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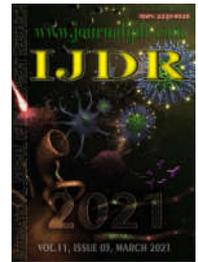
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## COOKIES ENRICHED WITH PANC FLOUR: ACCEPTANCE AND SENSORIAL CHARACTERIZATION

Gabriel S. Ribeiro<sup>a</sup>, Paloma G. de Sousa<sup>a</sup>, Laura B.G. Coutinho<sup>a</sup>, Juliana dos S. Vilar<sup>b</sup>, Mayara F. Lima<sup>b</sup>, Elaine Cristina de S. Lima<sup>a</sup> and Luciana R. T. Manhães<sup>a\*</sup>

<sup>a</sup>Departament of Fundamental Nutrition, Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Rio de Janeiro/RJ – Brazil; <sup>b</sup>Departament of Nutrition and Dietetics, Universidade Federal Fluminense - UFF - Niterói/RJ – Brazil;

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#### \*Corresponding author:

Luciana R. T. Manhães,

### ABSTRACT

Unconventional Food Plants (PANC) are characterized by native edible species that have a great food potential being source of many of nutrients, besides respecting agroecological and sustainability concepts. The present study aims to determinate the acceptance and sensory characterization of enriched cookies with different PANC flour using check-all-that-apply (CATA) methodology. The selected PANC flour were prepared and cookies elaborated. To perform the CATA method, 19 attributes were previously determined by a group of consumers and 80 consumers evaluated the samples, more overall liking and purchase intention. The samples S2 (ora-pro-nobis), S4 (anise) and S6 (peppermint) achieved the highest liking scores by consumers. According to the Cochran's Q test, 10 CATA terms were used to describe the samples. The most cited terms were Buttery flavor, Crunchy, Herbal flavor, Light color, Mild aroma and Sweet. The fortification of cookies with PANC flour proved to be a viable strategy to increase their consumption.

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## INTRODUCTION

Brazil is one of the countries with the highest biodiversity of fauna and flora. Unconventional Food Plants (PANC) are characterized by native, exotic, spontaneous, wild or cultivated edible species and they are traditionally consumed or used therapeutically in certain regions and cultures. Most of them have a spontaneous development in different environments and climates, while other types require simple and undemanding cultivation, with excellent adaptation to the environment (Paschoal and Souza 2015). PANC have great food potential being sources of multiples nutrients. However, they are not utilized by food industry or usually consumed by general population, despite their high economic and nutritional potential, valuing family farming and respecting agroecological concepts and sustainability (Paschoal and Souza 2015). An important factor that gives to PANC an advantage it is the minimal use of agricultural inputs or even the absence of pesticides in cultivation. PANC have the potential to increase the resilience and adaptation of agricultural production and local food systems (Kinupp e Lorenzi 2014). PANC insertion in the food chain can favors the access to high nutritional value food, and

also provides products cultivated through sustainable practices (Padilha et al. 2020). In the great existing PANC variety, we can mention lemon grass (*Cymbopogon citratus*), a highly aromatic herbaceous that is native of southern India and cultivated in tropical countries such as Brazil (Kinupp 2007). Its basal leave portions (tender core, inner part) can be chopped into thin slices and used in fish flavoring, soups and sauces (Kinupp and Lorenzi 2014). Ora-pro-nobis (*Pereskia aculeata* Mill), is another PANC example that has a high level of total protein, it has been called "poor's meat". It also has high iron content and can be considered a source food (15% of the iron DRI). Therefore, the presence of these two important nutrients means that this PANC can be used as food supplement in both human and animal feed (Rocha et al. 2009). In addition, the Banana plant Inflorescence (*Musa ssp*), popularly known as the "banana tree's heart" is a carbohydrate and protein rich food, and an important mineral and fiber source. Anise (*Pimpinella anisum* L), can be used in sweet and snack recipes. Anise essential oil, ethanolic and aqueous extracts have a bronchodilator action, it also has a strong antioxidant activity and remarkable antibacterial action for gram positive and gram negative bacteria (Gulçin et al. 2003). Peppermint (*Mentha piperita* L.) is another PANC that is a popular herb used in the form of

oil, extract, tincture, infusion or fresh in association with savory, sweet and juiced dishes. Its essential oils guarantee a fresh odor and a pungent flavor followed by a refreshing sensation (Herro and Jacob 2010). Antioxidants natural sources are known and frequently found in the plant kingdom. Several herbal extracts such as rosemary, coriander, sage, thyme and basil have been studied due to the antioxidant property, which can be attributed to their phenolics compounds content (Wettasinghe and Shahidi 1999). New cocoyan (*Xanthosoma sagittifolium*), one of the existing PANC species, presented a high amount of phenolic and flavonoid compounds, as well as high antioxidant activity, suggesting that the species is an important source of biological active molecules and that it can be used to minimize or prevent oxidative damage, which according to Balbino (2019) elucidates the antioxidant and functional power of PANC.

