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Fermented milk drink flavored with Murici pulp added of passion fruit bark flour

Gabriela Vieira Leal Couto[1], Marco Antônio Pereira da Silva[1], Hemilaine Campos Pádua[1], Diene Gonçalves Souza[1], Ligia Campos de Moura[1], Geovana Rocha Plácido[1], Márcio Caliari[2], Maria Siqueira de Lima[1], Luiz Eduardo Costa do Nascimento[1], Nayane Matias Silva[1], Bheatriz Silva Morais de Freitas[1]

[1]Instituto Federal Goiano Campus Rio Verde – Brazil.
[2]Universidade Federal de Goias – Brazil.

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This study aimed to evaluate the physicochemical parameters, antioxidant activity, color and sensory profile of fermented milk drink with murici and passion fruit bark flour (FCM). Four milk drink formulations were processed: 0% FCM + 5% murici pulp (Treatment 1 - control); 0.5% FCM + 5% murici pulp (Treatment 2); 1.0% FCM + 5% murici pulp (Treatment 3) and 1.5% FCM + 5% murici pulp (Treatment 4). The scanning electron microscopy (SEM) of FCM presented quite irregular particles and the presence of starch of circular shape and fibrous compounds connected to fragmented walls. After the analyses of milk drinks, a slight decrease in the mean pH values and an increase in the antioxidant activity according to the increase in FCM content in milk drinks were observed. The color of milk drinks tended to yellow and red in samples added of FCM due to the presence of carotenoids. In the sensory profile, the highest mean value was for the texture of yogurt without addition of FCM, and the lowest mean value was for taste of yogurt with 1.50% FCM.

Key words: *Byrsonima crassifolia* (L.) Rich.), *Passiflora edulis* Sims, functional drinks.

INTRODUCTION

Murici (*Byrsonima ssp.*) is a fruit from the Brazilian cerrado usually consumed fresh. When mature, the fruit is yellowish and smells like rancid cheese (Rezende et al., 2003). The pulp is soft and fleshy (Alves et al., 2003) and can be used to develop new products such as fermented drinks.

Functional foods provide additional benefits to consumers, reduce the risk of diseases and improve diet with the intake of substances whose beneficial effect is not obtained through usual diet (Palanca et al., 2006). Due to the benefits in the digestive process, recommendations for the intake of dietary fiber have increased in recent years; however, there are few studies on the application of these fibers, especially when they come from agro-industrial wastes (Miranda et al., 2013).

Many agro-industrial wastes that may have bioactive characteristics, due to their low popularity and little knowledge on commercial applications, have not received much attention as a source of natural antioxidants. Nevertheless, these still unexplored sources result in

E-mail: marcotonyrv@yahoo.com.br, Tel. (64) 3620-5637.

many benefits to human health, where wastes can be turned into new products (Dimitrios, 2006). Among these wastes, passion fruit bark reduces cholesterol levels and blood glucose and improves the performance of the gastrointestinal system, besides being a source of protein and fiber (Cordova et al., 2005).

The aim of this study was to develop milk drink formulations added of murici pulp and different passion fruit bark flour concentrations in order to add value to this waste and improve the functional qualities of the milk drink by increasing the fiber content. The study also assessed the best formulation and product acceptance by sensory analysis, as well as the physicochemical characteristics and antioxidant activity of the proposed formulations.

MATERIAL AND METHODS

Murici pulp

Fruits (Figure 1) were collected at Fazenda Gameleira, municipality of Montes Claros de Goiás, Brazil, located at 16°07 'S and 51 18' W, altitude of 592 m and transported to the Laboratory of Fruits and Vegetables, Federal Institute of Goiás, Rio Verde Campus. Fruits were washed, sanitized and selected according to the degree of maturation homogeneity. Subsequently, fruits were manually pulped to obtain whole pulp, packed in polyethylene bags, identified by labeling and stored at -18°C for later use. The experiment received positive opinion for execution under protocol number 020/2013.

Passion fruit bark flour

For drying of passion fruit bark, 1 kg of previously ground bark was used. Drying was carried out by positioning the tray with dimensions of 800 mm x 600 mm at the central region of the drying oven with air circulating and renewal model MA 035 Marconi® at temperature of 60°C and air flow of 7.728 kg / m^2.s. After drying, passion fruit bark flour was obtained by three millings in Diogomaq® multi-purpose grinder and conditioned at room temperature in low density polyethylene bags for later use.

Fermented milk drinks

Two and a half liters of milk base were used for each formulation (30% skimmed milk serum and 70% whole milk) with addition of 10% sucrose, followed by submitting the mixture to pasteurization heat treatment at temperature of 90°C for 3 min, followed by lowering the temperature to 42°C, with subsequent addition of starter cultures composed of *Streptococcus Thermophilus, Lactobacillus Acidophilus* and *Bifidobacterium Lactis*.

Milk drink samples were incubated in an oven (BOD Quimis® Model Q-315d) at temperature of 42°C until pH reached 4.5. After coagulation, the oven temperature was readjusted to 20°C and clot was broken using a glass rod in a circular motion for 1 min. After temperature stabilization, thawed murici pulp pasteurized at 75°C for 15 s at concentration of 5% was added.

Four formulations of milk drink flavored with murici and added of passion fruit bark flour (FCM) were developed according to the following treatments: Treatment 1 - Milk drink flavored with murici without the addition of passion fruit bark flour (control); Treatment 2 - Milk drink flavored with murici plus 0.50% passion fruit bark flour; Treatment 3 - Milk drink flavored with murici plus 1% passion fruit bark flour and Tr7eatment 4 - Milk drink flavored with murici plus 1.50% passion fruit bark flour.

After addition the FCM, milk drink samples were filled into aseptic and identified polypropylene packages exposed in a laminar flow hood under ultraviolet light (UV) for 30 to 45 min followed by filling. Immediately, samples were stored under refrigeration at 4°C ± 1°C.

