

## Kefir ice cream flavored with fruits and sweetened with honey: physical and chemical characteristics and acceptance

<sup>1</sup>Januário J.G.B., <sup>1</sup>Oliveira, A.S., <sup>2</sup>Dias, S.S., <sup>2</sup>Klososki, S.J. and <sup>2\*</sup>Pimentel, T.C.

<sup>1</sup>Instituto Federal do Paraná – Campus Ivaiporã, PR 466, Gleba Pindaúva, Secção C, Parte 2, 86870-000, Ivaiporã, Paraná, Brasil

<sup>2</sup>Instituto Federal do Paraná – Campus Paranavaí, Rua José Felipe Tequinha, 1400, Jardim das Nações, 87703-536, Paranavaí, Paraná, Brasil

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### Abstract

The physical and chemical characteristics and the acceptance of Kefir ice cream flavored with banana, guava, lemon or passion fruit and sweetened with honey were evaluated and compared to those of a commercial pineapple ice cream. Kefir ice creams were more acidic (pH 5.6-6.1) and had lower content of proteins (3.49-4.74 g/100g), lipids (3.54-6.85 g/100g, except lemon ice cream, 9.9 g/100g) and ashes (0.78-1.05 g/100g) than the commercial product, but greater melting resistance. Banana ice cream showed firmness, cohesiveness and overall acceptance similar to the commercial product, but lower appearance and texture scores. The other ice creams had lower overall acceptance, but the consumers liked slightly to moderate the products. It can be concluded that it is possible to develop fruit-flavored ice creams with Kefir fermented milk and sweetened with honey that have physicochemical and acceptance similar to conventional ice creams available in the market.

### Keywords

Kefir

Ice cream

Probiotics

Fermentation

Sensory analysis

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### Introduction

In recent decades, consumers have increased awareness about health and quality of life, which has encouraged people to exercise, adopt healthy eating habits, and increase their consumption of foods with health benefits (Pinheiro *et al.*, 2005). Kefir is a fermented milk produced by incubating milk with Kefir grains (Satir and Guzel-Seydim, 2016). The grains are composed of a polysaccharide matrix of glucose and galactose, called Kefiran, in which a complex microbiota coexists in a symbiotic relationship. This microbiota is composed of lactic acid bacteria, acetic acid bacteria and yeasts (Magalhães *et al.*, 2011). Some of these cultures have probiotic properties, such as *Leuconostoc mesenteroides*, *Lactobacillus kefiranofaciens*, *Lactobacillus casei* and *Saccharomyces cerevisiae* (Leite *et al.*, 2015; Zanirati *et al.*, 2015).

The fermented milk Kefir has shown positive effects on the immune system, the gastrointestinal system and the metabolism of cholesterol. Some antitumor, antibacterial and antifungal properties have been demonstrated in vitro, animals or humans studies (Hertzler and Clancy, 2003; Vinderola *et al.*, 2006; De La Blanc *et al.*, 2007). For this reason, there has been increasing interest in the development and

improvement of products with Kefir.

Ice cream is a product of high sensory acceptance, recognized worldwide, and with high probability of business growth, because of the countless flavor options and their combinations. The production of ice cream using health promoting ingredients or with replacement of ingredients with risk factors for certain diseases, such as the addition of probiotic cultures and the replacement of sucrose, are areas with great potential for development (Souza *et al.*, 2010).

The ice-cream matrix might be a good vehicle for probiotic cultures, due to its composition, which includes milk proteins, fat and lactose, as well as other compounds. Moreover, the fact that it is a frozen product and the high pH values (5.5 to 6.5) certainly contributes to the survival of the beneficial cultures (Cruz *et al.*, 2009; Ferraz *et al.*, 2012). The incorporation of prebiotic compounds is also an alternative for functional ice creams (Balthazar *et al.*, 2015).

Honey bees had an increase in consumption due to its attractive color, pleasant aroma and sweet sour mouthfeel, besides being a natural source of antioxidants and other functional benefits, such as hypolipidemic, anticholesterolemic and antiatherogenic effects (Fiorda *et al.*, 2016). There

\*Corresponding author.