The dissemination of information about these plants and the incentive to their consumption can be an alternative to minimize expenses with the acquisition of foodstuffs, since PANC have an easier and spontaneous development, that contribute to the final price of these vegetables (Furtado 2018). However, the use of PANC as a raw material for the development of new food products needs to be carefully evaluated, because information about the sensory characteristics of food is a critical point for the success of this development (Stone and Sidel 2004). New products development is a strategic activity for industries. As a claiming of market, consumer has been demanding in quality terms for the purchased products. Food industry uses sensory science to measure important aspects about new products, before launching on the market. Understanding consumers behavior and the factors that influence their consumption are fundamental (Grunert and Trijp 2014). Traditional methods of sensory analysis of food can be applied by food industry, however there are challenges involving their use as, time availability and financial resources for the process. Such as Quantitative Descriptive Analysis (QDA), requires training, qualification and maintenance of a trained team of evaluators, who are able to verbalize the reliable perceptions of a product steadily (ABNT NBR 14140, 1998).

Several qualitative methods have been investigated to determinate how sensory characteristics are perceived from the point of view of consumers. Since the use of trained evaluators, as in the QDA methodology does not necessarily represent consumer's perception and behavior (Ares *et al.* 2011; Moussaou and Varela 2010). A methodology that recently has become popular is the Check- All-That- Apply (CATA), which consists of presenting a list of words or phrases to consumers, where they should select all the terms considered appropriate to describe the product. The samples must be monadically and balanced presented (Valentin *et al.* 2012; Dutcosky 2013; Ares and Jaeger 2015). It is common to use this method simultaneously with hedonic scales to understand, through a product characterization conducted by potential consumers of the product, which attributes were associated with (Ng *et al.* 2013). Usually, a minimum of 80 to 100 consumers is required, however in very complex samples, the analysis can be performed with 60 to 80 consumers (Ares *et al.* 2014). As a fast methodology, CATA provides information of sensory characteristics of products in a short time, thus presenting a great advantage in relation to QDA. For this reason, it frequently has been used in the first stages of products development. In addition, the fact that sensory characterization is carried out with consumers, it becomes closer to reality contributing to the success of the product in the market (Cadena *et al.* 2014). The present study aims to determinate the acceptance and sensory characterization of cookies enriched with different PANC flours using CATA methodology.

## MATERIALS AND METHODS

**Samples:** The PANC chosen for this study were: Lemon grass, Ora-pro-nobis, Banana plant Inflorescence (peel and fruit), Anise and Peppermint. They were selected and harvested in the morning, from family farms, on the West Zone in Rio de Janeiro city - RJ, Brazil.

They were later packed in separate plastic bags and transported to the Dietetic I Laboratory of Nutrition School, Universidade Federal do Estado do Rio de Janeiro (UNIRIO). In the laboratory they were defoliated and cleaned individually under running water to remove the main dirt, and then manually cut. Subsequently, they were subjected to bleaching in hot water (90°C) for 1 minute to enzymatic inactivation. Next the drying process was started to prepare the PANC flours. They were packed separately in aluminum molds (30 x 40 cm), each species in a separate mold, without overlapping between the leaves. The molds were placed in an air circulation oven (model 420-6D, Nova Ética) at 65°C for 12 hours to dry the leaves. After the PANC samples were individually milled in a blender (model RI 1764, Philips Wallita) and then sieved for homogeneity of the grain size. The obtained flours were packaged in sterile plastic packaging and labeled with their identification, until the moment of use, as elucidated in Figure 1. The criteria used to determine the type of product to be enriched with PANC flour took into account the ingredients necessary for the preparation, which should be low cost, easy to be acquired and prepared by population, besides being popular and frequently consumed by the Brazilian. Based on these characteristics, the preparation chosen was cookies, once the incorporation of fortified flours is facilitated, they are easy to eat and well accepted by all age groups. To choose the formulation of cookies, a search for cookie recipes in which the addition of PANC flours would be appropriate was carried out on the internet. After preliminary tests with standard recipes for sweet and salty cookies, a base recipe was selected, consisting of 28% butter, 26% wheat flour, 23% refined sugar, 18% wheat flour, 3% PANC flour and 1% biological yeast. The ingredients of the standard recipe were purchased in a local market, and the formulations were prepared at Dietary Technique I Laboratory at UNIRIO. The cookie has been prepared by butter and sugar combination using an electric mixer until it is very soft and aerated (approximately 10 minutes). The other ingredients were added and mixed to obtain a homogeneous mass and maintained in the refrigerator for 30 minutes. Subsequently, the cookie dough was opened on a greased tray, and then divided into 2 cm slices with the aid of a mold, until the homogeneity of the samples. They were baked in a preheated oven at 180°C for 20 minutes. After cooling, the cookies were packed in closed jars and labeled, with name, shelf life and date of manufacture until the sensory analysis was carried out. According to Figure 2. Six different cookies were made: S1 – Lemon grass flour cookie; S2– Ora-pro-nobis flour cookies; S3 – Banana plant Inflorescence peel flour cookies; S4 – Anise flour cookies; S5 - Banana plant Inflorescence fruit flour cookies; and S6 - Peppermint flour cookies. All cookies were prepared from the same base recipe and the same proportion of PANC flour quantity.