Analyses

The analyses of mineral macro and micronutrients of passion fruit bark flour were carried out at the Solocria Agricultural Laboratory located in Goiânia - Goiás, Brazil. Nitrogen was analyzed by distillation and complexation with boric acid with mixed indicator (bromocresol green + methyl red) and subsequent titration with 0.025 mol / L H_2SO_4 (sulfuric acid).

Phosphorus was analyzed by digestion of sample (FCM) with nitropercloric mixture and determination by colorimetry with Ammonium Molybdate and Ascorbic Acid. Potassium was analyzed by digestion of sample (FCM) with nitropercloric mixture and determination by flame photometry. Calcium, magnesium and micronutrients (Cu, Fe, Mn, Zn, Co, Mo) were analyzed by digestion of sample with nitropercloric mixture and elements were determined by atomic absorption. Finally, for boron determination, the sample was incinerated at 550°C for two hours in a muffle furnace. The residue was dissolved with 1: 3 HCl and the element was determined by colorimetry with Azomethine-H.

For physical assessment of murici pulp, dehydration was performed with sample previously frozen in freeze dryer - model enterprise (Terroni®). Lyophilized murici pulp and passion fruit bark flour were analyzed in a scanning electron microscope, Jeol, JSM-6610, equipped with EDS, ThermoScientific NSS SpectralImaging. The antioxidant activity of murici pulp and four types of treatments of milk drink flavored with murici and added of FCM was determined by the capacity to scavenge the DPPH free radical, according to methodology described by Rufino et al. (2007).

pH was measured using digital bench potentiometer - model LUCA® - 210P. The electrode was inserted in murici pulp samples and in milk drinks after homogenization without touching the bottom or sides of the package and thus reading was carried out. Three points in each pot were analyzed, corresponding to three replicates of each treatment. For titration of murici pulp, 10 g of sample were added to 100 ml of distilled water, the mixture was then filtered. Shortly after, four drops of 1% phenolphthalein solution was added to the filtrate and the mixture was titrated with 0.1 N sodium hydroxide solution up to the appearance of persistent pink color for about 30 seconds (Brazil, 2006). Acidity was determined in triplicate according to the following equation, and expressed as lactic acid percentage: lactic acid (%) = ((V x f x 0.9)/m), where: V = volume of 0.1 N sodium hydroxide solution used in the titration, in ml, f = correction factor of the 0.1 N sodium hydroxide solution; m = sample weight in grams.

The determination of total soluble solids of murici pulp was performed by direct reading in manual refractometer (ATAGO®) and expressed in °Brix. The results represent the average of three readings. The dry matter of passion fruit bark flour was determined by the difference between 100 and the moisture that was calculated according to AOAC method No. 925.09 (2000) up to obtaining constant weight. The analysis of the ether extract of passion fruit bark flour was performed according to AOAC method No. 925.38 (2000). The water activity (Aw) of passion fruit bark flour was determined in AqcuaLab device, CX-2, Washington, USA, at constant temperature (24±1°C).

The moisture contents in murici pulp, passion fruit bark flour and milk drinks were determined using an oven with forced air circulation. About 5 g of sample were weighted in previously dried and tared crucibles. Drying was carried out according to

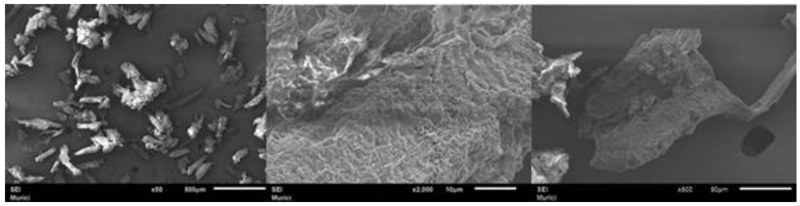

Figure 1. Scanning electron microscopy of lyophilized Murici pulp used in the processing of fermented milk drinks flavored with Murici (*Byrsonimacrassifolia* (L.) Rich.) added of passion fruit bark flour.

methodology proposed by AOAC (1995) for a period of 24 h at 105°C. The dry matter content of passion fruit bark flour was calculated by the difference between 100 and the moisture content.

The samples used for analysis of moisture in murici pulp, passion fruit bark flour and the different milk drink treatments were also used for the analysis of ashes. Ashes were determined by the total carbonization of the organic matter in a muffle furnace (Bravac, M2) at 550°C for about 10 h or until clear ashes are obtained as described in paragraph of AOAC 923.03 official method (1995).

For the crude protein analysis, total nitrogen was determined by micro-Kjeldahl method for murici pulp, passion fruit bark flour and milk drink treatments according to the AOAC International official method No. 960.52 (1995). Total nitrogen was converted into crude protein using factor 6.25 for the murici pulp and passion fruit bark flour. For milk drinks, factor 6.38 was used.

Fat was assessed using the Gerber method by placing 10 ml of sulfuric acid (density 1.820), 11 ml of milk drink and 1 ml of amyl alcohol in a butyrometer. The butyrometer was sealed with appropriate stopper. The mixture was placed in a Gerber centrifuge for five minutes at 1200 rpm. After this time, the butyrometer was transferred to a water bath at 65°C for 5 to 7 min with stopper down, and then, holding the stopper down, the fat layer was allocated within the butyrometer scale and the reading was taken in the inner part of the meniscus. The reading results directly indicated the fat percentage, and the analysis was performed in triplicate. The carbohydrate content of milk drinks was estimated by difference, subtracting values obtained for moisture, ash, protein and fat from one hundred.

Instrumental color parameters (L*, a* and b*) of milk drink and passion fruit bark flour samples were analyzed in HunterLab colorimeter model Color Flex EZ at the Laboratory of Postharvest of Plant Products, Federal Institute of Goiás, Rio Verde *Campus*, GO, Brazil. These parameters were used to determine the color indices: Hue angle, which is indicative of hue and chroma and define color intensity. Nine results were analyzed per treatment.

