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JAMELÃO CAPSULES CONTAINING BIOACTIVE COMPOUNDS AND ITS APLICATION IN YOGHURT

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ABSTRACT

Background. Jamelão fruit (*Syzygium cumini*), has recently attracted interest as a functional food for being rich in anthocyanins, which has antioxidant power, attractive color and stability in high acid foods.
Materials and methods. Samples of yoghurt with jamelão capsules obtained through the gelling process with sodium alginate solution and bioactive yoghurt (control + capsules) were evaluated. The samples were evaluated for composition, microbial viability, the stability on the anthocyanic pigments and its antioxidant activity.
Results. With the addition of jamelão pulp capsules there was a reduction in the *Streptococcus thermophilus* count. The addition of capsules in yoghurts were able to increase the amount of phenols and anthocyanins, as well as antioxidant potential at 28 days. The chromatographic analysis showed that process was efficient, being capable of encapsulating a large part of the bioactive compounds present in the pulp.
Conclusion. The addition of jamelão pulp capsules to yoghurts was shown to be a promising and viable alternative, since the bioactive compounds present in the fruit were present in the yoghurt.

Keywords: yoghurt, hydrocolloids, ionic gelation, *Syzygium cumini*

INTRODUCTION

Yoghurt and fermented milk are among the most common dairy products consumed worldwide, being considered important in the human diet and associated with numerous health benefits. However, the literature points out that dairy products have a limited content of bioactive compounds, so to overcome this limitation it is suggested the incorporation of plant-based or fruit additives to enrich yogurt (Bertolino et al., 2015).

The antioxidants present in fruits are excellent natural additives being presented as alternatives to synthetic additives. Among the natural antioxidants are phenolic acids, tannins, tocopherols and flavonoids, the latter being represented by anthocyanins and flavonols. Anthocyanins have high potential for use as a natural dye because of their attractive colors that have pharmacological properties contributing to

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their use in the therapeutic market (Lee et al., 2005). Jamelão (*Syzygium cumini*) is a tropical fruit, rich in anthocyanin with an intense black to violet color, shown as a natural phytochemical source with pharmacological applications (Ayyanar et al., 2013).

One of the most common methods of encapsulation is ionic gelation with formation of alginate gels by ion-crosslinking with multivalent cations (Poojari and Srivastava, 2013). The main purpose of encapsulation is to protect the core material from adverse conditions such as unwanted light and oxygen effects, slows down changes that may result in loss of aroma, color and nutritional value, and further promotes controlled release of the encapsulated matrix material. In this way, it is possible to increase the useful life of the product and the gradual release of the encapsulated compound (Nedovic et al., 2011).

There are few studies correlating the functional attributes of products developed with jamelão fruit extracts for dairy products. The objective of the study were to obtain capsules of jamelão pulp by the method of ionic gelation adding them in the yoghurt and evaluating its composition, microbial viability, the stability on the anthocyanic pigments of the bioactive compounds and its antioxidant activity during the storage.

MATERIAL AND METHODS

Materials

Milk and jamelão were bought from a local market in Sergipe/Brazil. *Lactobacillus delbrueckii* ssp. *bulgaricus* (*L. bulgaricus*) and *Streptococcus salivarius* ssp. *thermophilus* (*S. thermophilus*) were obtained from BV-Bela Vista®, YOG-03, Brazil. The reagents were purchased from Sigma Aldrich® and the culture media were purchased from Kasvi®.

Encapsulation procedure

The dripping methodology was used for the ionic gelling process. Jamelão pulp (100 mL) and sodium alginate 2% (m/V) sucked into the Caviar Box® kit (16 × 12 × 6 cm) and dripped into 1% calcium chloride aqueous solution. The capsules formed were drained and immersed in a vessel with water. The yield was obtained by weighing the jamelão pulp + alginate and then weighing the capsules, obtaining the ratio of the difference multiplied by 100.

Yoghurt preparation

It was used 10 L whole milk and 4% skim milk powder heated to 90°C for 5 minutes. Cooled to 43°C for addition of the mixed starter culture *L. bulgaricus* and *S. thermophilus* (Bela Vista®, YOG-03, Brazil). The milk (80% v/v) was transferred to packages containing the jamelão pulp capsules (20% w/v), and was incubated at 43°C until pH 4.6 and cooling to 4°C. The product was sealed and stored at 4°C ±1 for 28 days.