### Experimental procedure

**Sensory Characterization (CATA):** To determinate the list of CATA terms, a preliminary study was carried out, in which 10 consumers were selected. The criteria used to select the participants were: be interested in participating in the study, time availability and be a consumer of cookies. This study was carried out in Sensory Analysis Laboratory at Nutrition College of Universidade Federal Fluminense – UFF. Six cookie samples were presented in a monadically and balanced. Each participant used a blank sheet to describe all the characteristics that were perceived in each sample. At the end of the task, one of the researchers discussed with the participants to reach a consensus and determine the list of attributes that best described the evaluated samples. A total of 19 CATA terms were selected: Burnt aroma, mild aroma, sweet aroma, tea aroma, sweet, bitter taste, buttery flavor, condiment flavor, herbal flavor, lemon flavor, strange flavor, barely sweet, sweetery sweet, crunchy, dry, sticky, grainy texture, dark color and light color.

**Acceptance Test e CATA:** The sensorial test was carried out in the Sensory Analysis Laboratory at Nutrition College of Universidade Federal Fluminense – UFF, from November to December in 2019. Consumers (n=80) aged 18-65 years old, both male and female and cookie consumers were recruited through posters, social media and university websites, with voluntary participation.

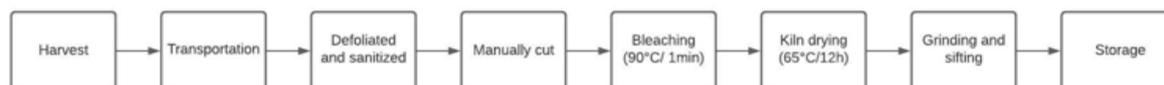


Figure 1. PANC flour processing flow chart

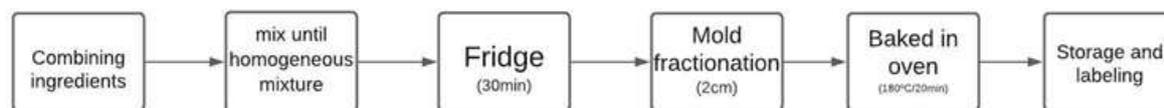


Figure 2. Flow chart of cookies preparation

After clarifying the study, they signed the Free and Informed Consent Form (ICF), approved by the Research Ethics Committee (CEP) of the Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Delivered by report Number-86612818.7.0000.5285. The samples were presented monadically, in a balanced order (Macfie *et al.* 1989) and overall liking was evaluated through a 9-point structured hedonic scale (1 = extremely disliked; 9 = extremely liked). After the overall liking, consumers completed the CATA Test, previously determined in the preliminary study. Balanced by consumer, the 19 CATA terms were presented and the participants checked all the terms they considered adequate to describe the samples. Then, the purchase intention was applied, using a 5-point structured scale (1 = certainly would not buy; 5 = certainly would buy) (Meilgaard *et al.* 1999). Finally, the participants answered a socioeconomic questionnaire, used to assist in the interpretation of results.