Texture was evaluated in Brookfield texturometer model CT3 Texture Analyzer for the following parameters: compression test, probe tip TA4 / 100, distance 50%, trigger load of 5 g, speed of 1mm / s. All milk drink treatments were analyzed in triplicate, with readings at 1, 8, 15, 22 and 29 days of storage. Samples were removed from the refrigerator moments before the test so that there was no change in results. Data were collected through the Texture Expert software for Windows software - version 1.20 (Stable Micro Systems). Hardness and adhesiveness parameters were used for assessing the results, which represent the average of three readings for each formulation.

The evaluation of the sensory characteristics was conducted in order to quantify the consumer preference for different types of milk drinks flavored with murici pulp and added of FCM, as well as the purchase intent. Sensory analyses were performed with students, teachers and servers of the Federal Institute of Goiás, Rio Verde Campus, GO, Brazil. To perform the sensory analysis, 50 untrained panelists composed the evaluation team. Four milk drink formulations added of murici were sensorially evaluated: without FCM (control) and with the addition of 0.5%, 1% and 1.5% passion fruit bark flour.

The model adopted for sensory analysis was the acceptance test for the comparison of milk drinks with different passion fruit bark flour concentrations. Sensory evaluation was based on scores given by judges through a 9-point hedonic scale, where value one (1) represents" disliked extremely" and nine (9) "liked extremely", in which overall impression (color), flavor, aroma and texture were judged. Along with the global aspect of products, the purchase intent of panelists on each of the samples was analyzed with a 5-point hedonic scale, where one (1) represented "certainly would not buy" and five (5) represented "I would definitely buy" (Ial, 2005).

Sensory analysis was performed in individual booths at the Laboratory of Sensory Analysis, Federal Institute of Goiás, Rio Verde Campus, GO, Brazil. The four samples were coded with three-digit numbers and delivered under white light in 50 ml white cups to each of the panelists. The amount of samples served was the same, about 20 mL, aiming not to influence their opinion. Milk drink samples were presented to panelists at temperature of approximately 6°C in a balanced and randomized form.

Statistical analysis

Graphs have been presented through the Microsoft Office Excel software version 2007. The SISVAR software (Ferreira, 2010) was used for the mean comparison tests.

RESULTS AND DISCUSSION

The quantitative analysis of macro and micronutrients of passion fruit bark flour is shown in Table 1. The mineral detected in greatest amount was potassium, with 2.80 g / 100 g. This mineral is attributed antihypertensive effect by inducing loss of sodium and water by the body, increasing the secretion of prostaglandins and reducing vascular resistance (Tomazoni and Siviero, 2009).

Santos et al. (2008) characterized macro and micronutrients in passion fruit bark (*Passiflora nitida*) and observed similar values for sodium and manganese, with average values of 103 mg / kg and 15.80 mg / kg respectively; however, the macronutrient contents (Ca = 2.35 g / Kg, P = 0.83 g / kg, N = 16.92 g / kg, K = 23.98 g / kg Mg = 1.01 g / kg, and S = 5.29 g / kg) were higher than those of passion fruit variety of this study (Table 1). SEM aims to analyze the sizes and shapes of crystalline and amorphous, inorganic and biological structures of a sample. Figures 2 and 3 show the scanning electron

Table 1. Values of macro and micronutrients present in passion fruit bark flour used in the processing of fermented milk drinks flavored with murici and passion fruit bark flour (*Byrsonimacrassifolia* (L.) Rich.).

Parameters	Value	Unit
Calcium	0.34	g/kg
Phosphorus	0.18	
Nitrogen	1.50	
Potassium	2.80	
Magnesium	0.10	
Sulfur	0.15	
Sodium	102.00	mg/kg
Copper	1.00	
Iron	210.00	
Manganese	19.00	
Zinc	43.00	
Cobalt	0.16	
Molybdenum	0.60	
Boron	91.00	

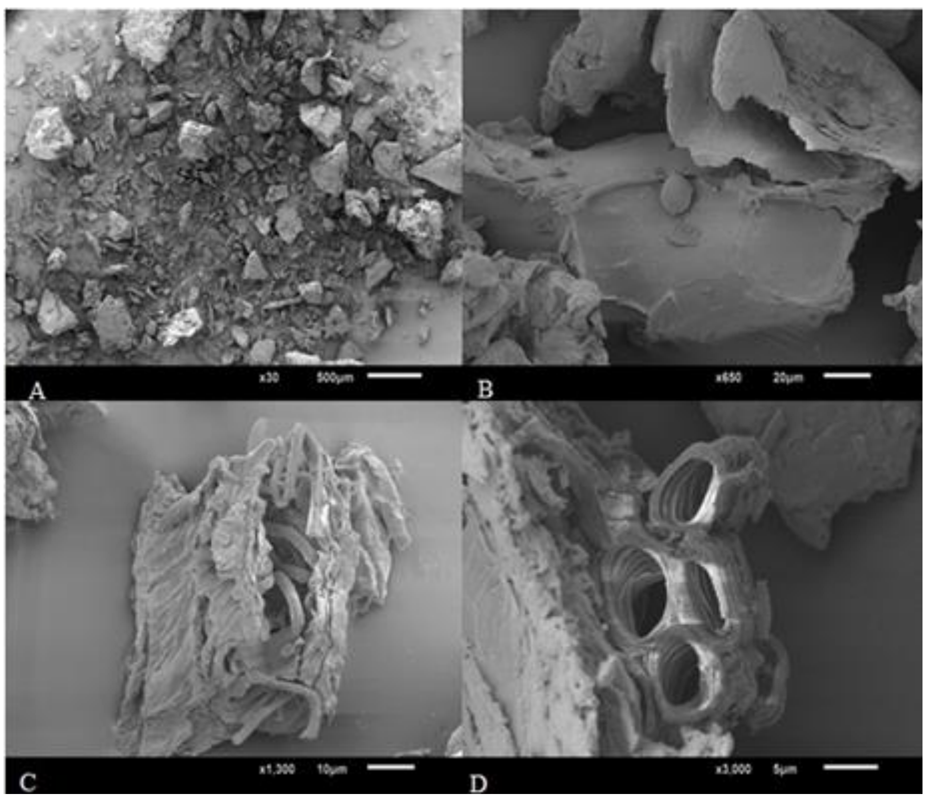

Figure 2. Scanning electron microscopy of passion fruit bark flour used in the processing of fermented milk drinks flavored with Murici (*Byrsonimacrassifolia* (L.) Rich.) added of passion fruit bark flour.

microscopy (SEM) of murici pulp and passion fruit bark flour, respectively.

