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Probiotic yoghurt flavored with organic beet with carrot, cassava, sweet potato or corn juice: Physicochemical and texture evaluation, probiotic viability and acceptance

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Abstract

The physicochemical and texture characteristics, probiotic viability and acceptance of probiotic yoghurts flavored with organic beet with carrot (10% each), cassava (10%), sweet potato (15%) or corn (10%) juice during refrigerated storage (4°C for 28 days) were evaluated. The yoghurts had similar ash contents, while the other components levels and pH varied. Sweet potato yoghurts were the most firm, consistent, viscous and cohesive yoghurts. Counts greater than 10^7 CFU/mL of probiotic culture were observed during refrigerated storage. The acceptance and purchase intent of beet with carrot, cassava and sweet potato yoghurts were higher than those of the corn yoghurt.

Introduction

In the last couple of decades, the growing concern about health and life quality has encouraged people to exercise, eat healthy food, decrease the consumption of food rich in sugar, salt and fat, and consume probiotic, prebiotic and organic foods (Pinheiro *et al*., 2005). Probiotics are live microorganisms that provide beneficial effects to consumers when administered in adequate amounts (Fao/Who, 2002). *Lactobacillus paracasei* ssp. *paracasei* (*L. casei*-01) cultures are safe for consumption (Zhang *et al*., 2013a) and have demonstrated beneficial effects on consumer health, such as stimulating the growth of probiotics in the gut and inhibition of pathogenic cultures (Zhang *et al*., 2013b; Bianchi *et al*., 2014), improved immunity (Ogawa *et al*., 2005), reducing the risk of intestinal damage related to colitis (Pan *et al*., 2014) and improved memory impairment (Xiao *et al*., 2014).

Organic agriculture has been consolidated in response to the growing questioning of directions acquired by modern agriculture, to which are pointed several negative correlations, such as harm to human health caused by various chemical inputs; elimination of natural predators, reducing biodiversity; nutritional imbalance and decreased resistance of cultivated plants; increasing land erosion; and socio-economic exclusion of small producers, among others (Bilich, 2010).

Brazil is the third largest producer of fruits and vegetables in the world (behind China and India) (Fao, 2004), but the losses are also high. It is estimated that 35 to 45% of vegetable products are lost or wasted since classification and selection on the farm until their use by the consumers (Tofanelli *et al*., 2009). One of the alternatives to avoid waste would be the use of vegetable production surpluses in food products, such as yoghurt.

World production and consumption of yoghurt increased greatly with the introduction of sweetened fruit-flavored yoghurts. This addition is typically around 15% of the total volume of the product and can provide increased acceptance, since not all consumers appreciate plain yoghurts. Furthermore, fruits cause the attenuation of the characteristic sour taste of fermented products (Zicker, 2011).

Few studies have evaluated the applicability of vegetables to flavor yoghurts (Collins *et al*., 1991; Cliff *et al*., 2013; Salwa *et al*., 2004), but none of them used organic vegetables or probiotics in the formulation. Therefore, the aim of this study

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was to evaluate the physicochemical and texture characteristics, probiotic viability and acceptance during refrigerated storage (4°C for 28 days) of probiotic yoghurts flavored with organic beet with carrot, cassava, sweet potato or corn juice.

Materials and Methods

Preparation of probiotic yoghurt flavored with organic vegetables juice

Whole milk (Lider®) was added 120 g/L of sugar (União®) and 35 g/L of skimmed milk powder (Molico®), in order to adjust the total solids content and improve yoghurt consistency. The base medium was then pasteurized at 85°C for 30 min in a water bath and cooled to 42°C. Then, 0.1 g/L of the probiotic culture (*L. casei* 01, Christian Hansen®) and 30 mL/L of starter cultures (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*; YC X-11 Christian Hansen®) were used to inoculate the milk mixture. The yoghurt base was incubated at 42°C for 5 hours.

For the preparation of juices, the organic vegetables were washed, sanitized (6 mL/L Pury Vitta® fruit disinfectant with 0.96g/100 mL active chlorine) and crushed using a fruit processor (Walita®). The juices were placed in glass containers, heat treated (80°C for 20 min) in a water bath and cooled in an ice bath until reaching 37°C. The vegetables were purchased from local market and were from a brand with organic proof seal (Bio Vida®).

The yoghurts were stirred and the organic vegetable juices added. The yoghurts with juice of beet with carrot (10% each), corn (10%), cassava (10%) and sweet potato (15%) were assessed. The products were stored in translucent polypropylene flasks (Prolab®) with 52 mm height and 52 mm diameter for 28 days at a temperature of 4°C.

Evaluation of the chemical composition and physicochemical and texture characteristics of the yoghurts

Moisture, protein, fat, ash, lactose and carbohydrate measurements were performed according to the Association of Official Analytical Chemists guidelines (Aoac, 2004). The chemical composition analyzes were performed on the first day of storage of the products.

