Açaí Flan, A Functional Food with *Lacticaseibacillus rhamnosus* HN001 Probiotic: Physicochemical Characteristics, Probiotic Survival, Sensory Acceptance and Consumer Perception

Running head: Açaí Flan Containing *Lacticaseibacillus rhamnosus* HN001

Paulyne Tolentino Anselmo¹, Beatriz Cardoso Sabino¹, Carla Prado Rosolém¹, Márcia Simoni de Melo Rodrigues¹, José Renato Silva¹, Karla Bigetti Guergoletto², Tatiana Colombo Pimentel²,³, Carina Moro Benis², Wilma Aparecida Spinosa² and Giselle Nobre Costa¹,²*  

¹Universidade Pitágoras Unopar, Programa de Mestrado em Ciência e Tecnologia de Leite e Derivados, Londrina, PR, Brazil  
²Universidade Estadual de Londrina, Departamento de Ciência e Tecnologia de Alimentos, Londrina, PR, Brazil  
³Instituto Federal do Paraná, Campus Paranavai, Paranavaí, PR, Brazil  

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**SUMMARY**

*Research background.* Açaí berry is rich in antioxidant compounds, therefore, it is closely associated with beneficial effects on health. In this research we aimed to evaluate the potential of using *L. rhamnosus* HN001 as probiotic culture on açai flan.

*Experimental approach.* The flan was evaluated for chemical composition, physicochemical and microbiological characteristics, and sensory acceptance during refrigerated storage (5 °C/42 days). Furthermore, the consumer perception of the product was evaluated using word association presenting to the consumers a photo of the product added or not with the ingredients used and information about the product.

* Corresponding author:  
Phone: +554333714585  
E-mail: gcnobre@gmail.com
Results and conclusions. The flan presented suitable chemical composition, mainly carbohydrates and proteins, probiotic viability reached 8 log CFU/g in the product and 4 log CFU/g after gastrointestinal simulation, typical açai coloration, significant antioxidant activity, and high sensory acceptance. The information about the ingredients and characteristics of the products increased the healthiness and positive feelings of the consumers about the product.

Novelty and scientific contribution. Açai flan has proven to be a suitable carrier for *L. rhamnosus* HN001 as a probiotic culture, further enhancing the characteristic beneficial properties of the fruit. Therefore, combining this information with marketing strategies that inform consumers about the benefits of the product can further improve its acceptance. As far as we know, this is the first study involving açai flan with added probiotic culture.

Keywords: *Lacticaseibacillus rhamnosus; Euterpe oleracea;* probiotic; dairy dessert; antioxidant; whey protein

INTRODUCTION

Flan-type dairy desserts are considered popular foods around the world and have an important contribution to the diet due to their calcium and vitamin D contents, as well as phosphorus, potassium, magnesium, riboflavin, niacin, essential fatty acids and proteins (1). Açai is a berry fruit native of Brazil and Bolivia whose characteristics has received a lot of attention in the last few years, mainly due to variety of phytochemical as polyphenols and its antioxidant activity which are associated many beneficial effects (2,3). Moreover, açai is source of energy, fibers, anthocyanins, minerals, and fatty acids, so, was included among the ten first superfoods (4).

Probiotics are microorganisms that confer beneficial effects on individuals when consumed in adequate amounts. The *Lactobacillus rhamnosus* were recently reclassified to *Lacticaseibacillus rhamnosus* (5). The HN001 strain has been associated with several health effects, such as modification of the intestinal microbiota, reduced prevalence of gestational diabetes and allergic diseases, among others (6,7).

Studies involving the inclusion of probiotic cultures in flans are still scarce (8-10) and, as far as the authors know, there is no application of the probiotic strain *L. rhamnosus* HN001 in flans and/or evaluation of incorporation of probiotic cultures in berry açai flans. Moreover, the functional ingredients as açai and whey protein isolate are added aimed to enriched the flan. Therefore, this study aimed to evaluate the potential of the açai flan as a carrier of the probiotic strain HN001. Furthermore, the consumer perception about the product and the impact of the available information was studied.
MATERIALS AND METHODS

*Lacticaseibacillus rhamnosus* inoculum

Pasteurized milk (De Leite, Londrina, Brazil), was sterilized at 100 °C/15 min, cooled, and added with 0.1 % (m/V) of the *L. rhamnosus* HN001™ (Dupont, Cotia, Brazil). Then, the mixture was incubated for 15 h at 37 °C (pre-inoculum). The pre-inoculum (0.8 % V/V) was added to the sterilized milk and incubated at 37 °C for 24 h. Analyzes of pH, titratable acidity and viability of the probiotic were performed after 0, 3, 6, 9, 15, 18, 21 and 24 h of fermentation in order to determine the optimum fermentation time.