When using magnification of 50 times, murici pulp (Figure 2) showed various particles predominantly of irregular shapes. Using magnification of 500 times, the composition is asymmetrical, showing the presence of a

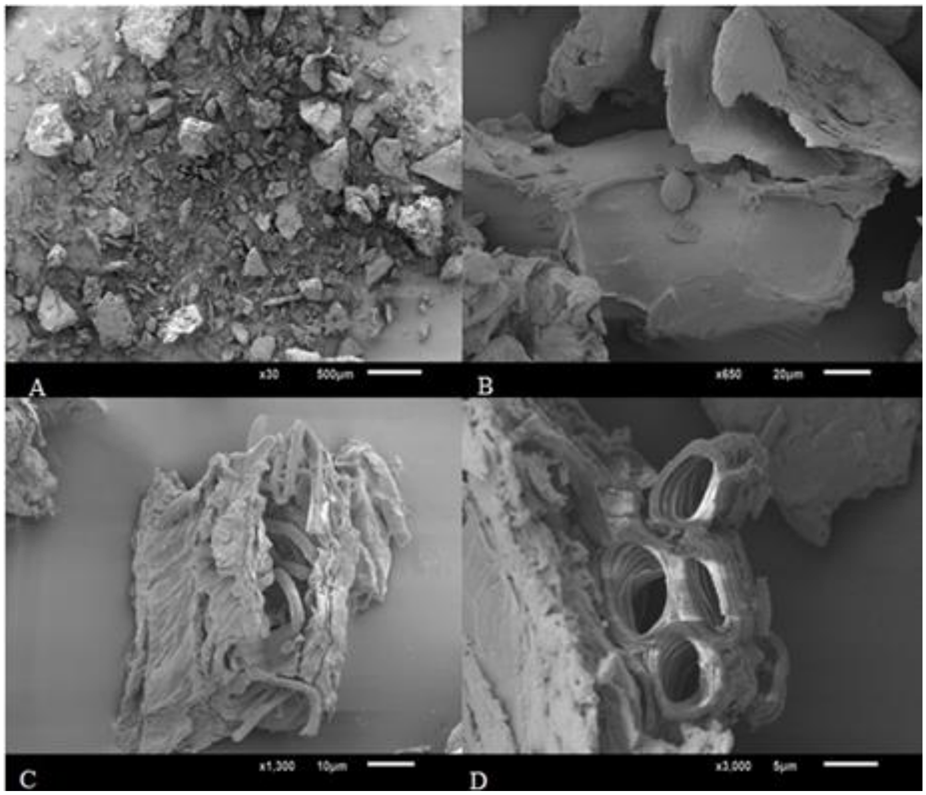

Figure 3. Scanning electron microscopy of passion fruit bark flour used in the processing of fermented milk drinks flavored with Murici (*Byrsonimacrassifolia* (L.) Rich.) added of passion fruit bark flour.

few fibrous filaments and dense and compact surface. Using magnification of 2,000 times, micrographs showed greater roughness and porosity, being possible to observe the disposition of some fibrous membranes.

Particles of different sizes in flour characterizes the degradation of the molecular matrix, granular structures and in the shape of lentils, represents the starch fraction and protein fraction, respectively (Roman-Gutierrez et al., 2002). In Figure 3, with magnification of 30 times, particles of different sizes and irregular surface structures with flat portions and some holes were observed. Figure 3B, with magnification of 650 times, shows a compact and amorphous mass, where it is possible to distinguish some starch granules indicated by the arrow from non-starchy material.

With magnification of 1,300 times (Figure 3C), the arrangement of fiber filamentous was observed. Unlike starch, fibers have no rounded structures, but rather more geometric shapes and some gaps that are responsible for the high incidence of permeable pores in fibers, which leads to high water absorption, characterizing fiber as a highly hygroscopic structure (Fiorda et al., 2013). It is known that FCM has considerable protein content, and Figure 3D shows particles of different sizes and shapes and structures with circular and lentil shape, suggesting characterization of polysaccharides and protein matrix.

The antioxidant activity of murici pulp extract and four milk drink treatments was assessed at three concentrations: 200%, 100% and 50% and their respective absorbance values were determined using equation with better fit and respective correlation coefficient R^2. The results were expressed as EC_{50} (extract concentration in g / L capable of reacting with 50% of the radical present in the DPPH solution). Therefore, the lower the EC_{50} value, the higher the antioxidant activity of the extract analyzed (Vieira et al., 2011). The standard curve constructed with the absorbance parameters in UV and concentration was determined by the percentage of scavenged DPPH with EC_{50} value = 182.07 g / L, with linearity and good correlation with the correlation determination coefficient $R^2 = 0.953$.

Roesler et al. (2007) reported lower antioxidant activity by DPPH of typical cerrado fruits such as cagaita pulp (EC_{50} = 387.5), pequi pulp (EC_{50} = 298.7), and higher antioxidant activity in araticum pulp (EC_{50} = 148.8) and lobeira pulp (EC_{50} = 163.0). Siguemoto (2013) also reported lower antioxidant activity in murici fruits collected in the city of Marabá - PA, Brazil, in which EC_{50} = 330.5 was obtained. This can be explained by the fact that fruits

Table 2. Proximate composition and instrumental color parameters (L *, a * and b *) of passion fruit bark flour.

Parameter	FCM
Water activity (Aw)	0.323
Dry matter (g/100 g)	90.83
Moisture (g/100 g)	9.17
Crude protein (g/100 g)	13.86
Ash (g/100 g)	9.85
Ether extract (g/100 g)	0.43
L*	70.78
a*	5.32
b*	21.30

were collected in different regions, thus obtaining different antioxidant activity values.