Email: [tatiana.pimentel@ifpr.edu.br](mailto:tatiana.pimentel@ifpr.edu.br)

are no studies that evaluate the applicability of Kefir fermented milk in the preparation of ice cream and the use of honey as sucrose substitute in Kefir ice cream. Therefore, the objective of this study was to characterize physically and chemically and to evaluate the acceptance of Kefir ice cream flavored with banana, lemon, guava or passion fruit and sweetened with honey, comparing them with a commercial ice cream flavored with pineapple and sweetened with sucrose.

## Materials and Methods

### Activation of Kefir grains

The Kefir grains were activated in whole milk (Cativa<sup>®</sup>) at 25°C in Bio Oxygen Demand (BOD) for one month by daily propagation (24 hours) (Montanuci *et al.*, 2012).

### Preparation of the Kefir fermented milk

For the preparation of Kefir fermented milk, whole milk (Cativa<sup>®</sup>) was added honey (160g/L) (Flora Apis<sup>®</sup>) and skimmed milk powder (75g/L) (Molico<sup>®</sup>), pasteurized in water bath at 85°C/30 min and cooled to 25°C in an ice bath. Then, 20 g/L of the activated Kefir grains were inoculated and the milk base was incubated at 25°C for 24h (Satir and Guzel-Seydim, 2016). Thereafter, the Kefir grains were removed by filtration using a sieving cloth and the fermented milk was stored at 4°C for 1 day until being used in the preparation of the ice cream.

### Preparation of Kefir ice creams flavored with fruits and sweetened with honey

The ice creams were prepared based on the formulation proposed by Gandolfi and Muller (2014), with modifications. Formulas of the mixes are shown in Table 1. The steps for production were based on those proposed by Homayouni *et al.* (2008) and Munhoz *et al.* (2010) for conventional ice cream, with modifications.

The fruits were washed, sanitized and stripped. Lemon and passion fruit were subjected to juice extraction using a commercial juice extractor (Walita<sup>®</sup>), while the pulps of banana and guava were obtained by processing the fruits in a blender (Walita<sup>®</sup>) for 2 minutes at medium speed. After that, the pulp or juices were mixed with Kefir fermented milk, pasteurized cream (Lider<sup>®</sup>) and Liga Neutra stabilizer (Emustab<sup>®</sup>).

The mixture was homogenized for 10 minutes in a blender and aged at 4°C for 12 hours to ensure complete hydration of all ingredients. Then, the mix was subjected to the 1st freezing (-25°C / 15 hours)

Table 1. Formulations of the ice creams

Ingredient (g)	Banana	Passion	Guava	Lemon
	Fruit			
Kefir fermented milk	1235	1235	1235	1235
Cream	75	75	75	75
Emulsifier	10	10	10	10
Stabilizer	3	3	3	3
Pulp/Juice	397	133	530	133

followed by addition of an emulsifier (Emustab<sup>®</sup>) and beat for 20 minutes in a household mixer (Walita<sup>®</sup>) for the incorporation of air until the emulsion formation. Then, the 2nd freezing occurred (-25°C / 17hours).

The fruits were added to the products in concentrations of 30g/100g for banana, 40g/100g for guava, 10g/100g for lemon and 10g/100g for passion fruit, based on preliminary assessments of the sensory characteristics (appearance, aroma, flavor and texture) of the products (data not shown).

Kefir ice creams are not available in the market, therefore, the formulations of this study were compared to a commercial ice cream (Treviso<sup>®</sup>) flavored with pineapple. This flavor was chosen because pineapple is a sour fruit, originating products with similar characteristics of those developed in this work. Furthermore, pineapple is the third fruit flavor ice cream most consumed in Brazil (ABIS, 2010). The frozen yogurt has more similar characteristics to the products prepared in this study, however, its production and consumption are still low in Brazil (ABIS, 2015).

### Chemical composition evaluation

The chemical composition was determined by the following procedures: moisture in an oven with air circulation at 80°C for 24 hours, ash by incineration at 550°C in muffle furnace, lipids by solvent extraction method (Sohxlet method), protein by the Kjeldahl method and carbohydrates by difference, according to the methodologies proposed by the AOAC (2004). Total nitrogen was converted to crude protein by a factor of 6.38.

