL^{-1})
Tropical juice	15.83 ± 0.10^{a}	11.91 ± 1.10^{a}	0.58 ± 0.09^{a}	169.62 ± 11.96^{a}	7.23 ± 1.16^{a}
Nectar	8.07 ± 0.05^{b}	6.06 ± 0.72^{b}	0.36 ± 0.02^{b}	120.02 ± 7.31^{b}	4.85 ± 0.37^{b}
Refreshment	4.80 ± 0.00^{c}	4.55 ± 0.67^{c}	0.27 ± 0.03^{c}	80.45 ± 8.75^{c}	3.61 ± 0.17^{c}

* Means followed by different letters in the same column are statistically differ ($p < 0.05$) by the Tukey test.

The total anthocyanin content observed in the tropical juice, nectar and refreshment were 11.91, 6.06 and 4.55 mg 100 mL^{-1}, respectively (Table 4). In the study of the stability of carotenoids, anthocyanins and vitamin C in acerola tropical juice, Freitas et al.[38] obtained lower values of anthocyanins than those in the present study, with values of 0.61 mg 100 mL^{-1} for acerola tropical juice packaged by the aseptic process and 0.41 mg 100 mL^{-1} for the hot fill process.

The total carotenoids was 0.58 mg 100 mL^{-1} for tropical juice, 0.36 mg 100 mL^{-1} for nectar and 0.27 mg 100 mL^{-1} for refreshment (Table 4).

The TEP content was 169.62, 120.02 and 80.45 mg GA 100 mL^{-1} for tropical juice, nectar and refreshment, respectively (Table 4). Araújo et al.[39], in a study on the influence of freezing on the antioxidant potential of blackberry (*Rubus fruticosus*) nectar (an excellent source of phenolic compounds), obtained values of total extractable polyphenols higher than those found in this study for the three types of beverages, with levels of about 190 mg GA 100 mL^{-1} during frozen storage.

For the ABTS•+ test, tropical juice had 7.23 μM trolox mL^{-1}, while nectar and refreshment showed 4.85 and 3.61 μM trolox mL^{-1}, respectively. The antioxidant activity increased according to the higher pulp content of the formulations, which led to a higher content of total extractable polyphenols. Therefore, the tropical juice, the beverage with the highest pulp concentration (35%), had the highest TEP content and consequently the highest total antioxidant activity. Araújo et al.[39] studying the correlation between the main bioactive compounds and antioxidant activity of blackberry nectar, observed a significant correlation ($p<0.05$) between the total phenolics (0.78), total anthocyanins (0.69) and ascorbic acid (0.78) with the antioxidant activity of this nectar.

Microbiological analysis

The microbiological analysis of tropical juice, nectar and refreshment prepared with the purple Brazilian cherry pulp were within the quality control standards required by law (Table 5)40. The low count observed, can be explained by the sanitary conditions in which the juice was prepared and the low pH and high acidity of the beverages, factors that restrict the growth of microorganisms.

Table 5 — Results from the microbiological analysis from the purple Brazilian cherry beverages

Beverages	Salmonella sp.	Mold and Yest (CFU/mL)**	Coliforms at 45ºC (MPN/mL)***
Tropical juice	Absence*	<10	<1,0
Nectar	Absence*	<10	<1,0
Refreshment	Absence*	<10	<1,0

* Absence in 25 mL. **CFU: Colony Forming Units. ***MPN: Most Provable Number.

Sensory evaluation

Of the 60 panelists, 48 were female and 12 male. Most of the panelists (73%) belonged to the group age of 18-25 years old which can be explained by the fact that the sensory analysis was performed at a university, where most of the panelists were students of the institution. Twenty percent of the panelists belonged to the 26-30 year old age group, 5% to the 35-50 year age group and 2% were above 50 years old. Forty four percent of the panelists indicated that they consume fruit juices daily and 33.9% consume them two or three times per week, demonstrating a good dietary habit in relation to the consumption of juices. Regarding the frequency of consumption of Brazilian cherry juice or nectar, 84% of panelists reported never having consumed it. This was expected because the Brazilian cherry is not a very common fruit in the state of Ceará. Most of the consumers (69%) responded that they like fruit juice. Among the panelists who participated in this study, 65% said that they neither like nor dislike Brazilian cherry juice. This statement is possibly due to the limited availability of this fruit in the local market, making their access to this fruit limited, which could also explain the high percentage (84%) of panelists who had never tasted Brazilian cherry juice.

The mean scores obtained for the color and appearance attributes of the tropical juice, nectar and refreshment were around 6 to 7 (slightly like to moderately like) and are, therefore, in the zone of acceptance. As for the aroma and flavor, the mean scores were among the categories 5-6 (neither liked/disliked or slightly liked) (Table 6).

