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## **Fruit nectar obtained from cupuaçu (*theobroma grandi-florum*) and açaí (*euterpe oleracea mart*) added with fructo-oligosaccharides: processing and quality evaluation**

*Néctar misto de cupuaçu (*theobroma grandi-florum*) e açaí (*euterpe oleracea mart*) adicionado de fruto- oligossacarídeo: processamento e avaliação da qualidade*

#### **Abstract**

Besides the nutrients provided from fruits, fruit nectars added with fructo-oligosaccharides (FOS) have been considered a healthier alternative for consumers, because their soluble fibers help strengthen the intestinal microbiota, promote satiety, help control blood sugar levels and prevent cardiovascular diseases and diabetes. From a technical viewpoint, FOS can replace sugars and fats in the preparation of food products. This study aimed to prepare formulations of mixed fruit nectar obtained from cupuaçu and açaí added with FOS. A total of 70 consumers were surveyed about three nectar formulations, which varied

according to the concentration of açai and cupuaçu. The quality of nectar formulations was evaluated based on microbiological analysis (yeast and mold counts, total coliforms counts, thermotolerant coliforms and *Salmonella* sp.), sensory evaluation (acceptance, preference, purchase intention and acceptance index), physicochemical (pH, titratable acidity and total soluble solids - TSS) and chemical characteristics (moisture, total phenolics, vitamin C, FRAP and DPPH analyses). Fruit nectars were microbiologically safe, and the appearance and color were the only parameters that varied between formulations in the sensory analysis. The acceptance of fruit nectars ranged from “liked slightly” (6) to “liked a lot” (8), but all formulations had the same preference and acceptance indexes above 70%. The nectar formulations did not vary in pH and TSS. Formulations of mixed fruit nectar obtained from cupuaçu and açai added with FOS are alternative products with potential for commercialization since they are additive-free and source of dietary fibers, making it a healthier choice of fruit nectar.

**Keywords:** Beverage. Fruits. Functional foods.

### Resumo

Néctares de frutas com fruto-oligossacarídeos (FOS) têm sido uma opção mais saudável para os consumidores, pois além dos nutrientes provenientes das frutas, possuem fibras solúveis que auxiliam no fortalecimento da microbiota intestinal, promovem a saciedade, controlam o índice glicêmico e previnem doenças cardiovasculares e diabetes. Além disso, o FOS, do ponto de vista tecnológico, pode substituir açúcares e gorduras na elaboração de produtos alimentícios. Sendo assim, objetivou-se desenvolver formulações de néctar misto de cupuaçu e açai, adicionado de FOS. Para isso, realizou-se pesquisa com 70 consumidores, seguida da elaboração de três formulações de néctar cuja variação estava associada à concentração de açai e cupuaçu. A qualidade das formulações dos néctares foi observada pela análise microbiológica (enumeração bolores e leveduras, enumeração de coliformes totais, coliformes termotolerantes e pesquisa de *Salmonella* sp.), sensorial (aceitação, preferência, intenção de compra e índice de aceitação), análise físico-química (pH, acidez total titulável e sólidos solúveis totais - SST) e química (umidade, fenólicos totais, FRAP, DPPH e vitamina C). As análises mostraram que os néctares estavam microbiologicamente seguros, sendo a aparência e a cor os únicos parâmetros que variaram



entre as formulações na avaliação sensorial. A aceitação dos néctares ficou entre “gostei ligeiramente” (6) e “gostei muito” (8); ambas formulações apresentaram a mesma preferência e índice de aceitação acima de 70%. As formulações de néctar não variaram quanto ao pH e SST. Diante das características observadas, as formulações de néctar de cupuaçu e açai adicionados de FOS apresentaram potencial para a comercialização, sendo uma opção mais saudável de néctar, pois os mesmos não possuem aditivos e são fonte de fibras dietéticas.