Extracts preparation

The samples were made by precipitating the yoghurt proteins with 20% trichloracetic acid (TCA; Zulueta et al., 2009). It used a ratio of 1:1 (v/v) yoghurt and 20% TCA in water. After stirring for 30 seconds, the samples were incubated in a heating bath at 42°C for 10 minutes, and then centrifuged for 15 minutes at 25°C. The supernatant was used for the analysis of phenolic compounds (Swain and Hillis, 1959), anthocyanins (Giusti and Wrolstad, 2003) and antioxidant activity (Brasil, 2007).

Physicochemical analysis of yoghurt

The lipid was determined by Gerber methodology and protein by micro Kjeldahl method. The reducing sugars in lactose was determined by Standard method (Lutz and Lutz, 1985). pH was measured by pH-meter (Ion, PHB-500-BI). The acid was determined by (ISO, 1997). Soluble solids was measured by Abbé bench refractometer. The moisture was determined by direct oven drying method at 105°C (Lutz and Lutz, 1985). The calcium was expressed according to (Silva and Queiroz, 1981) and ash method described by (In and Horwitz, 1995). The $ABTS^{\bullet+}$ radical was carried out as described by (Re et al., 1999). The Ferric Reducing Ability Power (FRAP) according to (Benzie and Strain, 1996).

HPLC analysis

4 g of jamelão sample were immersed into 100 mL of solvent mixture (methanol, water and formic acid) 70:28.5:1.5 (V/V). The extract was stirring on ultrasound for 15 minutes and centrifuged at 6,000 rpm at 25°C for 15 minutes. The extract was filtered and the solvent was then removed by rotavaporation (20 minutes at 37°C). The analysis was performed in a High Efficiency Liquid Chromatograph Brand Agilent

Technologies 1200 infinity series was equipped with automatic sampler (model 1260 Infinity G1329B). Injections were performed with 20 μL of solution and the detection accompanied with photodiode system.

Color

The color was determined using a Konica Minolta electronic colorimeter, model CR10, through the CIE Lab scale.

Texture profile

The analyzes were performed on Texture Analyzer (Brookfield-CT3) model with a flat bottom cylindrical probe of 35 mm diameter (A/BE 35) in probe gauge 60 mm, penetration force of 15 g and compression speed of 3 $mm \cdot s^{-1}$.

Rheological measurement

Rheological analyzes were performed in a rotational Rheometer (RM 300-Lamy Rheology) coupled to a thermostatic bath and microcomputer. The rate varied from 0.02 to 100 s^{-1} at 10°C and the results were adjusted to the Bingham, Herschel Bulkley and Waele Ostwald models to plot the viscosity and shear rate curves using RHEO 2000 software (Narsimhan, 1994).

Microbiological analyses

To quantify *S. thermophilus*, the culture medium M17 was used and *L. bulgaricus* MRS Lactobacillus Agar. For counting of molds and yeasts was used Agar Potato Dextrose (PDA) acidified with tartaric acid. For total coliforms, the most probable number (MPN) and *Salmonella* spp. (In and Horwitz, 1995).

Sensory analysis

The test was performed only with the bioactive yogurt (jamelão capsules) for 100 untrained adults (58 women and 42 men aged 18–50 years). The attributes appearance, aroma, taste, texture, overall impression and purchase intention. Sensory evaluation was performed in individual booths using a 9-point hedonic scale according to (Meilgaard et al., 1999; Protocol number of the ethics committee: 65230117.3.0000.0104).

Statistical analysis

The results were submitted to ANOVA, from SAS 9.3 software (SAS, 2001). The significant difference between the means ($p < 0.05$) was determined by Tukey's test.