The pH was determined using a digital potentiometer (Tecnal®) previously calibrated with phosphate buffers (Synth®) at pH 4.0 and 7.0. A colorimeter (Minolta®, model CR400) was used for the assessment of color parameters values, which directly provide the parameters L^* (lightness), a^* (red-green component) and b^* (yellow-blue component).

The texture parameters (firmness, consistency, cohesiveness and viscosity index) were determined by a single compression test using a texture analyzer (TA-XT plus®, Stable Micro System Ltd., Godalming, Waverley District, U.K.) equipped with a 5 Kg load cell. The formulations, in their original containers, were compressed with a 36-mm diameter cylindrical probe (P36 R) to a depth of 10 mm at a constant speed of 1 mm/s (pre-test and test speeds) (Balthazar *et al*., 2015). The physicochemical and texture analyzes were performed on days 1, 7, 14, 21 and 28 of storage of the products.

Probiotic viability

After homogenization, 1 mL of each yoghurt formulation was diluted with 9 mL of sterile 0.1g/100g peptone water (Oxoid®), mixed with a vortex mixer and subsequently serially diluted. Viable probiotic numbers were determined using the pour plate technique. The counts of *Lactobacillus paracasei* ssp. *paracasei* were determined on MRS (Difco) added 2mL/L of a 0.05% (w/v) vancomycin solution. and anaerobic (Anaerobac, Probac®) incubation at 37°C for 72 h (Tharmaraj and Shah, 2003). The probiotic viability was assessed on days 1, 7, 14, 21 and 28 of storage of the products.

Sensory evaluation of yoghurts

The sensory panel was composed of 93 untrained individuals (54% men and 46% women), ranging in age from 15 to over 50 years, with majority ageing 15-25 years (68%). Sensory analyzes were performed on tables and white light on the first day of storage of the products. Each judge received, in a randomized order and in monadic form, one cup of yoghurt of each formulation encoded with three random digits. To evaluate the acceptance of the formulations (appearance, aroma, flavor, texture and overall impression), the judges used a 9-point hedonic scale (9 = like extremely, 1 = dislike extremely). The purchase intent was assessed using a 5-point scale (5 = certainly buy, 1 = certainly would not buy) (Stone and Sidel, 2004; Pimentel et al., 2013). The acceptability index was calculated by dividing the mean score of the formulation by the highest value obtained for the same formulation (Dutcoscky, 2007).

Statistical analysis

The complete experiment was replicated two times using a completely randomized design. The physicochemical, texture and microbiological characteristics were performed in triplicates in each experiment repetition, every seven days for a 28 day period. A split plot design was used, in which the main treatment was the formulation and secondary treatment was the storage duration. The chemical composition was assessed in triplicates in each experiment repetition on the first day of storage. For acceptability and purchase intent the experimental design consisted of randomized complete blocks (the treatments were the formulations, and the blocks were the judges). Data were submitted to ANOVA and Tukey's comparison of the means test (p=5%). Statistical analyses were performed using the Statistical Analysis System (SAS) software.

Results and Discussion

Chemical composition

The results of the chemical composition of the yoghurts are given in Table 1. The prepared yoghurts showed similar ash levels (p>0.05) (0.9 g/100g), indicating that they had the same amount of mineral matter, independently of the vegetable used. The highest moisture content was found (p≤0.05) in beet with carrot yoghurt (77.9 g/100g) and the highest protein content in corn yoghurt (3.8 g/100g) (p≤0.05). The fat content was higher (p≤0.05) in cassava (2.70 g/100g) and corn (2.8 g/100g) yoghurts.

The variations in composition of the prepared yoghurts are consistent with the compositions of the vegetables used (Taco, 2011) and their respective additions. Furthermore, the chemical composition is similar to those found in the literature for fruit-flavored yoghurt (Tarakci and Küçüköner, 2003; Bakirci and Kavas, 2008; Bakri and Zubeir, 2009; Warakaulle *et al.* 2014) and, therefore, the probiotic yoghurts flavored with organic vegetable juices have adequate nutritional value that is comparable to the fruit-flavored yoghurts commonly sold in the market.

Physicochemical and texture characteristics

The results of physicochemical and texture analysis of the yoghurts during refrigerated storage are shown in Table 2. Yoghurts with added sweet potato or corn had lower pH (p≤0.05) than those made with beet and carrot or cassava, considering the last day of the storage of the products (day 28). The differences observed among formulations with respect to pH can be related to the different chemical compositions of the formulations (Table 1). The protein can interfere with the pH due to the buffering capacity of proteins, while the lactose is the preferred substrate used by microorganisms, leading to the formation of organic acids (Akalin *et al*., 2007).