**Palavras-chave:** Bebida. Frutas. Alimentos funcionais.

## INTRODUCTION

Brazil is the third largest fruit producer in the world. The food industry has invested more and more in ready-to-drink beverages with typical Brazilian fruits, e.g., açai berry and cupuaçu.<sup>1</sup> Açai is found all over the Amazonian region, and Pará is the leading producer state.<sup>2</sup> In Brazil, nearly 225 thousand tons of açai were processed in 2017,<sup>3</sup> while cupuaçu production reached 44,437 tons in 2007. These two fruits have the greatest commercial representation among the Amazonian fruits,<sup>4</sup> and are usually marketed in the form of pasteurized and frozen pulp.<sup>1</sup>

Açai (*Euterpe oleracea* Mart) is a source of anthocyanins, pigments responsible for the fruit color,<sup>5</sup> which are phenolic compounds with antioxidant activity, which can attenuate stress,<sup>6</sup> as well as a source of vitamin E and minerals (manganese, copper, boron, calcium, sodium, magnesium, potassium and chrome).<sup>7</sup> Açai berry contains dietary fibers that help promote a healthy digestive system as well as fatty acids such as oleic and linoleic acids.<sup>8</sup> Cupuaçu (*Theobroma grandiflorum*) is a source of ascorbic acid (110mg/100g of pulp),<sup>9</sup> minerals (calcium, phosphorus, iron, potassium, magnesium, sodium, and zinc),<sup>10</sup> dietary fibers and phenolic compounds.<sup>11</sup>

Tropical fruits are largely accepted by consumers but most of these fruits are highly perishable, representing great post-harvest losses, which can be minimized by processing them into products such as juices and nectars.<sup>12</sup> According to legislation, nectar is a nonfermented drink obtained by diluting the edible portion of the fruit and sugars, or vegetable extracts and sugars, with drinking water, and can be added with acids and sold for direct consumption.<sup>13</sup> Today, there is a high demand for mixed drinks, a preference observed in products that use formulations with different fruits, which provide new flavors, meeting consumer expectations.<sup>14</sup>

In the preparation of multifruit beverages, ingredients with functional properties such as the fructo-oligosaccharides (FOS) can be added to the mixture.<sup>15</sup> These have gained enormous

repercussion among the food industries because they can replace sugar or fat contained in the product without changing the food calories.<sup>16</sup> They can be found in foods such as banana, onion, garlic, asparagus, wheat, rye, artichoke, among others, either alone or in the composition of food products.<sup>17</sup>

FOS are soluble fibers that act as prebiotics, strengthening the intestinal microbiota by stimulating the selective growth of intestinal bacteria that are beneficial to health and contributing to better nutrients absorption.<sup>18</sup> Soluble fibers help in delayed gastric emptying, in the absorption of glucose and cholesterol, in improving the control of plasma levels, thus contributing to reduce risks of development of cardiovascular diseases and diabetes, besides acting as satiety promoters.<sup>19</sup>

Considering the consumer demand for more healthful foods and the fact that cupuaçu and açai are typically Brazilian fruits, the aim of this study was to develop and assess the microbiological, sensory, physicochemical and chemical characteristics of mixed nectar formulations of cupuaçu (*Theobroma grandiflorum*) and açai (*Euterpe oleracea* Mart), added with fructo-oligosaccharide.

## METHODOLOGY

### Ethical issues

This study was previously approved by the Research Ethics Committee of the Federal University of Sergipe (UFS), in 31 October 2017, protocol number 2.359.117.

The preparation of formulations of cupuaçu and açai nectars, as well as their sensory evaluation, took place at the technical and dietetic laboratory of UFS, São Cristóvão – SE campus.

### Consumer survey

Prior to the preparation of the nectar formulations, a survey with 70 nectar consumers was carried out with students, teachers and employees of UFS, with varied ages, of both sexes. The consumer survey consisted of administering a questionnaire with 11 objective, multiple choice questions relating to consumer preferences about ready-to-drink beverages, consumption frequency, main product characteristics, consumption of health-beneficial products, and how much this individual would pay for a mixed nectar added with compounds with alleged benefits to health. The respondents received instructions to complete the questionnaire properly, and there was no influence on the response decisions.