**Data analysis:** Participant's socioeconomic profile was expressed through percentages. The overall liking data and purchase intention data were submitted to Variance analysis (ANOVA) and Tukey's test at 5% significance. The samples were considered as a variation source and consumers as a random effect. The acceptability index was also calculated from the expression:  $IA (\%) = A \times 100 / B$ , with A = average grade for the product, and B = maximum grade given to the product (Peuckert *et al.* 2010). A good repercussion IA has been considered at  $\geq 70\%$  (Dutcosky 2013). The frequency of mention for each CATA term was determined by counting the number of consumers who used the term to describe each sample. The Cochran Q test (Manoukian 1986) was performed to identify significant differences between the samples regarding the frequency of each sensory term used, it was followed by the sign test (Meyners, Castura and Carr 2013), that identify significant differences between samples for each sensory descriptor. The Correspondence Analysis (CA) was performed on the frequency table to obtain the samples representation and the relation between them and the terms of the CATA questions. The confidence ellipses around the projected coordinates of the samples were obtained through bootstrapping (Ringrose 2012). All statistical analyzes were performed using R language software (R Core Team 2014). The FactoMineR package was used to the Correspondence Analysis (CA) and to build the confidence ellipses, and the RVAideMemoire and ExPosition packages were used to Cochran Q test.

## RESULTS E DISCUSSION

**Consumers profile:** Consumers who participated in the study (n = 80) were mostly women (79%). Young adults until 30 years old (60%), whose education, in most of cases were incomplete college (65%), and the average family income between 2 to 10 minimum salaries (71%). The vast majority reported consuming cookies at least once a week (93%), demonstrating that the participants are acquainted to the characteristics of the product, and they are possible target consumers, if the product were marketed (Table 1).

**Overall liking and purchase intention:** In the overall liking test, the samples S2 (ora-pro-nobis), S4 (anise) and S6 (peppermint) were the most accepted by consumers (averages 6.7, 6.3 and 6.4, respectively) (Table 2).

It is noteworthy that the sample S2, whose PANC flour was composed of ora-pro-nobis, considered the "poor's meat" for its interesting protein content (Rocha *et al.* 2009), can be an economically viable option to offer protein to people, especially among vegetarians and those with lower socioeconomic profile. The samples S4 and S6 that have in their composition anise and peppermint flour respectively have a strong and marked aromatic note. For this reason, it may have contributed to their acceptance. The S3 and S5 (average 5.6 and 5.6, respectively) samples were less well accepted than sample S2 ( $p < 0.05$ ). This result is probably related to the bitter taste conferred by the flours with peel and banana plant Inflorescence fruit present in these samples (Barbosa 2019).

Table 1. Profile of consumers participating in the study (n = 80)

Characteristic	Description	Frequency (%)
Gender	Male	21
	Female	79
Age	< 20 years old	20
	21 - 30 years old	55
	31 - 40 years old	11
	41 - 60 years old	10
	> 60 years old	4
Education Level	Incomplete Junior School	1
	Complete Junior School	0
	Incomplete High School	0
	Complete High School	11
	Incomplete College	65
	Complete College	8
	Incomplete Post graduated	4
Complete Post graduated	11	
Family income	Until 2 salaries	23
	2 - 3 salaries	12
	4 - 6 salaries	34
	6 - 10 salaries	18
	10 - 15 salaries	6
	More than 15 salaries	6
	More than 25 salaries	1
Cookies consumption frequency	Never	7
	1 - 2 x/week	60
	3 - 4x/week	25
	5 - 6x/week	3
	Everyday	5

The acceptance index corroborated with results of the overall liking, since they indicated that the samples S2, S4 and S6 were the only ones that presented indexes above 70%, suggesting that these formulations would have a higher potential in the market, compared with the others. The overall liking averages obtained in the vegetable flour enriched cookie's samples in the present study were similar to those found by other authors. The study conducted by Farias *et al.* (2011) obtained overall liking averages between 5.6 and 6.7 for cookies enriched with macambira flour (kernels and bracts). In gluten-free cookies enriched with different amounts of buriti flour, Freitas *et al.* (2020), related overall liking averages between 5.7 and 6.8. The literature findings suggest that the addition of vegetable flours may reduce the acceptance of the products, due to the modification of conventional sensory characteristics of cookies. Thus, understanding which characteristics negatively affect acceptance is

essential for the optimization of these products. The purchase intention test revealed consumers indecision regarding the acquisition of the evaluated samples, since all samples had averages close to 3, compatible with the statement "I have doubts if I would buy", with no significant difference between the evaluated samples ( $p < 0.05$ ) (Table 2). In the study by Farias *et al.* (2011), cookies enriched with macambira flour (*Bromelia laciniosa*) had a 56% of purchase intention. Comparing the results of the present study with the presented author, a similar pattern is observed, if we evaluate this data as a percentage, the samples had an average purchase intention value of 47%.