RESULTS AND DISCUSSION

Physicochemical properties of yoghurt

The yield of the jamelão capsules was 76.13%, due to the losses of the product in the Caviar Box® kit, which retained the pulp and also due to the deformation of some capsules that had to be discarded due to differences in their form spherical. The chemical composition parameters (Table 1) evaluated are within the normal range as established for yoghurts (Brasil, 2007). For the analyzed variables, there was a significant interaction only for the moisture content ($p < 0.05$), as the storage days increase, the treatments presented different behavior. It is observed that the moisture content of the bioactive yoghurt increased at fourteen days of storage ($p < 0.05$), being greater than the control yoghurt, remaining constant until the 28th day of analysis (Table 1). The alginate has a high water retention capacity, consequently the encapsulated pulp influenced the moisture content as it gradually released the bioactive compounds (Mukai-Correa et al., 2005). There was a significant difference ($p < 0.05$) between the treatments analyzed, and the solids content of bioactive yogurt reduced compared to the control at 28 days. The milk used to make the yoghurt had an average pH of 6.1 and titratable acidity equals to 0.17 g of lactic acid/100 g. During the fermentation process, pH decreased due to the production of lactic acid generated by *S. thermophilus* and *L. bulgaricus* cultures. The formulations studied showed the same behavior until the yoghurts reached pH 4.6. There was significant interaction between treatment and storage ($p < 0.05$), as the storage time increases there is a drop in pH and increased acidity (Table 1; Vital et al., 2015). In terms of lactic acid, the formulations being within the limit recommended by Brazilian legislation (Brasil, 2007) with ($p < 0.05$) showing increase over time, because the titratable acidity is directly proportional to the storage time.

Antioxidant activity of bioactive compounds

Two methods were used to determine the antioxidant properties: the first one allowed the evaluation of $ABTS^{\bullet+}$ radical sequestration capacity and the second,

Table 1. Physicochemical analysis of yogurt containing jamelão capsules during storage

Variable	Treatment	Storage, days			p-value		
		1	14	28	T	S	T×S
Moisture %	control	81.81 ±0.57^{aB}	80.23 ±0.47^{bB}	81.76 ±0.39^{aB}	<.0001	<.0001	<.0001
	capsules	88.44 ±0.17^{aA}	87.54 ±0.33^{aA}	87.23 ±0.61^{aA}			
	bioactive	80.89 ±0.82^{bB}	88.60 ±0.51^{aA}	87.44 ±0.43^{aA}			
Total solids °Brix	control	13.06 ±1.03^{aA}	11.66 ±1.35^{aAB}	13.93 ±1.35^{aA}	0.0003	0.8733	0.1778
	capsules	8.30 ±0.21^{aB}	9.00 ±0.72^{aB}	9.33 ±0.97^{aB}			
	bioactive	14.43 ±0.19^{aA}	14.13 ±1.43^{aA}	11.0 ±0.41^{bAB}			
Ashes, %	control	0.96 ±0.07^{aA}	1.01 ±0.11^{aAB}	0.92 ±0.01^{aB}	<.0001	0.6019	0.0576
	capsules	1.07 ±0.04^{aA}	1.17 ±0.02^{aA}	1.28 ±0.05^{aA}			
	bioactive	0.98 ±0.02^{aA}	0.77 ±0.01^{abB}	0.59 ±0.35^{bC}			
pH	control	4.57 ±0.01^{aA}	4.42 ±0.04^{bA}	4.32 ±0.01^{bB}	<.0001	0.0105	0.0562
	capsules	4.56 ±0.03^{aA}	4.43 ±0.01^{bA}	4.43 ±0.08^{bA}			
	bioactive	4.54 ±0.01^{aA}	4.28 ±0.01^{bB}	4.34 ±0.04^{bB}			
Acidity	control	0.76 ±0.01^{cA}	0.85 ±0.03^{bA}	0.95 ±0.03^{aA}	<.0001	<.0001	0.0014
	capsules	0.72 ±0.01^{A}	0.73 ±0.01^{B}	0.75 ±0.05^{B}			
	bioactive	0.75 ±0.01^{bA}	0.91 ±0.01^{aA}	0.92 ±0.01^{aA}			

Means with different lowercase letters in the line differ statistically by Tukey's test ($p < 0.05$).
Means with different capital letters in the column differ statistically by Tukey's test ($p < 0.05$).
T – treatment, S – storage period, days.

the iron reduction potential by FRAP method. There was a significant difference ($p < 0.05$) for the antioxidant activity and the bioactive compounds analyzed (Table 2). The reduction of the antioxidant capacity of ABTS and FRAP of jamelão capsules is mainly due to the manipulation of the pulp, since the addition of hydrocolloids in the ionic gelation process alters their physicochemical composition. There were also

Table 2. Characterization of pulp extracts (*in natura*) and capsules (after processing), in relation to antioxidant activity (ABTS and FRAP), phenolic compounds and anthocyanins

Variables	Jamelão pulp	Jamelão capsules
ABTS, µmol eq. Trolox/100 g	995.76 ±1.01^{a}	753.14 ±1.62^{b}
FRAP, µmol de Fe_2SO_4/100 g	1 111.84 ±1.17^{a}	739.33 ±0.78^{b}
Anthocyanin, mg cyanidin/100 g	113.30 ±0.85^{a}	27.42 ±1.58^{b}
Phenolic compounds, mg EAG/100 g	104.80 ±1.12^{a}	23.11 ±1.85^{b}

Means with the same lowercase letter in the line not differ by the Tukey's test $p < 0.05$.

a decrease of the anthocyanins and phenolic compounds of the capsules after being processed. This decreasing occurred at the time of encapsulation, since, in this stage, the anthocyanin pigments were lost in the solutions of calcium chloride and water.