The greater acidity of sweet potato or corn added products can protect yoghurts from the development of food spoilage microorganisms, thereby increasing their shelf life. However, the acidity can alter the sensory characteristics of the yoghurts and decrease the viability of the probiotic culture (Pimentel *et al*., 2015).

During refrigerated storage, decreases in pH (p≤0. 05) of the yoghurts were observed. The increased acidity is the result of post-acidification of the products and is related to the continuity of fermentation by lactic acid bacteria during the storage period, with production of lactic acid (Aportela-Palacios *et al*., 2005). The mean pH values of the formulations ranged between 4.60 and 4.0 during the storage period, corroborating previous studies (McGrew and Aryana, 2007; Akalin *et al*., 2007; Pimentel *et al*., 2012).

Yoghurt flavored with beet and carrot showed pink color (L^*=50, a^*=31 and b^*=2.3), while the others yoghurts showed white color, being corn yoghurt slightly yellowish (>b^*). One factor that influences the color of yoghurt is the color of the ingredients used in it manufacture. The whole milk was common to all the treatments and formulations contained sugar, starter cultures and probiotic culture, all in powder form, not changing the color of yoghurts. The color difference between the products is related to the color of the vegetables used for flavoring them. The color parameters of yoghurts were stable (p > 0.05) during refrigerated storage. Color stability is an important characteristic for product acceptance by consumers, since the color is a primary quality attribute (Renuka *et al*., 2009).

The sweet potato yoghurt showed higher (p≤0.05) firmness, consistency, cohesiveness and viscosity index than the other yoghurts, with no difference (p>0.05) among them (beet with carrot, cassava and corn) for these parameters. Firmer and more consistent, viscous and cohesive yoghurts are considered to have best quality, because they are more accepted by consumers (Patrignani *et al*., 2006) and do not require the addition of gums or other thickening ingredients.

The increase in the yoghurt texture parameters values with sweet potato addition can be related to the acidity of the products (Table 2) and to the greater amylose content due to the increased amount of added sweet potato juice (15%). According to Kailasapathy (2006), under more acidic conditions there is a rearrangement of casein resulting in more compact and continuous structure in the yoghurt. Although the amylose content of sweet potato (24.1%) is lower than that of corn (28.7%) (Tetchi *et al.* 2007), the sweet potato juice was added in larger quantities (15%) than the corn juice (10%), resulting

Table 1. Chemical composition (g/ 100g) of the prepared yoghurts

Parameters	Beet with carrot (10% each)	Cassava (10%)	Sweet Potato (15%)	Corn (10%)
Moisture	77.9 ± 0.2^{a}	76.5 ± 0.4^{b}	76.9 ± 0.2^{b}	76.9 ± 0.3^{b}
Protein	3.3 ± 0.1^{c}	3.4 ± 0.2^{bc}	3.5 ± 0.1^{b}	3.8 ± 0.1^{a}
Fat	2.5 ± 0.1^{b}	2.7 ± 0.1^{a}	2.6 ± 0.1^{b}	2.8 ± 0.0^{a}
Ash	0.9 ± 0.0^{a}	0.9 ± 0.0^{a}	0.9 ± 0.0^{a}	0.9 ± 0.1^{a}
Lactose	3.3 ± 0.4^{b}	4.5 ± 0.3^{a}	4.2 ± 0.1^{a}	3.6 ± 0.3^{b}
Carbohydrate*	15.3 ± 0.2^{c}	16.5 ± 0.5^{a}	16.2 ± 0.2^{ab}	15.6 ± 0.2^{bc}

Means ± standard deviation in the same line with different small letters superscripts indicating significant difference at $p \leq 0.05$ among formulations (n=6)
(*)Including lactose content

in increased amylose content. Higher concentrations of amylose cause increased starch retrogradation during the gel formation and, consequently, result in a firmer gel (Sandhu *et al*., 2010). Li *et al.* (2014) state that gels of sweet potato and corn starches exhibit greater firmness than cassava starch gels.

The texture parameters were stable during the storage period (p>0.05), with only a slight decrease in the cohesiveness in sweet potato yoghurts. Stability in texture parameters during storage is desirable because it indicates that products with weeks of storage have similar characteristics to those newly manufactured (Pimentel *et al*., 2012).

Probiotic viability

The results of the viability of probiotic culture during refrigerated storage are shown in Figure 1. The counts of the probiotic culture were similar (p>0.05) among the yoghurt formulations on the first day of storage, indicating that the micro-organism was present in the same amounts in all formulations. There was a significant decrease in the probiotic culture counts in all yoghurts with the increase in storage time (p≤0.05), but the counts on the 1st and 28th days were similar (p>0.05). The initial loss of viability of probiotic cultures may be related to the decrease in pH during storage (Table 2), due to the accumulation of organic acids. Further recovery of the viability can be related to the high amount of free amino acids released during storage (Donkor *et al*., 2006) and to the adaptation of the cultures to the environment.