## Formulation and preparation of cupuaçu and açai nectar

The following ingredients were used in the nectar preparation: pasteurized and frozen pulp of açai (Pomar) and cupuaçu (Pomar), drinking water (Indaiá), chistal sugar (Cristal) and fructo-oligosaccharide (Nutraflora).

Initially, six preliminary tests were carried out to obtain formulations with acceptable sensory characteristics. Three formulations of cupuaçu and açai nectars were prepared (F1, F2 and F3), all of them with the same content of fructo-oligosaccharide (FOS), that is, 3.4g of FOS were added to each 100mL of nectar. The nectar formulations were different regarding percentages of pulp, totalizing 50% of pulp in each formulation. The formulations are not described, because there is an intention to file a patent application for these formulations at INPI – Instituto Nacional de Propriedade Industrial (National Institute of Industrial Property).

To prepare the cupuaçu and açai mixed nectar, added with FOS, the ingredients were weighed in analytical scale (Marte, 32200H, Philippines), and then mixed in blender (Philips Walita, Brazil) for two minutes, at speed 2. When ready, the nectars were put into glass bottles and pasteurized in water bath at 90°C for two minutes; then the bottles were immersed in ice bath to reduce temperature to 0°C. When cooled, the bottles were closed with cork stoppers and kept in refrigerator (Brastemp, Brazil) at 4°C until the beginning of analyses (24h).

### Microbiological assessment of the nectar

Prior to the sensory analysis, 200mL of each nectar formulation were taken to the laboratory of foods microbiology at the Nutrition Department of UFS, São Cristóvão campus. The microbiological analysis aimed to check the hygienic-sanitary conditions of the nectars processing. The following microbiological analyses were carried out: counts of molds and yeasts, counts of total coliforms, thermotolerant coliforms and *Salmonella sp.*<sup>20</sup>

### Sensory evaluation

The sensory evaluation was carried out using monadic and randomized presentation to 70 untrained tasters (18 to 50 years old) of both sexes. The participants were asked to read and sign the Free Consent Form before the analyses. The samples were evaluated in individual booths under white light. Approximately 20mL of each sample were served at 5°C in polypropylene cups identified with three-digit figures. The three cupuaçu and açai nectar formulations were evaluated for preference (ranking test), acceptance (hedonic scale) and purchase intention. The formulations preference was assessed according to the Friedman test.<sup>21</sup> Acceptance was assessed by a 9-point hedonic scale (9 - liked very much and 1- disli-

ked very much), with respect to appearance, sweetness, flavor, color and overall impression. The purchase intention scale ranged from one to five, and presented the following rating: 1 – surely would not buy; 2 – probably would not buy; 3 – maybe would buy or maybe not; 4 – probably would buy; and 5 – surely would buy.<sup>21</sup> The acceptability index (AI) was assessed by means of the expression  $AI (\%) = A \times 100 / B$ , where A= average grade assigned to the product, and B= maximum grade assigned to the product. The AI with good acceptance has been considered as > 70%.<sup>22</sup>

Chemical and physicochemical characterization

The three formulations (F1, F2 and F3) of cupuaçu and açaí mixed nectar, after the sensory evaluation, were evaluated for their chemical, physicochemical characteristics and antioxidant capacity, at the *Laboratório de Análise de Alimentos, Departamento de Nutrição* (Laboratory of Foods Analysis, Department of Nutrition), UFS, São Cristóvão campus. The following analytical parameters were adopted: moisture, determined by constant weight after drying at oven a 105°C; pH – measured by direct potentiometer (Jenway, 3505, England) reading; total titratable acidity (TTA) - expressed in citric acid /100g; vitamin C, by Tillmans’ method, by reducing 2,6-dichlorophenol (DCP) with ascorbic acid, expressed in mg of ascorbic acid/g sample; and total soluble solids (TSS), obtained by the refractive index of the nectar samples using a direct reading refractometer, expressed in °Brix. The ratio was calculated by total soluble solids to total acidity.<sup>23, 24</sup>