Flan processing

The flan was prepared using the ingredients: 23.6 % whole milk (De Leite, Londrina, Brazil), whose composition was: composition of 3.4 % protein, 4.7 % carbohydrates, and 3.5 % total fat. 8 % whey protein isolate (Artesana, Novo Hamburgo, Brazil), 18 % sucrose (União, São Paulo, Brazil), 0.4 % citric acid (Anidrol, Lençóis Paulista, Brazil), 3 % açaí powder (Relva Verde, Ibiporã, Brazil), 35 % açaí pulp (Pura pulp, Guaraçá, Brazil), 9 % of the probiotic culture inoculum and 3 % of unflavored gelatin (Green Grass, Ibiporã, Brazil).

The whole milk, whey protein isolate and sugar were weighed, and heat treated at 90 °C for 20 min in a water bath. Then the mixture was cooled in an ice bath to 40 °C, added with the other ingredients (citric acid, açaí powder, açaí pulp and unflavored gelatin) and homogenized in a mixer (Britânia, Curitiba, Brazil). Then, the inoculum of the probiotic culture was added, and the mixture packed in 30 mL plastic containers with lid (Galvanotek, Carlos Barbosa, Brazil), in which the syrup had already been added. The flan syrup was made using 20 % of açaí pulp, 0.3 % citric acid, 6 % water, and 9 % sucrose and water. The mixture was heated until boiling for 5 min and stored under refrigeration (5 °C) to analyses weekly for 42 days.

Viability of *L. rhamnosus* on flan and under simulated gastrointestinal conditions

The viability of *L. rhamnosus* HN001 was evaluated by plating on Man Rogosa and Sharpe (MRS) agar (Kasvi, São José dos Pinhais, Brazil) and anaerobic incubation at 37 °C for 72 h. The survival under simulated gastrointestinal conditions was performed according to the methodology described by Minekus *et al.* (11).

Physicochemical characteristics and antioxidant activity

The pH was evaluated using a pH meter (Kasvi, Curitiba, Brazil). Titratable acidity and chemical composition were determined according to AOAC (12). The texture profile was determined
using a TA3/1000 acrylic cylindrical probe (25.4 mm diameter) and Texture Analyzer CT3 texturometer (Middleboro, USA). Color parameters ($L^*$, $a^*$ and $b^*$) were determined using a colorimeter (Konica Minolta CR-400, Ramsey, USA). The antioxidant activity was determined by the ability to sequester 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical according to the method described by Brand-Williams et al. (13), and to the iron reduction method (FRAP) according to Benzie & Strain (14). The reagents used were analytical grade (Sigma-Aldrich, São Paulo, Brazil).

**Sensory analysis**

The flan (30 g) was evaluated for acceptance (overall impression, appearance, color, aroma, flavor, and texture) by 100 consumers (51 men and 49 women) using a 9-point structured hedonic scale (1=very much disliked, 9=very much liked). Purchase intent was assessed using a 5-point scale (1=I would definitely buy, 5=I would definitely not buy).

**Consumer perception evaluation**

The participants (n=474) received, via e-mail or social media, 3 different images (Fig. S1) and attributed characteristics to them. Thus, the words provided were considered for the analysis. They were divided into three groups (n=158): Group 1 (received a photo of the product, Fig. S1a), Group 2 (received a photo of the product providing the ingredients used, Fig. S1b), and Group 3 (received a photo of the product providing the ingredients used and a short description about the product, Fig. S1c). All the consumers were asked to describe what was their opinion about the product. The words, descriptions and associations provided by participants were considered for the analysis as described by Pinto et al. (16).

**Statistical analysis**

The experiment followed a completely randomized design and was repeated three times. Physicochemical and microbiological analyzes were performed in triplicates. Data were submitted to analysis of variance (ANOVA) followed by the Tukey’s test (p<0.05) using STATISTICA software (StatSoft, Tulsa, OK, USA) (15). The data of word association was analyzed according to Pinto et al. (16).