The antioxidant activity of milk drink flavored with murici and added of passion fruit bark flour was determined for all four treatments (0, 0.5, 1.0 and 1.5% FCM). A slight increase in the antioxidant activity of milk drinks with increasing passion fruit bark flour concentration was observed, and milk drink with 0% flour showed EC_{50} = 238.244 g / L with R^2 = 0.983 and milk drink with 1.5 % showed EC_{50} = 224.302 g / L, with R^2 = 0.997. This is because passion fruit bark exhibits high antioxidant capacity. Zeraik (2010) observed EC_{50} value = 35 g / L in passion fruit peel.

This study revealed that the higher the passion fruit bark flour concentration added to milk drinks flavored with murici, the greater their antioxidant capacity. pH, titratable acidity and total soluble solids (TSS) of murici pulp were 3.63; 0.77 g of lactic acid / 100 ml and 10.9 °Brix, respectively. Similar results were reported by GUIMARÃES & SILVA (2008), who analyzed murici pulp and obtained pH 3.42 and TSS of 10.67 °Brix.

The moisture content, ash and protein values of murici pulp analyzed in the present study were 73.29 g / 100 g; 0.97 g / 100g 1.72 g / 100g respectively, which were similar to values found by ROESLER et al. (2007), who studied the proximate composition of cerrado fruit pulps and found in araticum pulp (*Annonacrassiflora*) 67.85 g / 100 g of moisture; 0.77 g / 100 g of ashes and 1.80 g / 100 g of protein. Table 2 shows the proximate composition and instrumental color parameters (L *, a * and b *) of passion fruit bark flour.

The flour obtained by drying and grinding passion fruit bark showed low moisture content and aW, which protects flour against microbiological changes, since bacterial growth occurs at aW between 0.6 and 0.9 (LABUZA & ALTUNAKAR, 2008). Similar water activity and moisture values were found by Cazarin et al. (2014), who studied this flour and obtained aW of 0.43 and moisture of 9.48 g / 100 g.

Crude protein value of 13.86g / 100g was observed, which is greater than that reported by Souza et al. (2008), who found value of 11.76g / 100g for passion fruit bark flour and Pena et al. (2008), who analyzed passion fruit flour obtained by drying at 70°C and reported 11.3g / 100 g of protein. This allows classifying the passion fruit bark flour of the present study as source in protein, being an alternative for use in diets that require protein increment.

In the analysis of ash, relatively high result was obtained (9.85g / 100 g), when compared to result obtained by Souza et al. (2008), who found value of 8.13g / 100g for passion fruit bark flour and Cazarin et al. (2014), who reported 6.88g / 100 g of ash content for the same waste. The values of color instrumental parameters indicated that passion fruit bark flour can be clear, as it presented brightness close to white (70.78), because the closer to 100, the clearer the flour. Values observed by Vilhalva et al. (2011) for cassava bark flour were close to the FCM, whose L * and a * values were 64.54 and 4.51, respectively.

As for chromaticity coordinates a * and b *, the flour has color tending to red, with positive a * value (5.32) and to yellow, with positive b * value and away from zero (21, 30). The tendency of colors to red and yellow confirmed the presence of carotenoids, which are natural pigments present in passion fruits (Silva and Mercadante, 2002). Table 3 shows the average results of moisture, ash, protein, fat and carbohydrates of fermented milk drinks flavored with Murici (*Byrsonima crassifolia* (L.) Rich.) added of different passion fruit bark flour concentrations.

Regarding the proximate composition of milk drinks flavored with murici and enriched with FCM, Table 3 shows that the moisture content of samples decreased with increasing FCM concentration in milk drinks, and drink with 1.5% flour significantly differed (p <0.05) from the others. According to Gambelli et al. (1999), yogurt moisture content is about 87 / 100 g; however, this value depends on the type of milk and available soluble solids, because in this study, in addition to milk, milk whey, murici pulp and FCM were also used and thus the results corroborate those by Toledo (2013), who produced yogurt with passion fruit pulp and flour, in which yogurt without flour showed moisture of 78.73g / 100 g and for yogurt with the highest flour concentration (8 g / 100g), the moisture content was 73.13g / 100g.

There was a significant difference (p <0.05) in the ash content of milk drinks without flour and sample with the highest FCM concentration. This parameter concomitantly increased the FCM concentration, a result that was expected since FCM presented ash content of 9.85 g / 100 g, and its addition is a factor that significantly contributed to increase the ash content of milk drinks.

As can be seen in Table 3, the protein content of milk drinks increased with the addition of flour. This fact can be explained by the high protein content of passion fruit bark flour (11.76g / 100g) observed by Souza (2008) and the protein content of 13.86g / 100 g of FCM used in this

Table 3. Average moisture (g / 100 g), ash (g / 100g), protein (g / 100 g), fat (g / 100 g) and carbohydrate results of fermented dairy drinks flavored with Murici (Byrsonimacrassifolia (L .) Rich.) added of passion fruit bark flour.

Parameters	Passion fruit bark flour concentrations (%)				VC (%)
	0.0	0.5	1.0	1.5	
Moisture	82.12±0.08a	81.73±0.32a	81.65±0.32a	80.77±0.33b	0.35
Ash	0.54±0.14ª	0.67±0.02ab	0.69±0.03ab	0.78±0.01b	10.71
Protein	1.97±0.04ª	2.01±0.07ab	2.10±0.05b	2.26±0.02c	2.32
Fat	2.00±0.20ª	1.73±0.64ª	1.23±0.31a	0.93±0.92a	40.11
Carbohydrate	13.37±0.25a	13.84±0.76ab	14.31±0.55ab	15.25±0.97b	4.84

Different letters on the same line significantly differ by the Tukey test at 5% probability.