To evaluate total phenolics, DPPH and FRAP, an extract of 1g of nectar sample was obtained, which was diluted in 27mL of methanolic solution (8:2 methanol/water). Total phenolics content, expressed in ugEq of gallic acid/g of samples,<sup>25</sup> and the nectars antioxidant capacity was determined by DPPH (2,2-diphenyl-1-picryl-hydrazyl) free radical method, expressed in % of scanning of radical DPPH/g in the sample<sup>26</sup> and ferric reducing antioxidant power (FRAP) expressed in gM of ferric sulfate/g of sample.<sup>27</sup>

Statistical analysis

With the aid of IBM SPSS software, version 21, data of sensory, physicochemical, chemical and antioxidant activity analyses were subjected to analysis of variance (ANOVA) for repeated measures, in order to verify the means homogeneity. Homogeneous means (p<0.05) were analyzed by the Tukey’s test. P-values were considered significant when they were lower than 0.05. The results of sensory preference of cupuaçu and açaí nectar formulations were analyzed by the Friedman test. In this method, the sums of ranks of the nectar formulations are compared with the critical absolute value of the difference of the sum of ranks (the least significant difference), to determine significant preference at 5% probability level, obtained in a specific table.

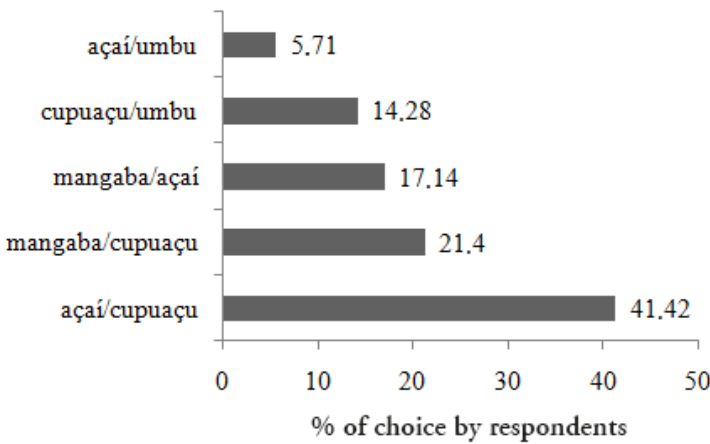
RESULTS AND DISCUSSION

Consumers survey

The survey on the proposed mixed nectar was conducted with 70 tasters, 57% women and 43% men, aged between 18 and 51 years. Of the consumers, 49% responded that they liked ready-to-drink beverages; 79% informed that they consumed this kind of product on a weekly basis; 60% responded that flavor is the most important characteristic of a product; and 89% said that they were concerned with consuming healthy foods and that the nutritional composition is a key factor in the choice of a food product. Of the options offered, as ingredients that could provide functional characteristics to the nectar, 51% of respondents chose the FOS and probiotic addition. Cardoso et al.<sup>28</sup> also observed a significant percentage (89.1%) of respondents, who indicated nutritional value as a determinant factor for the purchase of a product.

Figure 1 describes the choice options for a new fruit flavor for the nectar. In the survey, it was found that of 70 participants, 41% would consume the mixed nectar of cupuaçu and açaí, which might be associated with the habit of consuming these pulps.

Figure 1. Choice options for a new fruit flavor to compose the mixed nectar. (typical regional Brazilian fruits)



Market research survey is an effective tool to obtain information and direct researchers to the area in which they should act, according to their target audience.<sup>29</sup> Thus, it was possible to determine which fruit pulp would be accepted by most consumers for the proposed mixed nectar.

Microbiological assessment

RDC no. 12 of January 2001,<sup>30</sup> which regulates the sanitary microbiological standards for foods and beverages, specifies as microbiological standard for nectar only the absence of total coliforms in 50 mL. After the microbiological analysis of formulations of mixed nectar of cupuaçu with addition of FOS, it was observed absence of positive tubes for total coliforms and thermotolerant coliforms, being expressed as <3.0 MPN/mL; 1.43 x 10<sup>3</sup> (estimated) UFC of fungi/mL, and absence of typical colonies of *Salmonella sp* in 25mL. Therefore, the nectar formulations served to the tasters for sensory analysis were safe from the microbiological point of view.