The yoghurts contained greater than 10^7 CFU/mL of probiotic counts during the 28 days of refrigerated storage, therefore, the yoghurts showed higher counts than the recommended values (10^6 CFU/mL) to be

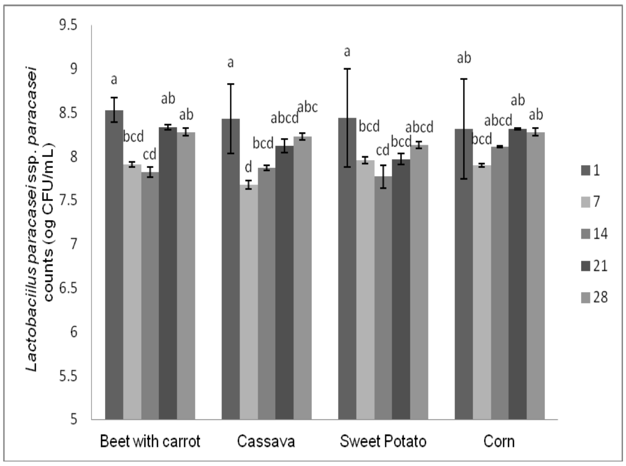

Figure 1. *Lactobacillus paracasei* ssp. *paracasei* (log CFU/mL) counts during refrigerated storage. Storage time (days): 1 (■), 7 (■), 14 (■), 21 (■) and 28 (■).The error bars represent the standard deviation (n = 6).

considered probiotics products (Donkor *et al*., 2007). The results indicate that there was good compatibility between the probiotic, the starter culture and the vegetables used and that it may be possible to use the health and functional claims attributed to probiotics (Pimentel *et al*., 2012). The higher acidity of the products with sweet potato or corn (Table 2) did not interfere in the probiotic counts. Therefore, it is possible to develop probiotic yoghurts flavored with juices of organic beet with carrot, corn, sweet potato or cassava.

Acceptance

In Table 3 are shown the results of acceptance (appearance, aroma, flavor, texture and overall impression), purchase intent and acceptability index of the prepared yoghurts. The acceptance in appearance, aroma, flavor, texture and overall