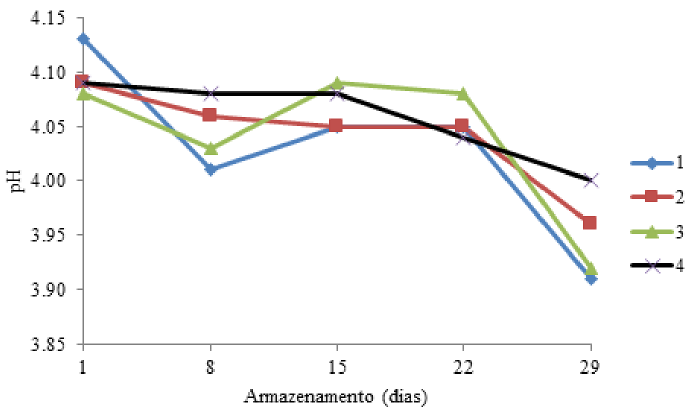

Figure 4. pH of fermented milk drinks flavored with Murici (*Byrsonimacrassifolia* (L) Rich.) added of passion fruit bark flour.

study. The four milk drink formulations showed content above legal standards (1.7%) defined by Brazilian legislation (Brazil, 2005).

The protein percentage of milk drinks with passion fruit bark flour was similar to those described by Thamer and Penna (2006), who prepared milk drinks added of probiotic and prebiotic bacteria and found protein content ranging from 1.93 g / 100 g to 2.46 g / 100 g.

The fat content showed no significant different (p> 0.05) among the four milk drink formulations. Cunha et al. (2009) found fat content ranging from 1.43 g / 100 g to 2.01 g / 100 g, in a study on the influence of the use of milk whey and probiotic bacteria in the properties of fermented milk drinks. Finco et al. (2011) observed higher lipid content (3.36 g / 100 g) in natural yogurt enriched with sesame flour.

In relation to the carbohydrate contents, there was a significant difference (p <0.05) between sample without the addition of flour and those with the highest FCM concentration. It was observed that with increased flour concentration, a slight increase in the carbohydrate content was observed. Similar results were reported by Pagamunici (2009), with average carbohydrate content of 13.78 g / 100 g for yogurt added of jaracatiá bran. The pH results of milk drinks flavored with murici and with 0% FCM - Control; 0.5% FCM (Treatment 2); 1.0% FCM (Treatment 3) and 1.5% FCM (Treatment 4) are shown in Figure 4.

The analysis of data allowed observing that during the storage period of milk drinks, pH showed a considerable reduction, since the initial pH ranged from 4.13 (Treatment 1) to 4.09 (Treatment 4), reaching 3.91 (Treatment 1) and 4.00 (Treatment 4) on day 29 of storage. Similar pH results were reported by Sivieri and Oliveira (2002), who analyzed milk drinks prepared with "fatreplacers" during 28 days of storage. The pH values at baseline ranged from 4.0 to 4.6, and after 28 days of storage, it ranged from 3.9 and 4.5.

According to Ellis (1996), microorganisms present in yogurt remain viable and even keeping the product at temperature of 5°C, they continue reproducing and acidifying the medium. Therefore, to establish whether yogurt is fit for consumption, pH and titratable acidity should be checked. The low pH from day 22 of storage on can be related to the action of *Lactobacilus acidophilus*, a microorganism known for its high capacity to produce acid in the fermentation medium (Macedo, 1997). According to Souza (1990), the yogurt acidity is quite variable and largely influences consumption. Thus, pH values from 4.6 to 3.7 are common. However, values

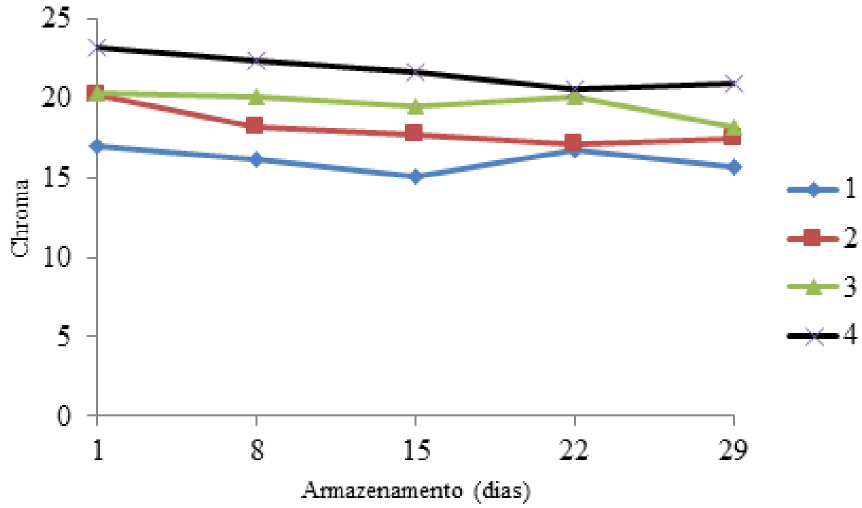

Figure 5. Chroma of fermented milk drinks flavored with Murici (*Byrsonima crassifolia* (L.) Rich.) added of passion fruit bark flour.

similar to those considered as ideal were found in milk drinks even after 29 days of storage.

Regarding the color of milk drinks, it was observed that the addition of FCM had no effect on chroma (C *) and Hue value (H *). The results are shown on Figures 5 and 6. The first feature observed in a food is its color, and this preview determines taste and quality expectations (Henry, 1996). The quality of a color is obtained by hue (h *) and saturation (C *). Hue is a feature that characterizes the quality of color such as red, green and blue, for example, enabling them to be differentiated. The hue angle (h *) ranges from 0° to 360°: 0° is the angle corresponding to the red color, 90° to yellow color, 180° to green color and 270 ° to blue color (Abreu et al., 2011). Saturation, also called purity, describes the intensity or quantity of a color, indicating the proportion in which it is mixed with black, white or gray, allowing differentiating strong from weak colors and when this variable has values near 0, there is predominance of neutral colors (gray) and when it has values close to 60, there is predominance of vivid colors (Ramos and Gomide, 2007).

Regarding chromaticity (C *), samples added of passion fruit bark flour showed higher values (20.37 to 23.35) compared to treatment without the addition of flour. Lower C * values correspond to a weaker color pattern and higher C * values correspond to a stronger color pattern. Thus, the addition of passion fruit bark flour resulted in milk drinks with more vivid colors. The analysis of data allowed observing that during the storage period, C * showed significant decreases since the initial data ranged from 16.98 (Treatment 1) to 23.18 (Treatment 4), reaching 15.63 (Treatment 1) and 20.91 (Treatment 4) on day 29 of storage, as can be seen in Figure 5.