### Physical and chemical characteristics of the ice creams

The pH of the ice creams was determined using a calibrated digital pH meter (Hanna-Instruments HI 3221<sup>®</sup>). In order to determine the increase in volume of ice-cream with respect to that of ice-cream mix, the overrun values were determined and calculated on a weight basis using the formula described by

Table 2. Chemical composition (g/100g) of the ice creams\*

Parameter	Formulation				
	Banana	Passion Fruit	Guava	Lemon	Pinneapple (Commercial)
Moisture	75.93 ± 0.04 <sup>c</sup>	79.26 ± 0.32 <sup>a</sup>	76.93 ± 0.20 <sup>b</sup>	77.42 ± 0.30 <sup>b</sup>	64.28 ± 0.17 <sup>d</sup>
Protein	3.49 ± 0.82 <sup>b</sup>	4.74 ± 0.45 <sup>b</sup>	4.10 ± 0.26 <sup>b</sup>	4.16 ± 0.75 <sup>b</sup>	5.83 ± 0.10 <sup>a</sup>
Lipids	4.00 ± 0.38 <sup>c</sup>	6.85 ± 1.42 <sup>b</sup>	3.54 ± 0.34 <sup>c</sup>	9.90 ± 1.50 <sup>a</sup>	8.96 ± 0.71 <sup>ab</sup>
Ash	1.05 ± 0.05 <sup>b</sup>	0.78 ± 0.02 <sup>c</sup>	1.05 ± 0.00 <sup>b</sup>	0.99 ± 0.04 <sup>b</sup>	1.78 ± 0.03 <sup>a</sup>
Carbohydrate	15.53 ± 1.19 <sup>a</sup>	8.37 ± 2.16 <sup>b</sup>	14.38 ± 0.05 <sup>a</sup>	7.53 ± 1.53 <sup>b</sup>	13.11 ± 2.03 <sup>a</sup>

\*Means ± standard deviation in the same row followed by different letters indicate statistically significant differences at  $p = 0.05$  ( $n=6$ )

Muse and Hartel (2004): overrun =  $[(W1 - W2)/W2] \times 100$ , where  $W1$  = weight of 250 mL of the mix and  $W2$  = weight of 250 mL of ice cream.

The meltdown test was conducted according to Granger *et al.* (2005). The ice cream samples (40 g), at a temperature of  $-25^{\circ}\text{C}$ , were placed on a 1 mm stainless steel mesh over a beaker and the amount of ice cream drained into the beaker was weighted every 10 min until total loss of structure. Then, melted weight (%) was plotted against the time (minutes).

Texture analysis (firmness, cohesiveness, consistency and index of viscosity) was conducted at room temperature ( $20^{\circ}\text{C}$ ) using a Texture Analyzer (TAXT Plus, Stable Microsystems<sup>®</sup>) equipped with a 3.6 cm diameter stainless steel cylindrical probe. Ice cream samples stored at  $-25^{\circ}\text{C}$  were tempered to  $-10^{\circ}\text{C}$  for 24 h before analysis and cut in squares of 4 cm each side. The conditions for analysis were as follows: penetration distance = 10 mm, force = 1.0 g, probe speed pre and during penetration = 1 mm/s and probe speed post penetration = 10.0 mm/s.

The color of ice creams was measured with a Minolta CR-400 colorimeter (Minolta<sup>®</sup>). The colorimeter had an 11 mm diameter viewing area and was calibrated with a white tile. The measurements were recorded as  $L^*$  (lightness),  $a^*$  (redness) and  $b^*$  (yellowness) color co-ordinates.