**RESULTS AND DISCUSSION**

In the selection of a probiotic microorganism to be included in a food product, the matrix in which it will develop plays a fundamental role in its multiplication and maintenance throughout its shelf life. Therefore, defining the growth medium can be crucial to the functionality of a probiotic strain. The incubation of milk caused a decrease in pH from 6.6 to 4.9 and an increase in titratable acidity from
0.2 to 0.5 % lactic acid over 24 h (Table 1). The decline in pH and the increase in acidity are result of the fermentation of milk by probiotic culture, which used lactose and other sugars present in the medium and produced lactic acid (17). The probiotic culture viability decreased after 3 h of fermentation (8.3 to 7.9 log CFU/g), with subsequent increase during the incubation period, reaching counts of 8.9 log CFU/g after 24 h (p<0.05). The initial decrease is due to the period of adaptation of the culture to the environment. There was no significant difference in the counts of probiotic culture between 15 and 24 h of fermentation (p>0.05) therefore, considering time and energy savings, it is suggested to use 15 h of fermentation to obtain the inoculum.

Here, 24 h was used to logistics facilitate. Studies that used L. rhamnosus in similar conditions reported viability of 8 and 9 log CFU/g for the strains used and maintenance of these levels until the end of the shelf life (18,19).

The açai flan presented composition (g/100 g) 58.6 g of moisture, 15.5 g of protein, 0.3 g of lipid, 0.8 g of ash and 24 g 100 of carbohydrates. Therefore, it is characterized as a dairy product with high protein and carbohydrate contents, and low lipid content.

The açai flan presented pH of 4.6 and titratable acidity of 0.1 % lactic acid (Table 2). During the storage period, the pH of the products decreased from 4.64 to 4.57 and the titratable acidity increased from 0.09 to 0.1 % lactic acid. The decline in pH and the increase in acidity are result of post-acidification of the products promoted by probiotic culture, which used lactose and other sugars present in the medium and produced lactic acid (17). The acidification of the product was slight (0.07 pH units and 0.01 % lactic acid), demonstrating that the probiotic culture does not present high fermentative capacity at low temperatures (18,19), which is interesting from the sensorial point of view as well as the stability during the shelf life.

The açai flan presented a red-purple color (L*=-39.6, a*=10.9 and b*=-5.87) (Table 2), which is typical of the açai pulp. During storage, there was a decrease in red color (lower values of a*, p<0.05) and maintenance of the parameters L* and b* (p>0.05), comparing the products on the 1st and 42nd days of storage. Red discoloration of products during storage may be associated with decreases in the anthocyanin concentration.

The flan was characterized as a soft and adhesive product, with a hardness of 4.54 (N), adhesiveness of 5.8 (mJ), cohesiveness of 0.39 and gumminess (N) of 1.99 (Table 2). During storage, there was a decrease in adhesiveness and an increase in cohesiveness and gumminess (p<0.05). In addition, there was an increase in firmness up to 35 days of storage with subsequent decrease, with no significant difference between the freshly prepared product (day 1) and that stored for 42 days (p>0.05). The texture parameters are characteristic of protein gels. The addition of WPC promotes
gelatinization with protein-protein interactions. Frederico et al. (9) and da Costa et al. (19) also observed similar characteristics in flans or ice cream added with whey. The acidification of the product observed during refrigerated storage may have contributed to the increase in firmness, cohesiveness, and gumminess of the product, as well as to the decrease of adhesiveness.

The flan showed antioxidant activity of 111.34–445.50 mg/mL (DPPH) and 0.81–1.43 mmol Fe²⁺/g (FRAP, Table 2), which may be considered appropriate from a health standpoint. During the storage period there was a decrease in antioxidant activity (higher values for DPPH and lower values for FRAP, p<0.05), which may be related to the loss of anthocyanins.

### TABLE 2

The açai flan had probiotic culture counts of 8.43–8.60 log CFU/g during the 42 days of refrigerated storage (Table 3). The minimum number of viable probiotic culture in a product should be in the range of 6 to 7 log CFU/g in order to observe the beneficial effects (10). Thus, the flan prepared in the present study could be considered a probiotic product throughout the storage period.

The açai flan had probiotic culture counts of 4.91–6.11, 3.17–3.60 and 4.07–4.58 log CFU/g during the gastric, enteric (small intestine) and enteric (large intestine) phases, respectively. Thus, the probiotic culture *L. rhamnosus* was able to survive to the simulated gastrointestinal conditions. There was a 3 log CFU/g decrease during the gastric phase, with subsequent recovery of probiotic culture in the enteric phases (~1 log CFU/g, p<0.05). Possibly, the probiotic was only injured during the gastric phase, with consequent decrease in its counts, but, when subjected to favorable conditions for its survival, the microorganism recovered viability, presenting higher counts in the first and second enteric phases. Costa et al. (19) reported a 5-log cycle reduction of the *L. rhamnosus* GG in açai ice cream when subjected to gastrointestinal tract simulation.