Similar results were found by Abreu et al. (2011), who developed mixed drinks with mango, passion fruit and cashew pulp added of different concentrations of prebiotics and observed C * values between 13.04 and 13.45 for drinks with the lowest and highest amounts of prebiotic, respectively. However, the opposite was observed by Toledo (2013), who produced yogurt with passion fruit flour and pulp and observed that samples added of 2 g / 100 g to 8 g / 100 g of passion fruit flour showed significantly lower C *values compared to treatment without flour (yogurt with 0% flour), concluding that the addition of the pulp and flour resulted in yogurt with more consistent color ("weak") due to the effect of the dark color of flour on the product.

The average Hue angle values (Figure 6) ranged from 85.30 (Treatment 1) to 80.13 (Treatment 4), indicating that milk drinks added of pulp and flour were within the yellow hue. It was found that as the concentration of passion fruit bark flour increased, the samples distanced from yellowish color. Thus, samples containing 0% and 1.5% passion fruit bark flour showed, respectively, the highest and lowest proportions of yellow color.

Toledo (2013) produced yogurt with passion fruit pulp and flour, and obtained similar results for the Hue angle, observing that as the concentration of passion fruit bark flour increased, the h * values decreased to 96.68 for yogurt without flour and 89.95 for yogurt with 8g / 100g of flour. The results of the texture analyses (hardness and adhesiveness) are shown as a function of the days of storage in Figures 7 and 8. It was observed that hardness increased for all formulations over the days, with minor variations in results.

Noronha et al. (2007) reported that the increase in hardness may be due to the decreased hydration of the protein network, resulting in lower plasticizing effect. According to Sodini et al. (2002), the main factors influencing yogurt hardness are protein content and type.

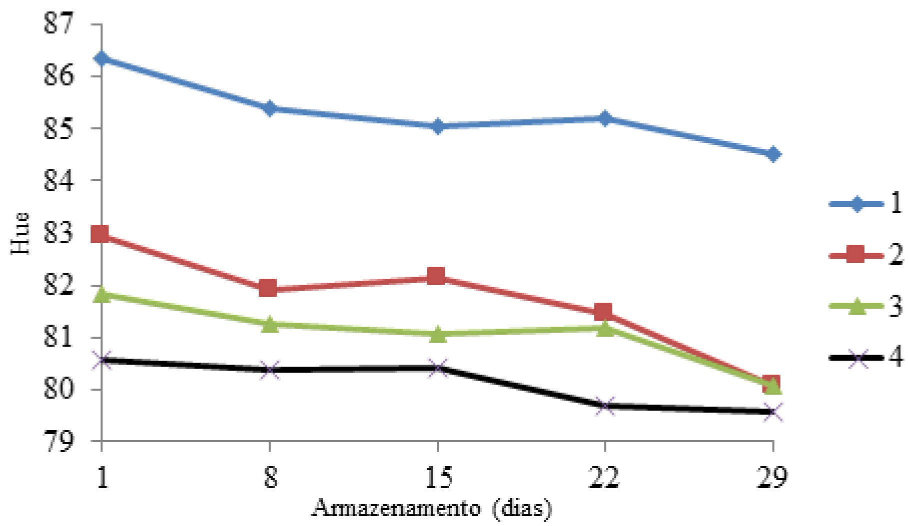

Figure 6. Hue angle of fermented milk drinks flavored with Murici (*Byrsonimacrassifolia* (L.) Rich.) added of passion fruit bark flour.

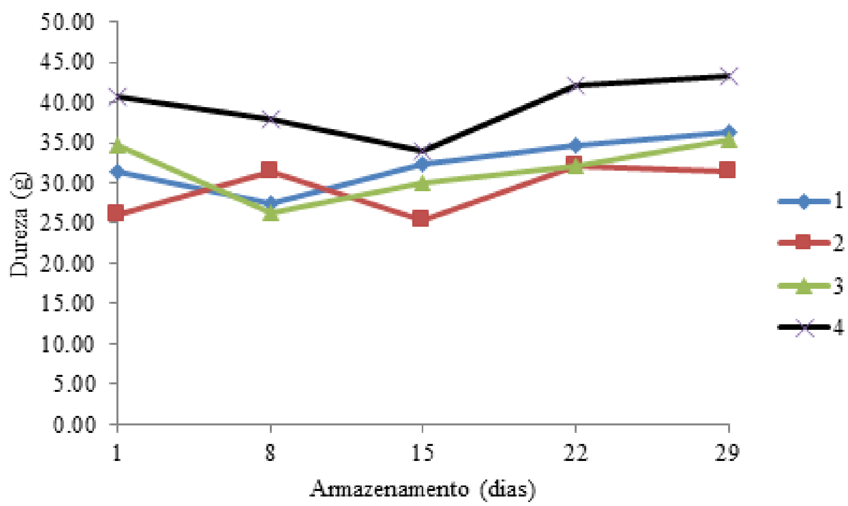

Figure 7. Hardness of fermented milk drinks flavored with Murici (*Byrsonimacrassifolia* (L.) Rich.) added of passion fruit bark flour.

A possible explanation for a slight variation during the storage period for each treatment would be the amount of FCM added to milk drinks. The higher hardness presented by drink with 1.5% FCM can be related to the higher total solids content (FCM). Cardarelli et al. (2003) observed a significant increase in hardness over 28 days of storage at 4°C for two symbiotic petit-suisse cheese formulations in which xanthan gum was added as a stabilizer and Castro (2007) observed increased hardness in milk drinks added of oligofructose compared to milk drinks without oligofructose. Stability or small variation in hardness during the storage period is desired, since, in this way, it is found that after a few weeks of storage, the product has characteristics similar to a newly manufactured product. Stability is highly desirable to keep physical, chemical and sensory characteristics throughout the product shelf-life (Maruyama et al., 2006). Similarly to what was observed for hardness, it was found that the adhesiveness values were higher for milk drinks with higher FCM concentration (Figure 8). Higher mean adhesiveness values were observed for Treatment 4 (average of 0.78) compared to Treatment 1 with lower FCM concentration (average of 0.44). According to Fox et al. (2000), adhesiveness refers to the force required to remove the food that is stuck in the mouth (generally on the palate) during the normal chewing process.