Phenolic compounds by HPLC

As shown in Figure 1, when comparing chromatogram B and C it is observed that the microencapsulation of the bioactive compounds was efficient, since according to the results analyzed in HPLC, the capsules presented almost all the peaks detected in the jamelão pulp. The data obtained by pulp and jamelão capsules correspond respectively: total gallic acid of 121.25 ±31.72 and 65.84 ±19.45 mg/100 g; caffeic acid of 43.84 ±2.45 and 32.36 ±8.45 mg/100 g; p-coumaric acid of 1.61 ±0.53 and 0.49 ±0.92 mg/100 g; rutin of 0.82 ±0.32 and 0.38 ±0.49 mg/100 g. In bioactive yoghurt at 28 days of storage, it was possible to quantify only gallic acid, corresponding to 48.43 ±0.53 mg/100 g. The sum

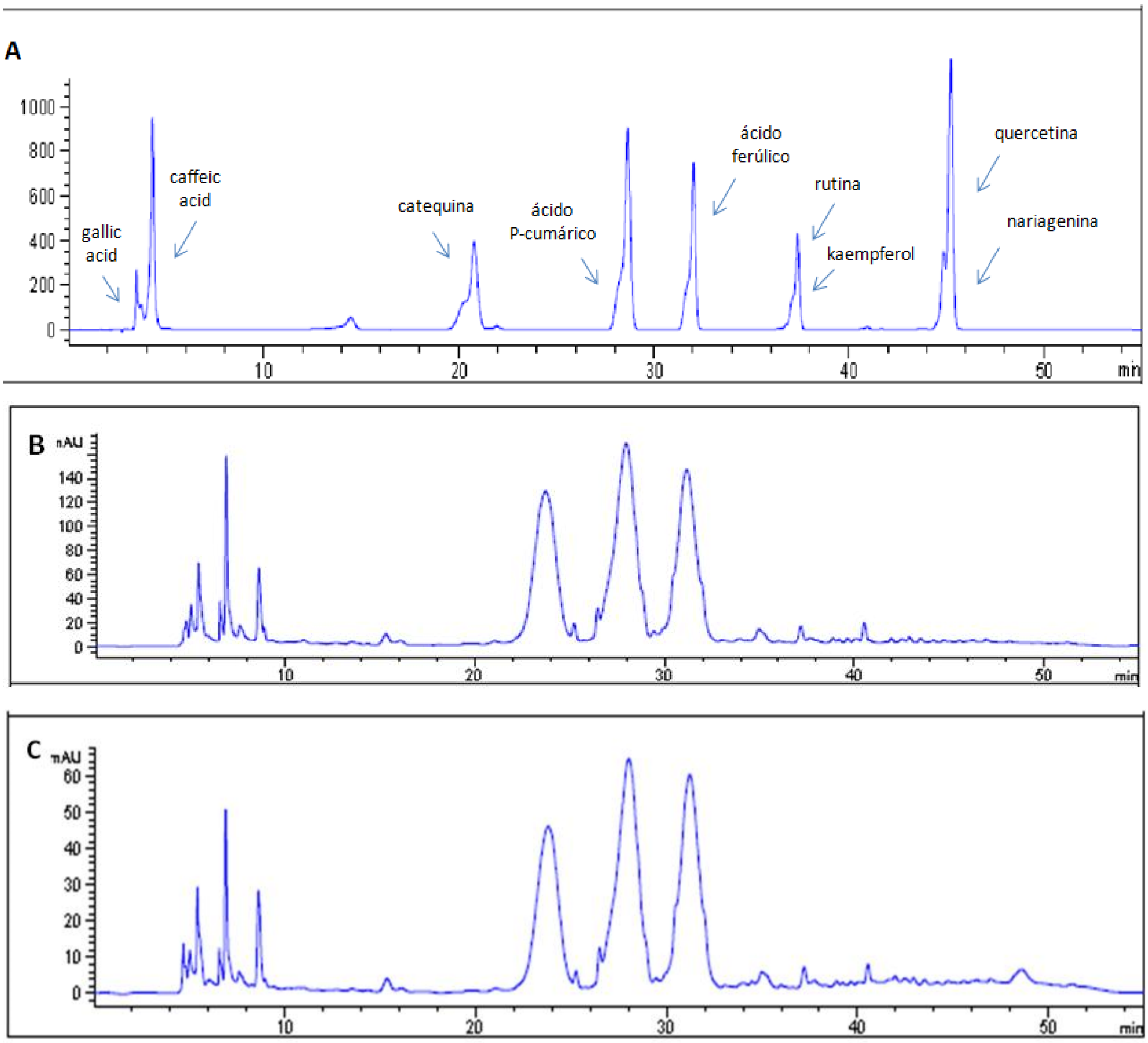

Fig. 1. Chromatographic profile of compounds identified at 280.4 nm wavelength in the extracts: A – mix of patterns, B – jamelão pulp, C – jamelão capsules

Table 3. Effect of the addition of the capsules in yoghurt color

Color	Treatment	Storage period, days					*p*-value		
		1	7	14	21	28	T	S	T×S
L	control	59.57 ± 0.30^{cA}	64.17 ± 1.03^{bA}	62.56 ± 0.92^{bcA}	68.50 ± 1.38^{aA}	69.66 ± 0.41^{aA}	<.0001	<.0001	<.0001
	capsules	28.87 ± 1.22^{cC}	34.27 ± 0.80^{bC}	38.27 ± 1.10^{aC}	37.47 ± 0.56^{aC}	32.13 ± 0.75^{bC}			
	bioactive	56.03 ± 0.61^{bB}	36.13 ± 0.23^{dB}	59.67 ± 0.32^{aB}	48.53 ± 0.25^{cB}	57.94 ± 0.66^{abB}			
a	control	2.83 ± 0.05^{abC}	2.46 ± 0.30^{abC}	1.66 ± 0.25^{bcB}	3.30 ± 0.20^{aB}	1.10 ± 0.51^{cC}	0.0202	<.0001	<.0001
	capsules	5.93 ± 0.75^{aB}	4.20 ± 0.43^{bB}	6.83 ± 0.37^{aA}	5.67 ± 0.73^{aA}	5.80 ± 0.20^{aB}			
	bioactive	7.66 ± 0.51^{abA}	7.50 ± 0.34^{abA}	6.56 ± 0.41^{bA}	5.20 ± 1.13^{cA}	7.86 ± 0.05^{aA}			