Table 6 — Mean scores for sensory attributes (color, appearance, aroma, sweetness, flavor and overall impression) evaluated for the purple Brazilian cherry beverages (n=4)

Beverages	Color	Appearance	Aroma	Sweetness	Flavor	Overall impression
Tropical juice	7.10 ± 1.92^a	7.03 ± 1.67^a	5.75 ± 1.96^a	5.37 ± 2.46^b	5.38 ± 2.34^b	5.80 ± 2.19^b
Nectar	7.12 ± 1.53^a	7.03 ± 1.42^a	5.77 ± 1.83^a	6.17 ± 1.85^a	$5.92 \pm 1.92a^b$	6.42 ± 1.62^a
Refreshment	6.50 ± 1.85^a	6.68 ± 1.79^a	5.78 ± 1.85^a	6.35 ± 2.01^a	6.28 ± 2.03^a	6.38 ± 1.78^a

* Means followed by different letters in the same column are statistically differ ($p < 0.05$) by the Tukey test.

Botaro et al.[41], when developing a beverage formulated with tropical juice and aqueous extract of white lupine (*Lupinusalbus* L.), obtained grades similar to those determined in this study for the tropical juice with regard to the appearance attributes (6.14), aroma (5.75), flavor (5.61) and overall impression (5.70), and appearance was the attribute with the best sensory acceptance, probably due to the contribution of the color of Brazilian cherry to the beverage.

Related to sweetness, the refreshment and the nectar did not significantly differ ($p>0.05$) from each other, but they differed from the tropical juice ($p<0.05$), probably due to the higher content of soluble solids and lower titratable acidity that conferred an increased perception of sweetness to the beverages on the part of the panelists.

For the aroma attribute, there was a significant difference ($p<0.05$) between the refreshment and the tropical juice. The nectar did not significantly differ ($p>0.05$) from the refreshment and the tropical juice, probably because it has an intermediate content of pulp compared to the other drinks. These differences are possibly due to the higher acidity in tropical juice, which masks the sweetness, changing the flavor. The lowest scores for tropical juice related to the sweetness and flavor, and these may be related to the preference of the panelists for sweeter drinks.

Lopes et al.[28] evaluated the sensory acceptance of nectars produced with the red Brazilian cherry pulp (20°Brix and 50% of pulp) and obtained an average score of 6.49 for the attribute appearance, 6.5 for aroma and 6.28 for flavor, demonstrating good acceptance in relation to nectar with high pulp content. The average for the aroma attribute was close to that observed in this study for the refreshment, the product with the best acceptance and the lowest pulp content, and higher than the averages given for nectar and tropical juice.

In relation to purchase intention, there was a distribution of marks in the frequency histogram, where 50% of the panelists claimed that they definitely or probably would buy the refreshment of purple Brazilian cherry (18.33% certainly buy and 32% probably buy). In relation to the nectar and tropical juice, purchase intent was lower than that for refreshment. For nectar, approximately 48% of the panelists gave scores within the acceptable range (15% of the panelists said they certainly would buy and 33% probably buy). For tropical juice, the scores were well distributed, with 23.33% of the panelists certainly buying and 20% probably buying, resulting in an acceptance of 43.66%.18.33% had doubts about buying and 38 33% of the panelists gave scores in the rejection region, with 20% probably not buying and 18.33% certainly not buying. The lowest purchase intention was observed for tropical juice, this result may be related to the rejection noted for the attributes flavor and sweetness of this beverage, since the refreshment, a product with the highest percentage of purchase intent, also obtained the highest acceptance percentage regarding the taste and sweetness attributes.

CONCLUSION

The purple Brazilian cherry pulp, as well as the nectar and the tropical juice, presented chemical and physicochemical characteristics according to the standards required by the Brazilian legislation, which measures values of titratable acidity and reducing sugars ranging according to the pulp content in each beverage.

In the purple Brazilian cherry pulp appreciable amounts of the bioactive compounds: ascorbic acid, anthocyanins, carotenoids and total extractable polyphenols were observed, which probably contributed to the high antioxidant activity.

Among the beverages analyzed, tropical juice showed the highest antioxidant compound contents and antioxidant activity due to the largest quantity of pulp in its formulation.

Regarding the sensory evaluation, the refreshment, nectar and tropical juice obtained mean scores between the range of acceptance and indifference to the acceptance testing and purchase intent. The refreshment, nectar and tropical juice had highest values for the color and appearance attributes. The refreshment had the highest percentage in relation to purchase intention, which may be attributed to the influence of flavor and sweetness.

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