### TABLE 3

The flan received scores above 7 on a 9-point hedonic scale for aroma, flavor, and texture, indicating that consumers moderately liked these attributes in the product. In addition, the flan received scores more than 8 on appearance, color, and overall impression attributes, indicating that consumers liked these attributes very much. Product acceptance was 89%. Regarding purchase intent, 60% of consumers indicated that they would certainly or probably buy the product, and only 4% indicated that they would definitely not buy.

Related to the consumer perception about the product, the consumers received 3 different images (Fig. S1) and attributed characteristics to them. Thus, the words provided were considered for the analysis.
Regarding the consumer perception analysis, researchers sent invitations for voluntary participation in the survey through social media. Participants were shown a sequence of product images over three different weeks (Fig. S1a), an image along with the ingredients (Fig. S1b), and an image with some attributed beneficial effects (Fig. S1c). They were asked to provide their opinion on the product using a single word, and the responses obtained were grouped to create an analysis map. The words associated to the product were grouped on the categories: composition, health, positive feelings, negative feelings, sensory, and description (Table 4). It could be observed that the inclusion of the information about the ingredients used and, mainly, the description of the product (Fig. S1c) resulted in an increase in the perception of healthiness and positive feelings in the consumers. In fact, clinical trials (20) have suggested that açai consumption provides many beneficial health effects, and due to its medicinal properties and the absence of undesirable effects, açai and foods containing it have a promising future, along with vast economic potential in the food and cosmetic industries.

TABLE 4

CONCLUSIONS

Açai flan may be a carrier of L. rhamnosus HN001 as a probiotic culture, presenting suitable chemical composition, physicochemical characteristics and antioxidant activity, and sufficient probiotic culture counts in the product and under simulated gastrointestinal conditions. The methodology used to evaluate consumer perception, involving voluntary participation through social media, allowed for the clear association of flan images and ingredients with aspects of healthiness and positive feelings among consumers. The results contribute to the evolving landscape of functional foods, combining scientific exploration with consumer perception analysis to clarify the potential impact of probiotic and açai-based products.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS’ CONTRIBUTION

P.T. Anselmo and B.C. Sabino were responsible for sampling, laboratory analyses and manuscript writing. M. Rodrigues and J.R. Silva were responsible for laboratory analyses. C.P. Rosolém, C.M. Beni and T.C. Pimentel were responsible for interpretation of the results and revisions of the manuscript. W. Spinosa and K.B. Guergoletto were responsible for interpretation of the results, validation and writing revision. G.N. Costa was responsible to study design and supervision.

ORCID ID

P.T. Anselmo https://orcid.org/0009-0001-3588-506X
B.C. Sabino https://orcid.org/0009-0004-8488-4153
C.P. Rosolém https://orcid.org/0000-0003-0277-1485
C.M. Benis https://orcid.org/0000-0003-2327-6299
M.S. M. Rodrigues https://orcid.org/0009-0001-4802-834X
J.R. Silva https://orcid.org/0000-0002-8289-7768
K.B. Guergoletto https://orcid.org/0000-0002-8285-2711
T.C. Pimentel https://orcid.org/0000-0003-4600-8932
W.A. Spinosa https://orcid.org/0000-0001-9532-0135
G.N. Costa https://orcid.org/0000-0001-6231-9445

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Table 1. Viability of the probiotic culture and physicochemical characteristics (pH and titratable acidity) of milk during 24 h of fermentative process