During the storage period, there was an increase in adhesiveness values for all milk drink formulations, which

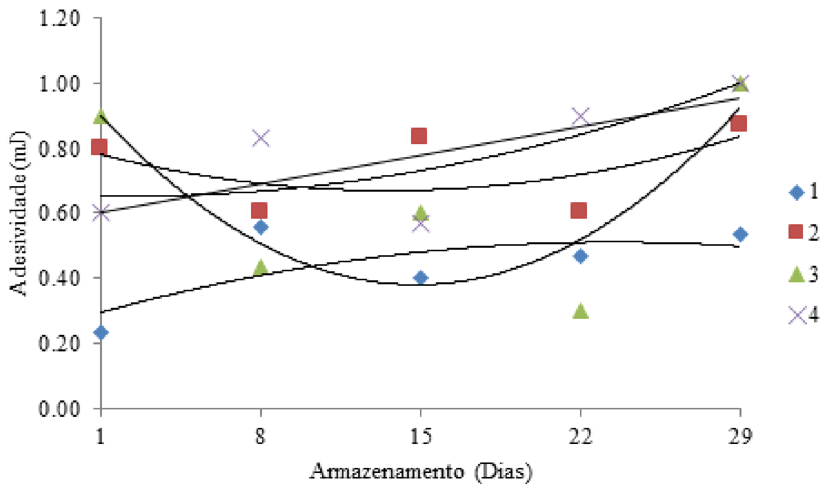

Figure 8. Adhesiveness of fermented milk drinks flavored with Murici (*Byrsonimacrassifolia* (L.) Rich.) added of passion fruit bark flour.

Table 4. Mean values and standard deviation of the sensory analysis of parameters color, flavor, aroma, texture and purchase intent (IC) of fermented milk drinks flavored with Murici (*Byrsonima crassifolia* (L.) Rich.) added of passion fruit bark flour.

Parameters	FCM concentration (%)				CV (%)
	0.0	0.5	1.0	1.5	
Color	7.18±1.77a	6.60±1.63a	5.36±2.18b	4.78±2.34b	33.48
Flavor	6.86±1.85a	5.38±1.93b	4.18±2.04c	3.60±2.14c	39.79
Aroma	6.02±2.19a	5.26±2.20ab	4.46±2.27b	4.40±2.42b	45.15
Texture	6.30±2.08a	5.22±1.76ab	4.74±2.05b	4.18±2.40b	40.80
IC	3.68±1.06a	2.80±1.05b	2.32±0.98bc	1.82±0.87c	37.39

Different letters on the line significantly differ by the Tukey test at 5% probability.

is similar to results found by Buriti et al. (2010), who observed an increase of adhesiveness values for guava mousse added of inulin during refrigerated storage. Table 4 presents the average values of sensory parameters color, flavor, aroma, texture and purchase intent for the four types of milk drink flavored with murici and added of passion fruit bark flour at eight days of storage. The sensory evaluation of the color of milk drinks flavored with murici with different FCM concentrations (0%, 0.5, 1.0 and 1.5%) showed that panelists gave higher score to drink without FCM. The color of milk drink with 1.5% flour was less attractive for panelists and drinks containing 0% and 0.5% significantly differed ($p < 0.05$) from drinks containing 1.0 and 1.5% of flour. As seen in Table 4, the higher the flour concentration present in the sample, the greater the rejection by panelists. Thus, it was found that samples containing 0 and 1.5% were those obtaining the highest and lowest scores, respectively.

Lupatini et al. (2011) evaluated biscuits enriched with passion fruit bark flour and okara and also obtained lower acceptance for treatment with the highest flour percentage, this fact is due to the bitter aftertaste in the product added of passion fruit bark flour. The result for flavor and texture of milk drinks flavored with murici and with different FCM concentrations showed that panelists gave the highest score to drink with 0% flour. The aroma and texture of drinks with 1.5% flour were less attractive; however, milk drink with 0.5% murici pulp did not differ significantly ($p > 0.05$) from drinks with 0 and 1.0% of flour.

Regarding purchase intent, significant difference ($p < 0.05$) was observed among treatments 1, 2 and 4, and the highest score was given to treatment 1 (3.68%), followed by treatments 2, 3 and 4. Despite the higher acceptance and purchase intent of drink with 0% FCM, many panelists declared they would consume sample with 0.5% flour by associating it to a more healthy and nutritious product due to the presence of fibers and proteins from flour.

These results indicated that although panelists not have preferred samples with high FCM concentration, some panelists declared they would consume drink with0.5% FCM, which can be a food product of great interest, since the addition of passion fruit bark flour greatly contributes to enhance nutritional properties.

CONCLUSION

The addition of passion fruit bark flour in milk drinks flavored with murici intensified the color, resulting in milk drinks with more vivid colors, tending to yellow and red. Regarding the physicochemical aspects, it was concluded that the addition of passion fruit bark flour had a positive influence on the texture of milk drinks, which increased with increasing FCM concentration, as well as the protein content and antioxidant activity of milk drinks.

Regarding the sensory evaluation, higher acceptance was obtained for drinks without the addition of flour. However, milk purchase intent, showing that the addition of pulp and flour influenced the sensory profile of samples, and treatments with 0 and 0.5% FCM showed the highest scores for most desirable attributes for milk drink flavored with murici added of passion fruit bark flour.

Further studies should be carried out in order to establish the best levels of FCM addition to improve acceptance, sensory characteristics and nutritional and technological qualities of milk drinks, being an alternative to reduce the disposal of this food industry by-product.

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Conflict of interests

The authors have not declared any conflict of interests.

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