#### Sensory characteristics evaluation

The sensory panel was composed of 100 untrained individuals (61 women and 39 men), where 86 aged 15-25 years old, 8 aged 25-35 years old, 5 aged 35-50 years old, and 1 was over 50 years. The acceptance testing of attributes (appearance, aroma, flavor and overall acceptance) using a 9-point hedonic scale (1 = disliked very much and 9 = liked very much) (Morais *et al.*, 2014; Paixão *et al.*, 2014; Dos Santos *et al.*, 2015; Horita *et al.*, 2016) and the purchase intent test using a 5-point scale (1 = would certainly not buy and 5 = would certainly buy) (Stone

and Sidel 2004) were performed on the first 3 days of storage of the product.

The judges evaluated the five formulations in the same session. During the session, the three-digit coded formulations at a temperature of  $-10^{\circ}\text{C}$  were evaluated one at a time in random order. Drinking water at room temperature and cream crackers were provided to clean the mouth before and between evaluations of the formulations. This project was approved by the Ethics Committee Involving Human Beings of the Ecoville Hospital (Number: 1.199.390; CAAE: 44477815.3.0000.5227).

#### Statistical analysis

The complete experiment was replicated two times using a completely randomized design. The chemical composition and physical and chemical characteristics were performed in triplicates in each experiment repetition on the first day of storage, except color and texture that were evaluated seven times in each repetition. In 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 of the ice creams

The results of the chemical composition of the ice creams are shown in Table 2. Considering only the Kefir ice creams, they had similar levels ( $p > 0.05$ ) of protein content. The higher moisture content ( $p \leq 0.05$ ) was found in passion fruit ice cream, while the highest content of lipids was observed in the lemon ice cream. Considering the ash content, the passion fruit ice cream had the lowest content. Finally, the

Table 3. Physical and chemical characteristics of the ice creams\*

Parameter	Formulation				
	Banana	Passion Fruit	Guava	Lemon	Pinneapple (Commercial)
Overrun (%)	87.5 ± 3.5 <sup>c</sup>	143.0 ± 9.9 <sup>a</sup>	84.5 ± 3.5 <sup>c</sup>	118.0 ± 0.3 <sup>b</sup>	ND
pH	6.1 ± 0.2 <sup>b</sup>	5.6 ± 0.1 <sup>c</sup>	5.9 ± 0.2 <sup>b</sup>	6.0 ± 0.1 <sup>b</sup>	6.5 ± 0.1 <sup>a</sup>
L*	67.4 ± 0.2 <sup>c</sup>	79.9 ± 0.2 <sup>a</sup>	71.5 ± 1.0 <sup>b</sup>	81.1 ± 0.2 <sup>a</sup>	81.1 ± 0.6 <sup>a</sup>
a*	1.7 ± 0.1 <sup>b</sup>	-1.5 ± 0.1 <sup>c</sup>	4.0 ± 1.1 <sup>a</sup>	-2.2 ± 0.1 <sup>c</sup>	-4.3 ± 0.2 <sup>d</sup>
b*	9.8 ± 0.2 <sup>c</sup>	17.6 ± 0.3 <sup>a</sup>	12.4 ± 1.1 <sup>b</sup>	9.9 ± 0.2 <sup>b</sup>	17.8 ± 0.8 <sup>a</sup>
Firmness (g)	570 ± 73 <sup>bc</sup>	935 ± 268 <sup>ab</sup>	1448 ± 553 <sup>a</sup>	113 ± 8.0 <sup>c</sup>	277 ± 19 <sup>c</sup>
Cohesiveness	157 ± 36 <sup>b</sup>	277 ± 82 <sup>a</sup>	189 ± 34 <sup>ab</sup>	42 ± 4 <sup>c</sup>	111 ± 6 <sup>bc</sup>
Consistency (g.sec)	3814 ± 522 <sup>b</sup>	5880 ± 721 <sup>a</sup>	6427 ± 1711 <sup>a</sup>	619 ± 32 <sup>c</sup>	1574 ± 272 <sup>c</sup>
Viscosity (g.sec)	37.2 ± 5.1 <sup>ab</sup>	50.0 ± 14.4 <sup>a</sup>	41.6 ± 5.8 <sup>ab</sup>	9.7 ± 2.3 <sup>b</sup>	28.1 ± 7.5 <sup>c</sup>

\*Means ± standard deviation in the same row followed by different letters indicate statistically significant differences at p = 0.05 (n=6 for overrun and pH; n=14 for L\*, a\*, b\*, firmness, cohesiveness, consistency and viscosity)

ND = not determined

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

highest concentration of carbohydrates was observed in the banana and guava ice creams. Variations in the chemical composition of the Kefir ice creams are consistent with the composition and concentration of the fruits used (Brazilian Table of Food Composition, 2011).