Table 2. Physicochemical and texture parameters of the yoghurts

Parameter	Days of storage	Beet with carrot (10% each)	Cassava (10%)	Sweet Potato (15%)	Corn (10%)
pH	1	4.6 ± 0.0^{aA}	4.5 ± 0.0^{bA}	4.5 ± 0.0^{bA}	4.6 ± 0.0^{aA}
	7	4.3 ± 0.1^{aB}	4.3 ± 0.0^{aB}	4.2 ± 0.0^{bB}	4.2 ± 0.1^{bB}
	14	4.1 ± 0.0^{bC}	4.1 ± 0.0^{bC}	4.1 ± 0.0^{bC}	4.2 ± 0.0^{aB}
	21	4.1 ± 0.0^{aC}	4.0 ± 0.0^{bD}	4.1 ± 0.0^{aC}	4.1 ± 0.0^{aC}
	28	4.1 ± 0.0^{aC}	4.1 ± 0.1^{aD}	4.0 ± 0.1^{bD}	4.0 ± 0.0^{bD}
L*	1	50.6 ± 0.6^{cA}	74.7 ± 1.2^{aA}	72.4 ± 0.4^{bA}	73.2 ± 0.4^{abA}
	7	50.1 ± 0.6^{cA}	73.8 ± 1.1^{aA}	72.3 ± 0.5^{bA}	72.9 ± 0.3^{abA}
	14	50.9 ± 0.5^{cA}	74.0 ± 1.3^{aA}	72.2 ± 0.4^{bA}	73.0 ± 0.4^{abA}
	21	51.0 ± 0.5^{cA}	74.8 ± 1.0^{aA}	72.8 ± 0.3^{bA}	73.3 ± 0.3^{abA}
	28	51.0 ± 0.5^{cA}	74.7 ± 1.2^{aA}	72.5 ± 0.5^{bA}	73.4 ± 0.4^{abA}
a*	1	30.7 ± 0.4^{aA}	2.1 ± 0.2^{bcA}	2.4 ± 0.1^{bA}	1.8 ± 0.1^{cA}
	7	30.4 ± 0.4^{aA}	2.0 ± 0.1^{bcA}	2.4 ± 0.1^{bA}	1.8 ± 0.1^{cA}
	14	30.8 ± 0.4^{aA}	2.1 ± 0.1^{bcA}	2.5 ± 0.1^{bA}	1.8 ± 0.1^{cA}
	21	30.9 ± 0.3^{aA}	2.2 ± 0.2^{bcA}	2.4 ± 0.1^{bA}	1.7 ± 0.2^{cA}
	28	30.7 ± 0.4^{aA}	2.2 ± 0.3^{bcA}	2.4 ± 0.1^{bA}	1.8 ± 0.1^{cA}
b*	1	2.3 ± 0.3^{cA}	6.3 ± 0.2^{bA}	5.8 ± 0.1^{bA}	10.5 ± 0.3^{aA}
	7	2.1 ± 0.3^{cA}	6.3 ± 0.2^{bA}	6.0 ± 0.2^{bA}	10.6 ± 0.2^{aA}
	14	2.1 ± 0.2^{cA}	6.3 ± 0.2^{bA}	5.9 ± 0.1^{bA}	10.4 ± 0.4^{aA}
	21	2.4 ± 0.4^{cA}	6.2 ± 0.3^{bA}	5.9 ± 0.1^{bA}	10.5 ± 0.3^{aA}
	28	2.31 ± 0.21^{cA}	6.32 ± 0.25^{bA}	5.8 ± 0.1^{bA}	10.5 ± 0.3^{aA}
Firmness (g)	1	24.8 ± 1.7^{bA}	25.6 ± 0.9^{bA}	31.2 ± 3.2^{aA}	24.9 ± 0.7^{bA}
	7	26.4 ± 1.1^{abA}	25.6 ± 0.4^{bA}	28.6 ± 1.7^{aA}	25.2 ± 0.2^{bA}
	14	25.7 ± 0.8^{bA}	25.4 ± 0.1^{bA}	29.6 ± 3.5^{aA}	25.6 ± 0.5^{bA}
	21	25.1 ± 0.4^{bA}	25.6 ± 0.6^{bA}	31.8 ± 0.4^{aA}	25.4 ± 0.2^{bA}
	28	24.8± 0.9^{bA}	25.5± 0.4^{bA}	31.6± 0.5^{aA}	25.5± 0.2^{bA}
Consistency (g.sec)	1	143.1 ± 7.3^{bA}	144.3 ± 7.31^{bA}	168.2 ± 14.9^{aA}	142.7 ± 1.5^{bA}
	7	150.1 ± 3.3^{abA}	146.7 ± 3.8^{abA}	156.4 ± 7.2^{aA}	140.7 ± 0.4^{bA}
	14	146.6 ± 6.2^{bA}	143.5 ± 4.6^{bA}	158.4 ± 14.7^{aA}	143.1 ± 2.8^{bA}
	21	141.3 ± 2.1^{bA}	143.0 ± 2.9^{bA}	169.2 ± 3.8^{aA}	141.3 ± 0.6^{bA}
	28	141.2± 2.4^{bA}	143.9± 1.8^{bA}	170.1± 1.1^{aA}	140.9± 0.5^{bA}
Cohesiveness (g)	1	5.7 ± 0.2^{bA}	5.8 ± 0.3^{bA}	10.5 ± 2.4^{aA}	6.6 ± 0.5^{bA}
	7	5.6 ± 0.1^{bA}	5.7 ± 0.1^{bA}	8.0 ± 1.1^{aC}	6.4 ± 0.2^{bA}
	14	5.7 ± 0.2^{bA}	5.8 ± 0.1^{bA}	7.8 ± 0.7^{aC}	6.4 ± 0.3^{bA}
	21	5.7 ± 0.3^{bA}	5.4 ± 0.3^{bA}	9.1 ± 0.1^{aB}	6.4 ± 0.5^{bA}
	28	5.6± 0.3^{bA}	5.5± 0.2^{bA}	9.1± 0.1^{aB}	6.0± 0.0^{bA}
Viscosity index (g.sec)	1	0.9 ± 0.1^{bA}	1.0 ± 0.2^{bA}	3.5 ± 1.8^{aA}	1.2 ± 0.2^{bA}
	7	0.9 ± 0.2^{bA}	0.9± 0.2^{bA}	2.2 ± 0.8^{aB}	1.1 ± 0.1^{bA}
	14	0.8 ± 0.2^{bA}	0.9 ± 0.1^{bA}	1.6 ± 0.4^{aB}	0.9 ± 0.1^{bA}
	21	0.8 ± 0.2^{bA}	0.7 ± 0.1^{bA}	3.0 ± 0.4^{aA}	0.7 ± 0.1^{bA}
	28	0.8± 0.2^{bA}	0.7± 0.1^{bA}	2.8± 0.3^{aA}	0.7± 0.1^{bA}

L^* ranging from 0 (black) to 100 (white), a^* ranging from red ($+a^*$) to green ($-a^*$), b^* ranging from yellow ($+b^*$) to blue ($-b^*$)