**Table 2. Overall liking and purchase intention for cookie samples enriched with PANC**

Samples <sup>o</sup>	Overall likng	Purchase intention	Liking Index*
S1	5.48 <sup>b</sup>	3.04 <sup>a</sup>	60.9%
S2	6.66 <sup>a</sup>	3.45 <sup>a</sup>	74%
S3	5.60 <sup>b</sup>	3.02 <sup>a</sup>	62%
S4	6.33 <sup>ab</sup>	3.41 <sup>a</sup>	70.4%
S5	5.66 <sup>b</sup>	2.94 <sup>a</sup>	62.9%
S6	6.41 <sup>ab</sup>	3.44 <sup>a</sup>	71.3%

<sup>o</sup> S1= Lemon grass flour cookies; S2= Ora-pro-nobis flour cookies; S3 = Banana plant inflorescence peel flour cookies; S4= Anise flour cookies; S5= Banana Plant inflorescence fruit flour cookies; S6= Peppermint flour cookies. Means with different letters imply a significant difference according to the Tukey test with a 5% significance level. \*Liking Index was calculated considering: LI (%) = A x 100/B, wher A = average score obtained for the sample, e B = maximum score given to the sample.

**Table 3. Frequency that consumers selected each term in the CATA questionnaire to describe the cookie samples enriched with PANC**

		CATA Terms	p-valor*	Samples <sup>o</sup>					
				S1	S2	S3	S4	S5	S6
Aroma	Burnt aroma	<0.0001	2 <sup>d</sup>	7 <sup>c</sup>	36 <sup>a</sup>	14 <sup>bc</sup>	17 <sup>b</sup>	11 <sup>bc</sup>	
	Mild aroma	0.001	17 <sup>c</sup>	32 <sup>ab</sup>	24 <sup>bc</sup>	39 <sup>a</sup>	23 <sup>bc</sup>	22 <sup>bc</sup>	
	Sweet aroma	0.077 <sup>ns</sup>	17 <sup>a</sup>	19 <sup>a</sup>	7 <sup>b</sup>	17 <sup>a</sup>	12 <sup>ab</sup>	11 <sup>ab</sup>	
	Tea Aroma	<0.0001	50 <sup>a</sup>	22 <sup>b</sup>	4 <sup>d</sup>	14 <sup>bc</sup>	8 <sup>cd</sup>	19 <sup>b</sup>	
	Barely sweet	0.386 <sup>ns</sup>	17 <sup>a</sup>	26 <sup>a</sup>	19 <sup>a</sup>	26 <sup>a</sup>	20 <sup>a</sup>	22 <sup>a</sup>	
	Bitter taste	<0.0001	7 <sup>cd</sup>	3 <sup>d</sup>	26 <sup>a</sup>	13 <sup>bc</sup>	21 <sup>ab</sup>	2 <sup>d</sup>	
	Buttery flavor	0.0003	22 <sup>c</sup>	45 <sup>a</sup>	39 <sup>ab</sup>	34 <sup>ab</sup>	32 <sup>bc</sup>	45 <sup>a</sup>	
Taste or flavor	Condiment flavor	<0.0001	6 <sup>c</sup>	17 <sup>ab</sup>	5 <sup>c</sup>	10 <sup>bc</sup>	25 <sup>a</sup>	18 <sup>ab</sup>	
	Herbal flavor	<0.0001	46 <sup>a</sup>	34 <sup>ab</sup>	7 <sup>c</sup>	34 <sup>ab</sup>	19 <sup>b</sup>	37 <sup>a</sup>	
	Lemon flavor	<0.0001	33 <sup>a</sup>	6 <sup>b</sup>	3 <sup>bc</sup>	7 <sup>b</sup>	0 <sup>c</sup>	3 <sup>bc</sup>	
	Strange flavor	0.0004	11 <sup>b</sup>	11 <sup>b</sup>	16 <sup>b</sup>	10 <sup>b</sup>	28 <sup>a</sup>	9 <sup>b</sup>	
	Sweet	0.734 <sup>ns</sup>	26 <sup>a</sup>	28 <sup>a</sup>	27 <sup>a</sup>	29 <sup>a</sup>	22 <sup>a</sup>	30 <sup>a</sup>	
	Very sweet	0.762 <sup>ns</sup>	1 <sup>a</sup>	4 <sup>a</sup>	2 <sup>a</sup>	3 <sup>a</sup>	3 <sup>a</sup>	4 <sup>a</sup>	
	Crunchy	0.832 <sup>ns</sup>	61 <sup>a</sup>	63 <sup>a</sup>	65 <sup>a</sup>	67 <sup>a</sup>	64 <sup>a</sup>	65 <sup>a</sup>	
Texture	Dry	0.194 <sup>ns</sup>	25 <sup>a</sup>	17 <sup>a</sup>	28 <sup>a</sup>	21 <sup>a</sup>	22 <sup>a</sup>	21 <sup>a</sup>	
	Sticky	0.150 <sup>ns</sup>	13 <sup>a</sup>	10 <sup>a</sup>	20 <sup>a</sup>	14 <sup>a</sup>	16 <sup>a</sup>	17 <sup>a</sup>	
	Grainy texture	0.235 <sup>ns</sup>	15 <sup>a</sup>	13 <sup>a</sup>	17 <sup>a</sup>	14 <sup>a</sup>	22 <sup>a</sup>	20 <sup>a</sup>	
Appearance	Dark colour	<0.0001	11 <sup>c</sup>	15 <sup>bc</sup>	37 <sup>a</sup>	14 <sup>bc</sup>	21 <sup>b</sup>	22 <sup>b</sup>	
	Light colour	0.052 <sup>ns</sup>	30 <sup>ab</sup>	33 <sup>a</sup>	20 <sup>b</sup>	36 <sup>a</sup>	30 <sup>ab</sup>	25 <sup>b</sup>	