The Kefir ice creams had a lower content ( $p \leq 0.05$ ) of ashes, lipids (except lemon ice cream) and proteins than the commercial ice cream, but higher moisture content. For the carbohydrate content, the commercial, banana and guava ice creams had similar values ( $p > 0.05$ ). The differences in the chemical composition are related to the amount and type of ingredients used to prepare the products, and to the fact that the milk in Kefir ice cream was fermented. In fact, the Kefir ice creams were prepared using fermented milk Kefir, cream, emulsifier/stabilizer and fruits. The commercial ice cream had the basic ingredients (whole milk, whole milk powder, sugar, salt, sucrose, vegetable fat and pineapple pulp) and many others, such as carboxymethylcellulose, guar gum, distilled monoglycerides, sorbitan monostearate, polysorbate 60, modified starch, corn starch, cassava starch, fumaric acid, artificial flavor of pineapple, and artificial dyes (yellow tartrazine and sunset yellow). In recent years there has been an increased demand by consumers for “natural” products, requiring the use of the least possible amount of additives (Miao *et al.*, 2016). Thus, the products formulated in this study meet this demand.

Although there were differences in chemical

composition between the ice creams made in this study and the commercial product, other studies report similar chemical composition for ice cream with fermented milk (Silva *et al.*, 2015.) or for the traditional products (ABIS, 2015; Dertli *et al.*, 2016) when compared to the Kefir ice creams. However, the use of honey and the addition of fruits have caused a decrease in the total solids content. It is noteworthy that the Kefir ice cream could bring benefits to consumer health associated with the presence of probiotic cultures (Hertzler and Clancy, 2003; Vinderola *et al.*, 2006; De La Blanc *et al.*, 2007).

#### *Physical and chemical characteristics of the ice creams*

In Table 3 are presented the results of the physical and chemical characteristics of the ice creams. The pH of Kefir ice creams were in the range from 5.6 to 6.1 after 1 day of storage. Cruz *et al.* (2009) reported that the pH of ice cream is between 5.5 and 6. The banana, guava and lemon ice creams showed no significant differences in pH ( $p > 0.05$ ), while the passion fruit ice cream had the lowest pH ( $p \leq 0.05$ ).

When compared to commercial ice cream, the Kefir ice creams had lower pH independently of the fruit used, indicating that the formulated products were more acidic. This is due to the fact that commercial ice cream was produced from non-fermented milk and Kefir ice creams were prepared with fermented milk (Kefir). The greater acidity of Kefir ice creams can protect them from the development of food



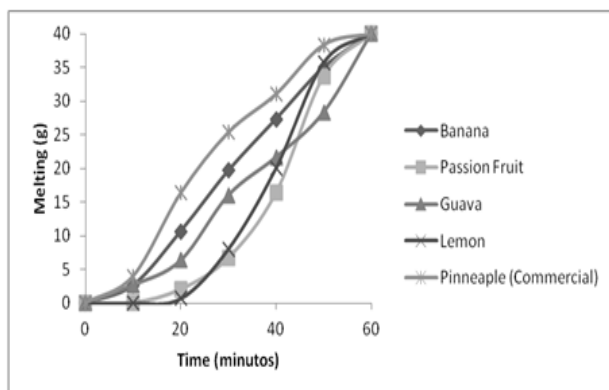


Figure 1. Melting rate of the ice creams (g/min)

spoilage microorganisms, thereby increasing their shelf life, although these products are freezing stored. However, the acidity can change the sensory characteristics of the products, resulting in a lower acceptance by consumers (Cruz *et al.*, 2009; Pimentel *et al.*, 2015; Pimentel, Madrona and Prudencio, 2015; Costa *et al.*, 2017).