Sensory acceptance and purchase intention

Sensory acceptance and purchase intention for the three formulations of mixed nectar of cupuaçu and açai added with fructo-oligosaccharide are described in Table 1. It can be seen that appearance and color were the parameters that varied for the formulations, but did not differ significantly (p>0.05) between formulations 2 and 3, showing that different cupuaçu and açai pulp concentrations had an influence on the sensory acceptance for these attributes. In the hedonic scale, it can be seen that the formulations had acceptability levels between “liked slightly” (6) and “liked very much” (8).

**Table 1.** Sensory acceptance and purchase intention of formulations made up of cupuaçu and açai mixed nectar added with fructo-oligosaccharide. São Cristóvão, Sergipe, 2018.

Sensory attributes	Formulations		
	F1*	F2*	F3*
Appearance	6.63±1.63 <sup>b</sup>	6.93±1.52 <sup>ab</sup>	7.37±1.43 <sup>a</sup>
Sweetness	6.93±1.57 <sup>a</sup>	6.89±1.77 <sup>a</sup>	7.13±1.51 <sup>a</sup>
Flavor	6.61±1.80 <sup>a</sup>	6.64±1.86 <sup>a</sup>	6.96±1.71 <sup>a</sup>
Color	6.77±1.75 <sup>b</sup>	7.23±1.19 <sup>ab</sup>	7.67±1.33 <sup>a</sup>
Overall impression	6.77±1.73 <sup>a</sup>	6.96±1.59 <sup>a</sup>	7.07±1.59 <sup>a</sup>
Purchase intention	3.19±1.30 <sup>a</sup>	3.21±1.25 <sup>a</sup>	3.63±1.13 <sup>a</sup>

\*Means and standard deviation (SD). Different letters in column indicate significant difference by the Tukey's test (p<0.05). F1 (Formulation 1); F2 (Formulation 2) and F3 (Formulation 3)

Purchase intention was ranked between “maybe would buy, maybe not” (3) and “probably would buy” (4), as can be seen in Table 1. The probable purchase intention of the proposed mixed nectar may be due to the lower consumption of açai and cupuaçu in Sergipe,

when compared to Pará, which accounts for 60% of açai consumption,<sup>31</sup> and 50% of cupuaçu consumed in Brazil.<sup>32</sup>

There is a strong relationship between what we culturally elect as food and what is cultivated and consumed by each people.<sup>33</sup> According to study conducted by Matos in 2013,<sup>10</sup> it can be obtained a purchase intention for F1(2.83), F2(3.93) and F3(4.12) for the three formulations of cupuaçu nectar, and the purchase intention is higher for the most sweetened flavor nectar.

Sensory preference

Table 2 shows the sum of ranks of preference for the formulations as indicated by 70 tasters. With respect to the order of preference, Friedman's table provides as critical absolute value of difference of the sum of ranks to establish significant preference (p<0.05) between samples equal to 28.

**Table 2.** Sum of ranks for the formulations of cupuaçu + açai mixed nectar added with fructo-oligosaccharide. São Cristóvão, Sergipe, 2018.

	Formulations*		
	F1	F2	F3
Sum of ranks	146 <sup>a</sup>	144 <sup>a</sup>	129 <sup>a</sup>
Difference vs. F1	---	2	17
Difference vs. F2	---	---	15
Difference vs. F3	17	15	---

\*Sums of ranks. Different letters in column indicate significant difference by the Friedman test (p<0.05). F1 (Formulation 1); F2 (Formulation 2) and F3 (Formulation 3)

Based on the results described in Table 2, it can be seen that the difference between the sum of ranks was equal to or higher than 28; therefore, there was no significant difference (p>0.05) between the samples. So, there is no difference in the preference between the formulations assessed, indicating that regardless of the concentration of cupuaçu and açai pulps, the sensory preference of nectars was the same for the 70 tasters.