<table>
<thead>
<tr>
<th>t/h</th>
<th>N (log CFU/g)</th>
<th>pH</th>
<th>Lactic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(8.3±0.28)c</td>
<td>(6.6±0.0)a</td>
<td>(0.2±0.0)de</td>
</tr>
<tr>
<td>3</td>
<td>(7.9±0.11)d</td>
<td>(6.1±0.15)c</td>
<td>(0.2±0.05)e</td>
</tr>
<tr>
<td>6</td>
<td>(8.4±0.15)c</td>
<td>(6.4±0.05)ab</td>
<td>(0.2±0.0)e</td>
</tr>
<tr>
<td>9</td>
<td>(8.5±0.11)bc</td>
<td>(6.3±0.05)b</td>
<td>(0.2±0.0)de</td>
</tr>
<tr>
<td>15</td>
<td>(8.7±0.02)abc</td>
<td>(5.7±0.10)d</td>
<td>(0.3±0.0)cd</td>
</tr>
<tr>
<td>18</td>
<td>(8.9±0.01)a</td>
<td>(5.4±0.05)e</td>
<td>(0.4±0.05)bc</td>
</tr>
<tr>
<td>21</td>
<td>(8.8±0.10)ab</td>
<td>(4.9±0.05)l</td>
<td>(0.5±0.05)ab</td>
</tr>
<tr>
<td>24</td>
<td>(8.9±0.04)ab</td>
<td>(4.9±0.05)l</td>
<td>(0.5±0.05)a</td>
</tr>
</tbody>
</table>

Results are expressed as mean±standard deviation (N=9). Different lowercase letters in the same column denote significant difference by the Tukey’s test (p<0.05)
Table 2. Physicochemical characteristics and color parameters of açai flan during refrigerated storage (5 °C)

| t(storage)/day | pH     | Titratable acidity/\% | L*   | a*   | b*   | Firmness | Adhesiveness | Cohesiveness | Gumminess | EC50 | FRAP |
|---------------|--------|------------------------|------|------|------|----------|--------------|--------------|-----------|-------|------|------|
| 1             | (4.64±0.07)ab | (0.09±0.01)b | (39.6±3.94)a | (10.9±1.60)a | (5.87±1.61)b | (4.54±0.70)b | (5.8±0.98)a | (0.39±0.03)b | (1.99±0.46)b | (111.34 ± 2.48)c^d | (1.43±0.01)bc^d |
| 7             | (4.72±0.13)c^d | (0.09±0.01)b | (37.2±3.11)c^d | (4.08±1.92)c^d | (4.62±1.76)c^d | (5.32±0.62)c^d | (5.5±0.45)c^d | (0.36±0.36)c^d | (2.11±0.61)c^d | (165.67 ± 9.91)c^d | (1.37±0.02)c^d |
| 14            | (4.57±0.06)c^d | (0.09±0.00)c^d | (33.4±2.47)c^d | (6.48±0.53)c^d | (8.27±0.71)c^d | (4.57±0.59)c^d | (5.1±0.78)c^d | (0.37±0.03)c^d | (1.86±0.74)c^d | (170.19 ± 5.84)c^d | (1.33±0.02)c^d |
| 21            | (4.46±0.05)c^d | (0.09±0.01)b | (34.3±2.66)c^d | (7.26±0.72)c^d | (6.96±1.31)c^d | (6.21±0.79)c^d | (5.4±0.99)c^d | (0.39±0.03)c^d | (2.95±0.63)c^d | (184.85 ± 3.52)c^d | (1.31±0.01)c^d |
| 28            | (4.33±0.10)c^d | (0.1±0.01)c^d | (33.3±2.59)c^d | (7.23±0.92)c^d | (7.45±0.75)c^d | (5.22±0.88)c^d | (5.1±0.68)c^d | (0.38±0.07)c^d | (2.21±1.02)c^d | (193.04 ± 7.54)c^d | (0.84±0.02)c^d |
| 35            | (4.45±0.16)c^d | (0.1±0.01)c^d | (33.7±2.85)c^d | (6.92±1.43)c^d | (8.22±1.35)c^d | (6.27±2.30)c^d | (1.2±0.94)c^d | (0.54±0.08)c^d | (4.59±1.12)c^d | (426.14 ± 8.31)c^d | (0.74±0.01)c^d |
| 42            | (4.57±0.14)c^d | (0.1±0.01)c^d | (36.9±2.97)c^d | (6.41±2.19)c^d | (8.09±1.70)c^d | (5.79±1.35)c^d | (0.3±0.34)c^d | (0.58±0.14)c^d | (4.19±1.01)c^d | (445.50 ± 6.69)c^d | (0.81±0.02)c^d |

Results are expressed as mean±standard deviation (N=9). Different lowercase letters in the same column denote significant difference by the Tukey’s test (p<0.05). Titratable acidity is expressed in % lactic acid, EC50 mg/mL, FRAP in mmol Fe^2+/g.
Table 3. Viability of probiotic culture in the product and under simulated gastrointestinal conditions