Indicates significant difference ( $p \leq 0.05$ ) according to Cochran's Q test; ns Indicates that there is no significant difference ( $p \leq 0.05$ ) according to Cochran's Q test; <sup>o</sup> S1= Lemon grass flour cookies; S2= Ora-pro-nobis flour cookies; S3 = Banana plant inflorescence peel flour cookies; S4=Anise flour cookies; S5= Banana plant inflorescence fruit flour cookies; S6=Peppermint flour cookies. The frequency of use of terms with different lowercase letters within a column are significantly different between weeks according to the sign test ( $p < 0.05$ ).

**Sensorial characterization (CATA):** According to Cochran's Q test, a significant difference ( $p < 0.05$ ) was observed in the frequency of 10 in the 19 CATA terms used to describe the cookie samples enriched with PANC flours, suggesting that consumers ( $n = 80$ ) noticed differences in the sensory characteristics of the products. Therefore 52.9% of the descriptor terms selected in the attributes list obtained a significant difference (Table 3). It suggests that that the CATA attributes chosen to compose the list of terms was adequate to describe the cookies enriched with PANC flours. Similar results were found by Abreu (2018) in the sensorial characterization of cookies with the addition of grape peel flour (*Vitis Labrusca*), where 50% of the descriptive terms presented a significant difference. Among the descriptive terms most cited by consumers in the characterization the samples were: Buttery flavor, Crunchy, Herbal flavor, Light color, Mild aroma and Sweet, suggesting that these attributes were the most important to sensory attributes the samples (Table 3). The representation of the CATA attributes and the six cookie samples enriched with PANC flour by the correspondence analysis (CA) are shown in Figure 3a. The first and second dimensions explained over 84.5% of the variance of the experimental data, suggesting that the

CATA terms used in the study were adequate to describe the samples. According to the confidence ellipses (Figure 3b) the samples can be arranged in 3 groups of samples according to the sensory characterization. Observing the confidence ellipses formed, with the CA data (figure 3a), it is possible to observe that the S1 sample (lemongrass) presented unique sensory attributes such as lemon flavor and Tea aroma. The samples S2, S4 and S6 (ora-pro-nobis, anise and peppermint respectively) have showed similar sensory characteristics and it have been close to most of the CATA Terms related to texture, sweet taste and aroma used in this study.