The guava ice cream had orange color (positive values for  $a^*$  and  $b^*$ ), while the banana ice cream had brownish color (positive values for  $a^*$  and  $b^*$  and lower  $L^*$  value). The lemon and passion fruit ice creams showed greenish yellow color (negative  $a^*$  value and positive  $b^*$  value), with more pronounced yellow color in the passion fruit product (more positive  $b^*$  value).

When compared to pineapple flavored commercial ice cream, passion fruit ice cream showed similarity ( $p > 0.05$ ) in  $L^*$  and  $b^*$  parameters. The fruits used in this study (guava, banana, passion fruit and lemon) were different from the fruit in the commercial ice cream (pineapple), which explains the instrumental color differences. It is noteworthy that the ice creams prepared in this study were not added dye, while the commercial ice cream had two artificial dyes (yellow tartrazine and sunset yellow). The color is one of the primary attributes of food quality (Renuka *et al.*, 2009).

Considering the texture parameters, the lemon ice cream presented firmness, consistency and cohesiveness similar ( $p > 0.05$ ) to the commercial ice cream. Similarly, the banana ice cream showed similar firmness and cohesiveness ( $p > 0.05$ ) to the commercial ice cream.

However, ice cream flavored with guava and passion fruit had increased texture parameters, i.e., guava and passion fruit ice creams were firmer, more consistent and had higher viscosity ( $p \leq 0.05$ ) than the commercial ice cream. With respect to cohesiveness, the passion fruit ice cream was more cohesive ( $p \leq 0.05$ ) than the commercial product. The increase in texture parameters on guava ice cream can be related

to the presence of pectin polymers in the guava pulp (Spiller, 2012). For the passion fruit ice cream, the higher acidity may have contributed to the alterations (Table 3).

The lemon and passion fruit ice creams had higher ( $p \leq 0.05$ ) overrun values than the guava and banana ice creams, which may be related to the lower pH of the passion fruit ice cream and the lower viscosity of these products (Table 3). Allen *et al.* (2006) reported that lower pH values might be responsible for improvements in the capacity of air incorporation of the ice cream mixture. Silva Junior and Lannes (2011) reported that more viscous systems do not favor foaming capacity. Hence, this parameter could have been the primary cause for the decrease in whipping ability of the guava and banana ice creams.

The overrun values were 84-143% (840-1430 g/L), depending on the type of fruit used. These results corroborate previous studies (Oliveira *et al.*, 2008; Homayouni *et al.*, 2008). Arbutcke (2006) reported overrun values between 50 and 100%, reaching 150% in some cases. The Brazilian legislation stipulates the minimum degree of overrun that ice-creams can show as 475 g/L, independently of the type of ice-cream, and refers to this parameter as apparent density (Brasil, 2005; Cruz *et al.*, 2009).

The high overrun values presented in this study may be related to the use of fermented milk (Kefir) in the preparation of the ice cream. Exopolysaccharides (EPS) produced by micro-organisms during the fermentation process can assist in the formation of a matrix capable of retaining oxygen more efficiently, increasing the amount of entrained air. In addition, the EPS are polysaccharides, having foam stabilization properties; which lead more air adsorption (Dertli *et al.*, 2016). Higher overrun values are preferred due to inhibition of ice crystals, enhancing the melting resistance and improving of foam stability during the storage period (Dertli *et al.*, 2016).

In Figure 1 is shown the melting rate of ice cream formulations. The ice creams flavored with lemon and passion fruit had lower ( $p \leq 0.05$ ) melting rate during the first 40 minutes, i.e., these products melt slowly. After 50 minutes, the guava ice cream showed a lower melting rate. The greatest resistance of guava ice cream to melting could be related to its greater consistency and firmness when compared with the other ice creams (Javidi *et al.*, 2016).