b	control	16.87 ± 1.06^{bA}	19.27 ± 1.43^{aA}	16.67 ± 1.06^{bA}	13.53 ± 0.81^{cA}	19.03 ± 0.25^{aA}	<.0001	<.0001	<.0001
	capsules	10.30 ± 1.21^{aB}	7.73 ± 0.80^{bB}	10.10 ± 0.2^{aC}	7.73 ± 0.68^{bC}	8.53 ± 0.55^{abC}			
	bioactive	10.83 ± 0.92^{bB}	8.60 ± 1.15^{cB}	13.17 ± 0.35^{aB}	10.40 ± 0.20^{bcB}	12.97 ± 0.97^{aB}			

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of the individual phenolic and flavonoid acids found in HPLC were higher in the following order: pulp > capsules. Bioactive compounds decreased throughout storage for control yogurt. The major bioactive compounds identified in this study were gallic acid, caffeic acid, p-coumaric acid, ferulic acid and rutin.

Color measurement

In the measurement of color in foods, the L^*, a^* and b^* color system is the most applied because it corresponds to a uniform distribution of colors (Wu and Sun, 2013). The L^* is a measurement of brightness, evaluated in a way to establish a gray scale, with values between black (0) and white (100) (Pathare et al., 2013). The value obtained (L) for the bioactive yoghurt was lower than the control, due to the influence of purple coloring. The parameter a^* corresponds to positive values for reddish colors and negative values for greenish, while b^* takes positive values for yellowish colors and negative values for bluish ones (Pathare et al., 2013). In agreement with the intense purple colorations of the jamelão, the results were positive corresponding to the a^* at 28 days of storage, shades tended to red and yellow. It was observed an increase of the yellow coloration with the passage of time, this change in color parameters is related to the occurrence of oxidation reaction, since there was deterioration of anthocyanins in the storage period studied (do Carmo Brito et al., 2017).