The results indicate that the S3 (banana plant Inflorescence peel) and S5 (banana plant Inflorescence fruit) samples were perceived as similar. However, the S3 sample received specific characteristics such as dark color, bitter taste and burnt aroma. The differences in the sensory characteristics of the samples were expected. In spite of having the same ingredient proportion and preparation form, each PANC has particular characteristics that make them unique. Although the S3 and S5 samples are obtained from the same PANC flour, the differences in the characterization of the samples suggest that the use of banana plant Inflorescence peel flour makes the cookies darker and adds negative sensory characteristics such as bitter taste and burnt aroma. Analyzing the external preference map (Figure 4), it is possible to observe which sensorial characteristics of the cookies contribute positively or negatively to the samples acceptance. The main attributes that contribute to increased acceptance were those related to sweet taste (barely sweet, sweet), color (light color), aroma (condment aroma, mild aroma) and flavor (buttery flavor). Attributes such as: herbal flavor, lemon flavor, tea aroma, burnt aroma, bitter taste, strange taste, dark color, sticky and grainy texture contributed negatively to the acceptance of the cookies.

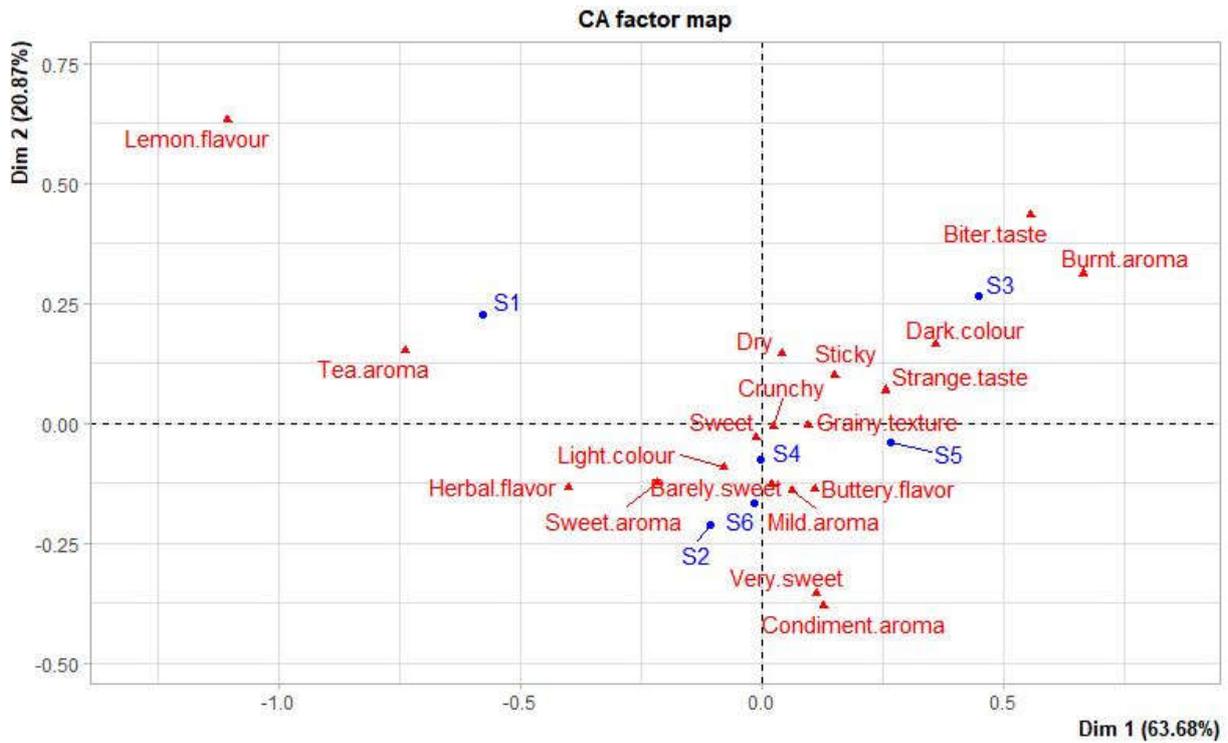


Figure 3a. Representation of samples and terms in the first two dimensions of the Correspondence Analysis (AC) on the frequency table data containing the percentage of mention of the terms of the CATA questions