The commercial ice cream showed lower melting time ( $p \leq 0.05$ ) than all Kefir ice creams over the evaluation time, which could be related to the chemical composition of the product. According to Akalin *et al.* (2008), more fat and total solids content

Table 4. Acceptance of the ice creams\*

Parameter	Formulation				
	Banana	Passion Fruit	Guava	Lemon	Pineapple (Commercial)
Appearance	7.9 ± 1.4 <sup>b</sup>	8.1 ± 1.0 <sup>b</sup>	7.2 ± 1.4 <sup>c</sup>	7.7 ± 1.4 <sup>b</sup>	8.6 ± 0.8 <sup>a</sup>
Aroma	8.1 ± 1.8 <sup>a</sup>	8.0 ± 1.1 <sup>ab</sup>	7.6 ± 1.3 <sup>b</sup>	6.9 ± 1.2 <sup>c</sup>	8.4 ± 1.6 <sup>ab</sup>
Flavor	8.4 ± 2.0 <sup>ab</sup>	7.8 ± 1.2 <sup>b</sup>	7.0 ± 1.7 <sup>c</sup>	7.0 ± 1.3 <sup>c</sup>	8.7 ± 1.7 <sup>a</sup>
Texture	7.8 ± 1.9 <sup>b</sup>	7.5 ± 1.5 <sup>b</sup>	6.5 ± 1.7 <sup>c</sup>	7.3 ± 1.4 <sup>b</sup>	8.7 ± 1.8 <sup>a</sup>
Overall impression	8.1 ± 1.6 <sup>ab</sup>	7.7 ± 1.4 <sup>bc</sup>	7.4 ± 1.3 <sup>c</sup>	7.4 ± 1.1 <sup>c</sup>	8.5 ± 1.4 <sup>a</sup>
Purchase Intent	4.5 ± 1.1 <sup>a</sup>	4.4 ± 0.8 <sup>a</sup>	3.9 ± 1.0 <sup>b</sup>	3.9 ± 1.1 <sup>b</sup>	4.8 ± 1.0 <sup>b</sup>

\*Means ± standard deviation in the same row followed by different letters indicate statistically significant differences at  $p = 0.05$  ( $n=100$ )

Hedonic values (color, aroma, flavor, texture and overall) are as follows: 1 = disliked very much; 9 = liked very much.

Purchase intent values are as follows: 1=would certainly not buy; 5=would certainly buy.

result in products that melt more quickly. In fact, the commercial ice cream had higher contents of fat and total solids than Kefir ice creams (except lipids for lemon ice cream) (Table 2).

A higher melting time is an interesting feature of the products prepared in this study. Higher melting time indicates that the ice creams would be more resistant to temperature fluctuations during storage and allows the consumer to consume the product without loss of its structure for more time. All the ice creams melted completely after 60 minutes, indicating similarity between the ice creams formulated and the commercial product, considering the time required for the total loss of structure.

The results of chemical and physical analyzes indicate that the Kefir ice creams were more acidic than commercial ice cream and had a higher melting resistance until 50 minutes. Texture parameters (firmness, cohesiveness and / or consistency) similar to the commercial product could be obtained with the use of banana or lemon. Changes in other parameters were related to the composition of the fruit used.

#### Acceptance of the ice creams

In Table 4 are showed the results of the acceptance of the products by consumers. The acceptance in terms of the appearance, aroma, flavor, texture and overall impression of the ice creams was higher than 6 on a hedonic 9-point scale, indicating that the consumers liked at least slightly the products. Regarding the purchase intention, the results were found near 4 in a 5-point scale for all formulations tested, indicating that consumers would most likely buy the products. The high acceptability of the products by consumers

was an interesting result considering that this type of product is not available in the market.

Commercial ice cream showed greater acceptance ( $p \leq 0.05$ ) related to the appearance than the Kefir ice creams. The use of fermented milk in the preparation of Kefir ice cream may have caused changes in the visual characteristics of the products. Moreover, the color of the product could have influenced the appearance acceptance, because Kefir ice creams were not added dye, being the color of the products from the fruits used. On the other hand, the commercial ice cream had artificial dyes (yellow tartrazine and sunset). In fact, differences in color of the ice creams were observed in instrumental analysis (Table 3).