The acceptability indices (AI) obtained for the sensory attributes of the formulations of cupuaçu and açai mixed nectar added with fructo-oligosaccharide were, respectively, 75%, 77% and 80%. We can say that the three formulations had good consumption potential, since the results for the different attributes were higher than 70%.<sup>22</sup>



Physicochemical and chemical assessment

Table 3 shows the physicochemical and chemical characterization of three formulations of cupuaçu and açaí mixed nectar added with fructo-oligosaccharide. It can be seen that the only parameters that did not differ significantly ( $p < 0.05$ ) between the formulations of mixed nectar were total soluble solids and pH. Moisture was higher in formulation 3 (86.73), followed by 2 (86.10) and 1 (85.94). The mean values of total titratable acidity and ratio were the same between formulations 1 and 2, but differed from formulation 3. Vitamin C did not differ statistically ( $p > 0.05$ ) between formulations 2 and 3, as well as between formulations 1 and 2. Regarding total phenolics and FRAP, formulation 1 exhibited the highest means, while formulation 2 (206.91) indicated the highest mean value for DPPH.

**Table 3.** Physicochemical and chemical characteristics of cupuaçu and açaí mixed nectar with addition of fructo-oligosaccharide. São Cristóvão, Sergipe, 2018.

Characteristics#	Formulations		
	F1*	F2*	F3*
Moisture	85.94±0.05 <sup>c</sup>	86.10±0.01 <sup>b</sup>	86.73±0.05 <sup>a</sup>
TTA	4.89±0.41 <sup>a</sup>	4.72±0.20 <sup>a</sup>	3.43±0.01 <sup>b</sup>
SST	12.05±0.23 <sup>a</sup>	12.20±0.00 <sup>a</sup>	12.02±0.09 <sup>a</sup>
Ratio	2.47±0.16 <sup>b</sup>	2.59±0.12 <sup>b</sup>	3.51±0.03 <sup>a</sup>
pH	3.64±0.00 <sup>a</sup>	3.53±0.01 <sup>a</sup>	3.59±0.01 <sup>a</sup>
Vit. C	45.71±4.66 <sup>b</sup>	52.86±5.47 <sup>ab</sup>	57.14±0.00 <sup>a</sup>
Total phenolics	305.66±19.42 <sup>a</sup>	178.17±15.71 <sup>b</sup>	214.92±13.89 <sup>b</sup>
DPPH	193.29±2.19 <sup>c</sup>	206.81±0.91 <sup>a</sup>	199.47±2.55 <sup>b</sup>
FRAP	19.39±0.73 <sup>a</sup>	13.73±0.31 <sup>c</sup>	16.82±0.41 <sup>b</sup>

\*Means and standard deviation (SD). Different letters in column indicate significant difference by the Tukey's test ( $p < 0.05$ )  $n = 4$ . F1 (Formulation 1); F2 (Formulation 2) and F3 (Formulation 3). # Moisture is expressed in %; TTA (total titratable acidity) expressed in g citric acid/100g; vitamin C expressed in mg of ascorbic acid/g sample; phenolics expressed in  $\mu\text{gEq}$  of gallic acid/g of sample; DPPH was expressed in  $\mu\text{gEq}$  of Trolox/g of sample; FRAP were expressed in  $\text{mmolEq}$  of ferric sulfate/g sample.

The moisture level found in the three formulations (F1, F2 and F3) is around 86%, indicating that the main component of nectars is water (Table 3). The shelf life of the product, as well as its texture, consistency and viscosity are directly related to the water content present. The existence of water occurs as water activity and water binding, resulting in total water content, which is the moisture content. Most of the microorganisms



that cause deterioration proliferate more rapidly in an environment with high water activity ( $> 0.90$ ).<sup>34,35</sup> The moisture content found in this study (Table 3) is similar to the one found by Damiani et al.,<sup>36</sup> in mixed nectar of cajá-manga (*spondias Cytharea* Sonn.) and mint with 84% moisture.