Texture profile analysis

Hardness, which is an important parameter for yogurt texture, and the hardness of bioactive yoghurt was higher ($p < 0.05$) than the control yoghurt, increasing gradually until the 28 day of analysis (Table 4). It was observed that jamelão pulp capsules addition in the bioactive yoghurt contributed to the increase of the cohesiveness and gumminess ($p < 0.05$) when compared to the control. The values of cohesiveness is a parameter that is related to the extent to which a material can be compressed before breaking and at 28 days, there was a significant effect on storage time ($p < 0.05$). For the gumminess attribute, the highest values were also attributed to the 28 days of storage for the bioactive yoghurt ($p < 0.05$). This characteristic is related to the force necessary to disintegrate the mass of the food during chewing. Bioactive yoghurt presented higher values, since over time, the bioactive compounds stored in the capsules migrate to the product and the capsule matrix solidifies, increasing the force to disintegrate the food. Regarding the elasticity, the bioactive yoghurt was less elastic because it had influence of the capsules

Table 4. Changes in the mechanical characteristics of yogurt

Texture	Treatment	Storage period, days			*p*-value		
		1	14	28	T	S	T*S
Hardness, N	control	4.87 ±0.08^{bA}	5.52 ±0.15^{aB}	5.18 ±0.27^{abB}	<.0001	<.0001	<.0001
	bioactive	4.77 ±0.08^{cA}	8.37 ±0.28^{bA}	9.65 ±0.26^{Aa}			
Cohesiveness	control	0.01 ±0.04^{aA}	0.02 ±0.08^{aB}	0.02 ±0.04^{aB}	<.0001	<.0001	<.0001
	bioactive	0.01 ±0.04^{cA}	0.180 ±0.02^{bA}	0.32 ±0.07^{aA}			
Gumminess, N	control	0.01 ±0.09^{aA}	0.11 ±0.09^{aB}	0.11 ±0.01^{aB}	<.0001	<.0001	<.0001
	bioactive	0.02 ±0.08^{cA}	1.52 ±0.22^{bA}	2.31 ±0.07^{aA}			
Elasticity, mm	control	12.13 ±0.12^{bA}	13.43 ±0.23^{bA}	18.93 ±1.75^{aA}	<.0001	0.0028	0.0296
	bioactive	1.07 ±0.03^{aB}	1.30 ±0.36^{aB}	2.29 ±0.15^{aB}			

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in the product. As the increase in elasticity is the ability of a sample after deformation to regain original shape, the control treatment differed statistically ($p < 0.05$) from the bioactive, this is because during storage, the capsules of jamelão pulp expelled the contents in its envelope as an alternative to return to their original state, which are polysaccharide crystals, changing their shape and influencing the elasticity of the product.

Rheological and structural yogurt properties

The flow behavior for control and bioactive yogurt samples showed the same rheological properties during the storage. Both exhibit behavior of non-Newtonian and pseudoplastic fluid. The viscosity, which is a function of the shear rate, was higher for the bioactive yoghurt. The viscosity remained constant until a given shear rate was obtained (Fig. 2). This corresponds to the behavior of a gel-like solid structure, where a proper disruption of the structure is required before an appreciable flow can be achieved (Fangary et al., 1999). According to Schramm (2006), this behavior occurs because of the decrease in viscosity as a function of the shear rate applied. The same behavior was observed by Mathias et al. (2013), working with different brands of yogurts and Sah et al. (2015), studying textured and rheological properties of fortified yogurt with pineapple peel powder during storage.

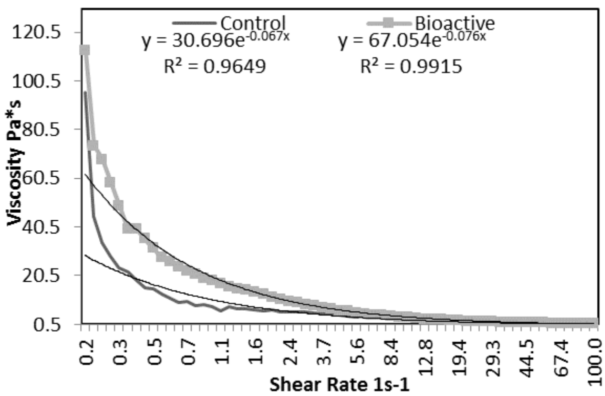

Fig. 2. Relation of viscosity × shear rate of control and bioactive yogurts

The results were adjusted to the model of Ostwald de Waele and the values obtained in this research corroborate with findings in the literature (Sah et al., 2015; Yilmaz et al., 2015).