The passion fruit, guava and banana ice creams showed similar acceptance ( $p > 0.05$ ) in aroma to the commercial ice cream, while the lemon ice cream was the least accepted ( $p \leq 0.05$ ) in this parameter. The lower scores of lemon ice cream can be related to the acid aroma of this product. Kefir ice creams were not added artificial flavoring, unlike the commercial product that contained artificial flavor of pineapple.

The acceptance of banana ice cream in flavor was similar ( $p > 0.05$ ) to the commercial ice cream, while the guava and lemon ice creams were less accepted ( $p \leq 0.05$ ) in this parameter. The greater acidity of the ice creams made with Kefir (Table 3) might have reduced the product acceptance by consumers. The banana pulp likely "masked" the higher acidity due to the more intense fruit flavor and the use of the pulp in high concentration (30%). It is worth noting, however, that the scores to the flavor were greater than 7 on a 9-point scale for all formulations, indicating that consumers liked moderately the flavor

of all of the products.

With respect to texture, commercial ice cream had greater acceptance ( $p \leq 0.05$ ) than Kefir ice creams. The Kefir ice creams were prepared in experimental laboratory conditions using commercial freezer and mixer. The slow freezing capacity of commercial freezers may have contributed to the formation of larger size ice crystals, which were perceived by consumers during the evaluation of the products. With respect to guava and passion fruit ice creams, the lower acceptance may be related to the higher values in texture parameters, making them “heavier” products (Table 3).

In the overall impression evaluation, banana ice cream was as accepted ( $p > 0.05$ ) as the commercial ice cream, while the others ice creams were the least accepted ( $p \leq 0.05$ ) products. Considering the purchase intent, banana, passionfruit and commercial ice creams showed higher values ( $p \leq 0.05$ ), but all the ice creams obtained values close to 4 on a 5-point scale, indicating that consumers would certainly buy the products.

The results of sensory analysis indicate that it is possible to prepare Kefir ice cream flavored with banana and sweetened with honey that have similar overall acceptance of commercial pineapple ice cream sweetened with sucrose, without requiring the use of acidulant, flavoring or dye. For using the other fruits, improvements must be made, especially concerning the appearance and texture of the products, although appropriate levels of acceptance have been observed for all attributes.

From the formulation point of view, this study promotes the possibility to obtain ice creams with appropriated chemical composition, chemical and physical characteristics and color properties without using dyes, flavorings or acidulant. In addition, there is an incentive to use honey as substitute of the sucrose, with its possible beneficial effects to human health.

From industry point of view this study states that the Kefir fermented milk could be used in the preparation of ice cream, promoting better technological characteristics, such as high overrun values and melting resistance, what can make the ice creams more resistant to temperature fluctuations during storage and allows the consumer to consume the product without loss of its structure for more time. It can be suggested that consumers have a preference for products with lower acid aroma and taste and lower texture parameters, i.e, softer and not too viscous or consistent products. Therefore, the use of fruits that increase the acidity or the texture parameters of the products should be carefully evaluated and changes

in the process can be made, as stop the fermentation at higher pHs, for example.

It is noteworthy that further studies should use descriptive analysis with trained panel (Gaze *et al.*, 2015; Pimentel, Madrona and Prudencio, 2015, Janiaski *et al.*, 2016) or consumers (Cruz *et al.*, 2013; Santos *et al.*, 2015) for better characterization of the samples and confirmation of the inferences presented in this study. Studies in vivo are also welcome (Lollo *et al.*, 2013, 2015; Morato *et al.*, 2015).

## Conclusion

The utilization of Kefir fermented milk to prepare ice creams results in more acid products than the commercial product, but with greater resistance to melting. The flavoring of Kefir ice cream with banana, guava, passion fruit or lemon and the addition of honey results in products with physical, chemical and nutritional characteristics suitable for consumption, with the differences in the parameters related to the chemical composition and concentration of the fruit used. Banana ice cream presented similar overall acceptance to the commercial product, being suggesting improvements in the appearance and texture of the product. The use of the other fruits requires minor modifications, considering that all products showed acceptance higher than 6 on a 9-point scale (like slightly). Further studies should assess the processing of the products in industrial equipment and evaluate the stability of these products during storage under freezing.

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