<table>
<thead>
<tr>
<th>t(storage)/day</th>
<th>N(Lacticaseibacillus rhamnosus HN001)/(log CFU/g)</th>
<th>Product</th>
<th>Gastric phase</th>
<th>Small intestine</th>
<th>Large intestine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(8.43±0.38)&lt;sup&gt;abA&lt;/sup&gt;</td>
<td>(6.11±0.01)&lt;sup&gt;baA&lt;/sup&gt;</td>
<td>(3.17±0.24)&lt;sup&gt;dA&lt;/sup&gt;</td>
<td>(4.29±0.25)&lt;sup&gt;cA&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>(8.60±0.32)&lt;sup&gt;abA&lt;/sup&gt;</td>
<td>(4.91±0.27)&lt;sup&gt;baA&lt;/sup&gt;</td>
<td>(3.24±0.46)&lt;sup&gt;cA&lt;/sup&gt;</td>
<td>(4.67±0.22)&lt;sup&gt;baA&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>(8.46±0.31)&lt;sup&gt;abA&lt;/sup&gt;</td>
<td>(5.33±0.23)&lt;sup&gt;baA&lt;/sup&gt;</td>
<td>(3.60±0.27)&lt;sup&gt;cA&lt;/sup&gt;</td>
<td>(4.07±0.18)&lt;sup&gt;baA&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>(8.57±0.15)&lt;sup&gt;abA&lt;/sup&gt;</td>
<td>(5.57±0.07)&lt;sup&gt;baA&lt;/sup&gt;</td>
<td>(3.15±0.01)&lt;sup&gt;dA&lt;/sup&gt;</td>
<td>(4.58±0.08)&lt;sup&gt;cA&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

Different superscript lowercase letters on the same line indicate a significant difference on the same day at the different stages of digestion (p<0.05). Different superscript capital letters in the same column indicate significant difference in each phase of digestion in the gastrointestinal tract over the refrigerated storage time (p<0.05).
Table 4. Contingency table showing the main sensory descriptors and the frequency of use of each by consumers

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Examples</th>
<th>Control</th>
<th>Ingredients</th>
<th>Ingredients and description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition</td>
<td>Caloric, fat, sugar, protein, anthocyanins, phenolic compounds, bioactive compounds, vitamins, lactose, fiber, flavonoids, nutrients</td>
<td>9(-)**</td>
<td>52(+)**</td>
<td>36</td>
</tr>
<tr>
<td>Health</td>
<td>Antioxidant, Healthy, Nutritious. Energetic, Functional, Probiotic, Microbiota regulation, Strength, Well-being, Diet, Fitness, Supplementation, Beneficial microorganisms, Metabolism, Muscle, Satiety, Digestive, Enriched, Young, Intestine</td>
<td>1(-)***</td>
<td>145(+)**</td>
<td>165(+)***</td>
</tr>
<tr>
<td>Positive feelings</td>
<td>Delicious, Beautiful, Pleasure, Tasty, Attractive, Good, Colorful, Showy, Appetizing, Different, Refreshing, Fresh</td>
<td>61</td>
<td>94(-)*</td>
<td>130(+)*</td>
</tr>
<tr>
<td>Negative feelings</td>
<td>Strange, too industrialized, Bad, unhealth, fattening, cracked, not appetizing, anxiety, blood, artificial, sickening, too sweet, bitter, bland taste, residual taste, sandiness</td>
<td>18</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td>Sensory</td>
<td>Icy, sweet, soft, red fruit flavor, bright, chocolate, creamy, moist, juicy, firm, good appearance, beautiful color, flavor, texture, acid, homogeneous, strawberry</td>
<td>117(+)**</td>
<td>79(-)*</td>
<td>58(-)***</td>
</tr>
<tr>
<td>Description</td>
<td>Pudding-like, flan, with syrup, guava-paste like, gelatin-like, Sweet cheese-like, Açaí-like, Semi-solid, Dark, Natural, Chocolate cake-like, Ice cream like</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td></td>
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</tr>
</tbody>
</table>

The number of citations for each sensory test and the results of the chi-squared analysis per cell are presented. (+) or (−) indicate that observed values are higher or lower than the expected theoretical value. Categories mentioned by at least 5% of respondents. *p<0.05, **p<0.01, ***p<0.001
SUPPLEMENTARY MATERIAL

Fig. S1. The images were sequentially (a, b, c) presented to the consumers to evaluate the perception about the product.