Means ± standard deviation in the same row followed by different lowercase letters indicate statistically significant differences at $p \leq 0.05$ between formulations of yoghurts for the same storage day. Means ± standard deviation in the same column followed by different uppercase letters indicate statistically significant differences at $p \leq 0.05$ for each formulation affected by the storage time (n=6)

Table 3. Acceptance, purchase intent e acceptability of the yoghurts

Parameter	Beet with carrot (10% each)	Cassava (10%)	Sweet Potato (15%)	Corn (10%)
Appearance	7.9 ± 1.2^{a}	8.3 ± 0.9^{a}	8.0 ± 1.1^{a}	7.3 ± 1.8^{b}
Aroma	6.6 ± 1.9^{bc}	7.5 ± 1.6^{a}	7.3 ± 1.7^{ab}	6.0 ± 2.3^{c}
Flavor	6.7 ± 2.3^{b}	7.9 ± 1.3^{a}	7.3 ± 2.0^{ab}	5.7 ± 2.7^{c}
Texture	7.4 ± 1.6^{a}	7.4 ± 1.8^{a}	7.6 ± 1.6^{a}	6.0 ± 2.5^{b}
Overall Impression	7.3 ± 1.9^{a}	7.9 ± 1.4^{a}	7.6 ± 1.6^{a}	6.2 ± 2.4^{b}
Purchase Intent	3.7 ± 1.2^{b}	4.2 ± 0.9^{a}	3.9 ± 1.2^{ab}	3.0 ± 1.5^{c}
Acceptability	80%	87%	84%	69%

Means ± standard deviation within a row with different lowercase letters indicate ($p \leq 0.05$) differences between formulations of yoghurts for the same sensory attribute
Hedonic Values (appearance, aroma, flavor, texture and overall impression): 1 - disliked extremely; 9- liked extremely
Purchase Intent: 1- definitely not buy; 5 - certainly buy

impression of beet with carrot, cassava and sweet potato yoghurts was higher ($p \leq 0.05$) than that of corn yoghurt. The addition of corn starch to yoghurts increases the viscosity, but can result in a grainy texture and diminished acceptance of the products by consumers (Williams *et al.*, 2004).

The other yoghurts (beet with carrot, cassava and sweet potato) did not differ ($p > 0.05$) in the evaluated acceptance in appearance, texture and overall impression. For aroma, taste and purchase intent, cassava yoghurt showed greater acceptance ($p \leq 0.05$) than the beet with carrot yoghurt. Cassava and sweet potato yoghurts were similar ($p > 0.05$) for these parameters. The results indicate that the higher acidity and the fact that the sweet potato yoghurt was firmer and more cohesive, consistent and viscous did not affect how consumers liked the yoghurt and the desire to consume or purchase the product.

All formulated yoghurts showed acceptance scores higher than 6 in all attributes (except for corn yoghurt score for flavor), indicating that the judges liked at least slightly the products. The acceptance scores in aroma, flavor and texture indicate that it is possible to prepare yoghurts with adequate sensory characteristics using juices of vegetables, without the addition of flavorings or thickening ingredients.

Regarding the sensory properties, a product is considered accepted when it reaches acceptability index of at least 70% (Dutcocky, 2007), so the yoghurts flavored with beet with carrot, cassava or sweet potato reached the required standard. In the case of corn yoghurt, the aroma, taste and texture should be improved in order to increase the acceptability of the product.

Conclusions

It is concluded that the use of organic beet with carrot, cassava or sweet potato juice to flavor yoghurt results in products with appropriate nutritional, physicochemical, textural and sensory characteristics, and an adequate probiotic viability (*Lactobacillus paracasei* ssp. *paracasei*) for 28 days of refrigerated storage. The differences between the studied yoghurts are related to the characteristics of the vegetables. In the case of corn yoghurt, the aroma, taste and texture should be improved before commercialization, as the product has suitable nutritional, physicochemical and textural properties and probiotic culture viability.

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References

Akalin, A.S., Gönç, G., Ünal, G. and Fenderya, S. 2007. Effects of fructooligosaccharide and whey protein concentrate on the viability of lactic culture in reduced-fat probiotic yoghurt during storage. Journal of Food Science 72(7): 222-227.

AOAC (Official Methods of Analysis). 2004. 15th Ed., Association of Official Analytical Chemists, Washington, DC., USA.

Aportela-Palacios, A., Sosa-Morales, M.E. and Vélez-

Ruiz, J.F. 2005. Rheological and physicochemical behavior of fortified yoghurt, with fiber and calcium. Journal of Texture Studies 36(3): 333-349.

Aryana, K.J. and McGrew, P. 2007. Quality attributes of yoghurt with *Lactobacillus casei* and various prebiotics. LWT 40(10): 1808-1814.