Bacterial count during storage

The absence of coliforms and *Salmonella* spp. during storage evidence good hygienic sanitary practices of food during the process of product elaboration and about the time and temperature of adequate storage. The counting of mold and yeast population in the

Table 5. Mold and yeast counts for *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus*

Microbiological	Treatment	Storage period, days			*p*-value		
		1	14	28	T	S	T×S
Molds and yeasts CFU/g	control	$<10^1$	$<10^1$	1.0×10^1			
	bioactive	$<10^1$	$<10^1$	3.0×10^2			
S. thermophilus $\log_{10}$ UFC/g	control	8.77 ± 0.05^{aA}	8.88 ± 0.01^{aA}	8.91 ± 0.15^{aA}	<.0001	<.0001	<.0001
	bioactive	8.16 ± 0.06^{aB}	8.60 ± 0.08^{aA}	8.03 ± 0.02^{aB}			
L. bulgaricus $\log_{10}$ CFU/g	control	8.45 ± 0.03^{abA}	8.56 ± 0.18^{aA}	8.24 ± 0.03^{bA}	0.0872	0.0324	0.4106
	bioactive	8.15 ± 0.18^{abA}	8.45 ± 0.09^{aA}	8.20 ± 0.17^{bA}			
Coliforms		absent	absent	absent			
Salmonella spp.		absent	absent	absent			

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evaluated yogurts differed over time, where the bioactive yogurt had higher CFU number at 28 days of storage in relation to the control. This is due to the addition of jamelão pulp capsules, since the inclusion of fruit in its composition makes it susceptible to the growth of yeasts. The presence of yeasts may be based on the environment that is friendly to the development of these microorganisms, mainly due to the pH being in the range of 4.5–4.0 and presence of oxygen inside the package. Furthermore, the yeasts use O_2 as a contact surface to develop. In any case, the yeast population is within the standards recommended by the Brazilian legislation. There was a significant difference ($p < 0.05$) for *S. thermophilus* (control × bioactive; Table 5). As the shelf life increases, the viable counts of the microorganisms reduce. The addition of the capsules and decrease in pH values caused changes in the bioactive yogurt, reducing the number of CFU/g in relation to the control treatment. Taking into account that in the bioactive yogurt contained the capsules of jamelão pulp, which is rich in anthocyanins and have known antibacterial properties (Barbieri et al., 2017; Singh et al., 2016).

Effect of technology on consumer perception. The acceptability test was performed only with the developed product, which is the bioactive yoghurt. Regarding weekly consumption of yoghurt, 31% of the population consumes it once a week, followed by 28% who consume more than twice a week and 25% rarely consume. The results presented averages with good acceptance for the evaluated attributes. It was observed that the scores in terms of appearance and overall impression obtained averages close to 8.0, being considered as "liked a lot". For the attributes flavor and texture, they reached 7.02 and 7.01 respectively, corresponding to "liked regularly". In terms of flavor, the grade was 6.01, indicating "liked slightly". The evaluators did not gave higher notes on the basis of low sweetness content, since there was no addition of sugar in the product, a factor that would limit the purchase of the product for a part of the population that appreciates the sweet taste. Even with these observations, the yoghurt with jamelão pulp capsules showed a consumer interest of 3.79, which is equivalent to "I would probably buy" to "I have doubts if I would buy" scale.

CONCLUSIONS

The addition of jamelão capsules in the yoghurt altered the physical properties of the product (increased moisture, decreased Brix and ash throughout storage). The capsules added in the yoghurt were able to change the color of the yoghurt and the *S. thermophilus* count was lower for the bioactive yoghurt. The use of the capsules in yoghurts alters the properties of rheology and texture characteristics (hardness, cohesiveness, gumminess and elasticity). After the microencapsulation processing, there was reduction of the antioxidant capacity, phenolic compounds and anthocyanins. The sensory analysis showed that the product was well accepted and that consumers would possibly buy the product. Jamelão capsules can be an ingredient that added in yogurt adds nutritional value and enhances antioxidant capacity.

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