The acidity in formulations 1 (4.89) and 2 (4.72) was higher than that found in formulation 3 (3.43), which indicates that different concentrations of cupuaçu and açaí pulps have an effect on this parameter (Table 3). In general, fruits with higher levels of acidity have low acceptance, but this characteristic favor the production of by-products from these fruits, eliminating the use of organic acids to preserve them.<sup>37</sup>

The total soluble solids (TSS) obtained for the three formulations of cupuaçu and mixed nectars were the same ( $p > 0.05$ ) in all formulations, varying from 12.02 to 12.20°Brix (Table 3). TSS are made up of water-soluble compounds, represented by sugars, acids, vitamin C and some pectins, and are used to identify total sugars contents in fruit, which enable to indicate their maturation level.<sup>37</sup>

The ratio in the mixed nectar formulations was higher in formulation 3 (3.51), and lower in the other formulations (1 and 2), which clearly indicates that different kinds of fruits and their concentrations may influence it (Table 3). Ratio is a key parameter used in evaluations of citric juices because it is a good indicator of the fruit maturity.<sup>38</sup>

The pH levels (3.53 to 3.64) found in the three formulations of mixed nectar did not differ significantly ( $p > 0.05$ ), as can be seen in Table 3. The pH level observed in the formulations of cupuaçu and açaí mixed nectar (Table 3) makes these products more susceptible to fungal proliferation, considering that most bacteria prefer  $\text{pH} > 4.5$  to grow.

As can be seen in Table 3, the formulations of cupuaçu and açaí mixed nectar heave significant amounts of vitamin C (45.71 to 57.14), twice as much vitamin C present in açaí and cashew nectar (19.5mg/100mL).<sup>39</sup> The vitamin C levels in all formulations of cupuaçu and açaí mixed nectar (Table 3) met the recommended level of 45mg/day.<sup>40</sup> This vitamin provides protection against oxidation in the cell's aqueous medium due to its reducing power.<sup>41</sup>

With respect to total phenolics, all formulations exhibited expressive quantities of phenolics, the highest content being found in formulation 1 (305.66), which might have reflected on their greater capacity to reduce iron (FRAP) (Table 3). Phenolic compounds may influence on the nutritional value and sensory quality of foods, because they have a high antioxidant activity and play a key role in the control of oxidative stress in the body.<sup>42</sup> FRAP is also used to measure the antioxidant capacity of fruits, in which the ferric tripyridyltirazine ( $\text{FeIII-TPZ}$ ) complex is reduced to ferrous complex ( $\text{FeII-TPZ}$ ) in the presence of an antioxidant and in acid conditions.<sup>43</sup>

With regard to DPPH, the formulation that exhibited the highest ability to sequester 2,2-diphenyl-1-picrylhydrazyl radical was formulation 2 (206.81), followed by formulation 3 (199.47) and 1 (193.29), according to Table 3. The DPPH method can be used to assess the antioxidant activity of specific compounds or of an extract in a short period of time. It is a method widely used to assess the antioxidant capacity of fruits,<sup>43</sup> considering that each fruit seasonality is a determinant factor for its antioxidant potential.<sup>8</sup>

The cupuaçu and açai mixed nectar is a novel product, and so it does not have references in the literature. However, its results, expressed in physicochemical, chemical analyses, total phenolics and antioxidant capacity (Table 3), are similar to the ones found in other products made from the same fruits, thus being within the expected range.

CONCLUSIONS

Cupuaçu and açai mixed nectar, added with fructo-oligosaccharide, proved to be microbiologically safe and with sales potential, since the formulations reached similar results in sensory acceptability.

The nectar formulations exhibited a high antioxidant capacity and high content of vitamin C.

Addition of FOS to the açai and cupuaçu mixed nectar raised the commercial and nutritional value of the product, being a healthier nectar option because this food does not contain additives and is a source of dietary fibers.

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### Contributors

De Jesus MMA participated in the conduction of the entire survey research and preparation of the scientific paper. Ferreira IM participated in the microbiological, chemical and physicochemical analyses and interpretation of results. Santos LVN participated in the preparation of the product, conduction of the sensory evaluation and interpretation of results. Silva AMO contributed to the interpretation of results and writing the manuscript. Carvalho MG participated in the conduction of the survey research, interpretation of results and writing the manuscript.

Conflict of Interests: The authors declare no conflict of interest.

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Received: March 14, 2018

Reviewed: February 06, 2019

Accepted: February 24, 2019