Bakirci, I. and Kavaz, A. 2008. An investigation of some properties of banana yoghurts made with commercial ABT-2 starter culture during storage. International Journal of Dairy Technology 61(3): 270-276.

Bakri, J.M.E. and Zubeir, E.M.E. 2009. Chemical and microbiological evaluation of plain and fruit yoghurt in Khartoum State, Sudan. International Journal of Dairy Science 4(1): 1-7.

Balthazar, C.F., Gaze, L.V., da Silva, H.L.A, Pereira, C.S., Franco, R.M, Conte-Júnior, C.A, de Freitas, M.Q. and Silva, A.C.O. 2015 Sensory evaluation of ovine milk yoghurt with inulin addition. International Journal of Dairy Technology 68(2): 281-290.

Bilich, F.B. 2010 Análise da distribuição de olerícolas orgânicas no Distrito Federal. Dissertação (Mestrado em Agronegócios), Universidade de Brasília, Brasília. 74p.

Bianchi, F., Rossi, E.A., Sakamoto, I.K., Adorno, M.A.T, Van de Wiele, T. and Sivieri, K. 2014. Beneficial effects of fermented vegetal beverages on human gastrointestinal microbial system in a simulator. Food Research International 64: 43-52.

Brasil. Ministério da Agricultura, Pecuária e Abastecimento e da Reforma Agrária, Resolução nº5 de13 de novembro de 2000. 2000. Oficializa os ―Padrões de Identidade e Qualidade (PIQ) de Leites Fermentados. Diário Oficial da República Federativa do Brasil, Brasília.

Cliff, M.A., Fan, L., Sanford, K., Stanich, K., Doucette, C. and Raymond, N. 2013. Descriptive analysis and early-stage consumer acceptance of yoghurts fermented with carrot juice. Journal of Dairy Science 96(7): 4160-4172.

Collins, J.L., Ebah, C.B., Mount, J.R., Demott, B.J. and Draughon, F.A. 1991. Production and evaluation of milk-sweet potato mixtures fermented with yoghurt bacteria. Journal of Food Science 56(3): 685-688.

Donkor, O.N., Nilmini, S.L.I., Stolic, P., Vasiljevic, T. and Shah, N.P. 2007. Survival and activity of selected probiotic organisms in set-type yoghurt during cold storage. International Dairy Journal 17(6): 657-665.

Donkor, O.N., Henriksson, A., Vasiljevic, T. and Shah, N.P. 2006. Effect of acidification on the activity of probiotics in yoghurt during cold storage. International Dairy Journal 16(10): 1181-1189.

Dutcocky, S.D. 2007. Análise Sensorial de Alimentos. 2nd Ed, Curitiba: Ed. Champagnat. 239p.

FAO/ WHO. Guidelines for the evaluation of probiotics in food. 2002. Report of a Joint Food and Agriculture Organization of the United Nations, World Health Organization Working Group of Drafting Guidelines for the Evaluation of Probiotic in food, Ontario, Canadá. Available in: *ftp://ftp.fao.org/es/esn/food/wgreport2.pdf.*

Food and Agriculture Organization of the United Nations (FAO). 2004. Production of fruits and vegetables and share in the world. Available in: < *http://faostat.fao.org/site/339/default.aspx*>.

Kailasapathy, K. 2006. Survival of free and encapsulated probiotic bacteria and their effect on the sensory properties of yoghurt. LWT 39(10): 1221–1227.

Li, S., Zhang, Y., Wei, Y., Zhang, W. and Zhang, B. 2014. Thermal, pasting and gel properties of commercial starches from different botanical sources. Bioprocessing and Biotechnology 4: 1-6.

Ogawa, T., Asai, Y., Tamai, R., Makimura, Y., Sakamoto, H., Hashikawa, S. and Yasuda, K. 2005. Natural killer cell activities of synbiotic *Lactobacillus casei* ssp. *casei* in conjunction with dextran. Clinical and Experimental Imunology 143(1): 103-109.

Pan, T., Guo, H.Y, Zhang, H., Liu, A.P., Wang, X.X. and Ren, F.Z. 2014. Oral administration of *Lactobacillus paracasei* alleviates clinical symptoms of colitis induced by dextran sulphate sodium salt in BALB/c mice. Beneficial Microbes 5(3): 315-322.

Patrignani, F., Lanciotti, R., Mathara, J.M., Guerzoni, M.E. and Holzapfel, W.H. 2006. Potential of functional strains, isolated from traditional Maasai milk, as starters for the production of fermented milks. International Journal of Food Microbiology 107(1): 1-11.

Pimentel, T.C., Garcia, S. and Prudencio, S.H. 2012. Effect of long-chain inulin on the texture profile and survival of *Lactobacillus paracasei* ssp. *paracasei* in set yoghurts during refrigerated storage. International Journal of Dairy Technology 65(1): 104-110.

Pimentel, T.C., Cruz, A.G. and Prudencio, S.H. 2013. Short communication: Influence of long-chain inulin and *Lactobacillus paracasei* subspecies *paracasei* on the sensory profile and acceptance of a traditional yogurt. Journal of Dairy Science 96(10): 6233-6241.

Pimentel, T.C., Madrona, G.S. and Prudencio, S.H. 2015. Probiotic viability, physicochemical characteristics and acceptability during refrigerated storage of clarified apple juice supplemented with *Lactobacillus paracasei* ssp. *paracasei* and oligofructose in different package type. LWT – Food Science and Technology 63(1): 415-422.

Pinheiro, M.V.S, Oliveira, M.N., Penna, A.L.B. and Tamime, A.Y. 2005. The effect of different sweeteners in low-calorie yoghurts — a review. International Journal of Dairy Technology 58(4): 193-199.

Renuka, B., Kulkarni, S.G., Vijayanand, P. and Prapulla, S.G. 2009. Fructooligosaccharide fortification of selected fruit juice beverages: effect on the quality characteristics. LWT- Food Science and Technology 42(5): 1031-1033.

Sandhu, K.S., Kaur, M. and Mukesh. 2010. Studies on noodle quality of potato and rice starches and their blends in relation to their physicochemical, pasting and gel textural properties. LWT - Food Science and Technology 43(8): 1289-1293.

Salwa, A.A., Galal, E.A. and Neimat, A.E. 2004. Carrot yoghurt: sensory, chemical, microbiological properties and consumer acceptance. Pakistan Journal of Nutrition 3(6): 322-330.

Stone, H. and Sidel, J. 2004. Sensory evaluation practices. 3th ed. New York: Academic Press.

Tabela Brasileira de Composição de Alimentos/ NEPA –UNICAMP 2011 4th ed. Campinas: NEPA-UNICAMP. 161 p.

Trakçi, Z. and Küçüköner, E. 2003. Physical, chemical, microbiological and sensory characteristics of some fruit-flavored yoghurt. YYU Veterinary Faculty Journal 14(2): 10-14.

Tetchi, F.A., Rolland-Sabaté, A., Amani, GN'G. and Collona, P. 2007. Molecular and physicochemical characterisation of starches from yam, cocoyam, cassava, sweet potato and ginger produced in the Ivory Coast. Journal of the Science of Food and Agriculture 87(10): 1906–1916.

Tharmaraj, N. and Shah, N.P. 2009. Antimicrobial effects of probiotics against selected pathogenic and spoilage bacteria in cheese-based dips. International Food Research Journal 16: 261-276.

Tofanelli, M.B.D., Fernandes, M.S., Carrijo, N.S. and Martins Filho, O.B. 2009. Levantamento de perdas em hortaliças frescas na rede varejista de Mineiros. Horticultura Brasileira 27(1): 116-120.

Williams, R.P.W., Glagovskaia, O. and Augustin, M.A. 2004. Properties of stirred yoghurts with added starch: effects of blends of skim milk powder and whey protein concentrate on yoghurt texture. Australian Journal of Dairy Technology 59(3): 214-220.

Zhang, H., Wang, Y., Sun, J., Guo, Z., Guo, H. and Ren, F. 2013a. Safety Evaluation of *Lactobacillus paracasei* subsp. *paracasei* LC-01, a probiotic bacterium. Journal of Microbiology 51(5): 633-638.

Zhang, H., Sun, J., Liu, X., Hong, C., Zhu, Y., Liu, A., Li, S., Guo, H. and Ren, F. 2013b. *Lactobacillus paracasei* subsp. *paracasei* LC01 positively modulates intestinal microflora in healthy young adults. Journal of Microbiology 51(6): 777-782.

Xiao, J., Li, S., Sui, Y., Wu, Q., Li, X., Xie, B., Zhang, M. and Sun, Z. 2014. *Lactobacillus casei*-01facilitates the ameliorative effects of proanthocyanidins extracted from lotus seedpod on learning and memory impairment in scopolamine-induced amnesia mice. Plos One 9: 1-9.

Warakaulle, S.T.S.K., Weerathilake, W.A.D.V. and Abeynayake, N.R. 2014. Production and evaluation of set type yoghurt incorporated with water melon *(Citrallus lanatus)*. International Journal of Scientific and Research Publications 4: 1-4.

Zicker, M.C. 2011. Obtenção e utilização do extrato aquoso de Jabuticaba (*Myrciaria jabuticaba* (Vell) Berg) em leite fermentado: caracterização físico-química e sensorial. Dissertation (Master in Food Science), Universidade Federal de Minas Gerais, Belo Horizonte. 139p.