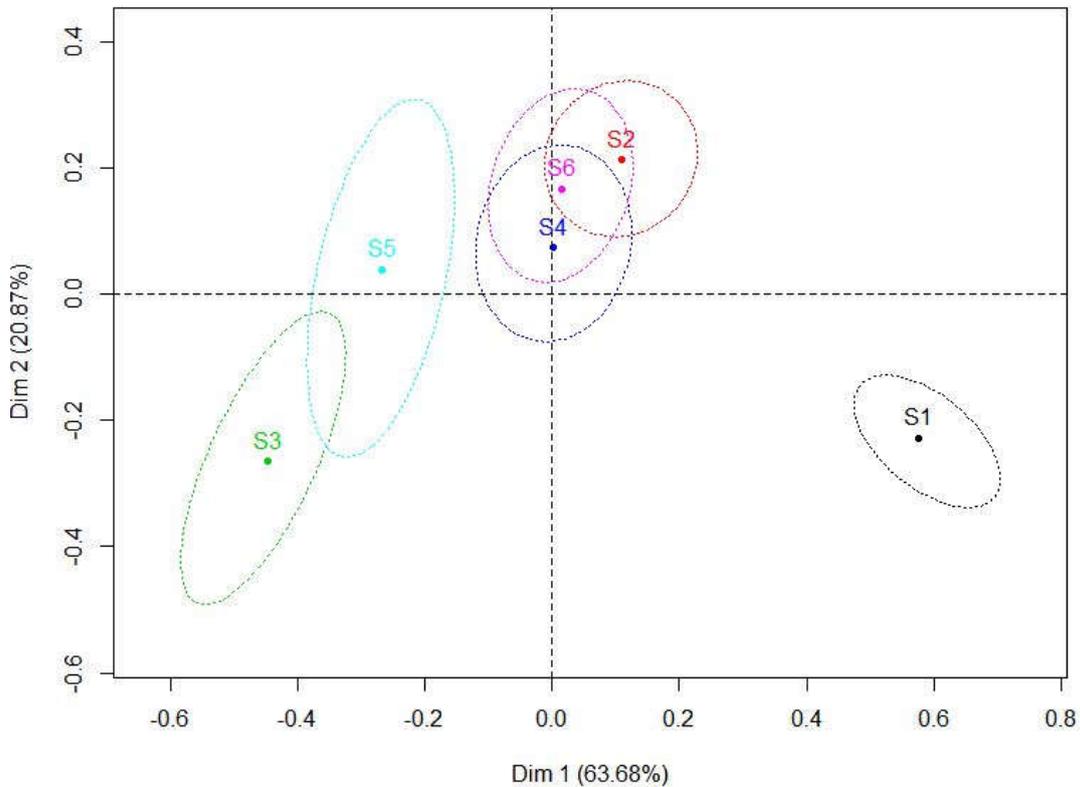
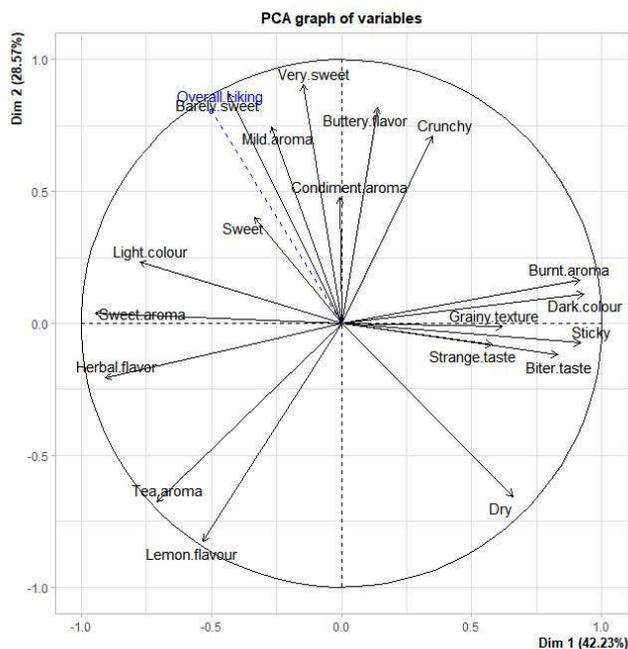


Figure 3b. Representation of samples and terms in the first two dimensions of the Correspondence Analysis (AC) on the frequency table data containing the percentage of mention of the terms of the CATA questions

Therefore, the samples that have the least market potential are the S1, S3 and S5 samples (lemongrass, banana plant Inflorescence peel and banana plant Inflorescence fruit), which require further research related to obtaining the flour, to minimize negative sensory characteristics. As in the present study, Santana *et al.* (2011) observed that characteristics related to texture were perceived as negative when evaluating rich fiber cookies prepared by partially

replacing wheat flour by yellow passion fruit peel and potato starch flour. In the present study, the use of the CATA methodology was appropriate to carry out the sensory characterization of the cookies enriched with PANC flours. The use of this methodology, simultaneously with overall liking and the purchase intention test and allowed the determinate the potential of using PANC to enriched cookies However, depending on the PANC to be used, the presence of

negative sensory characteristics was identified, which reduce its acceptance by consumers. The results found demonstrate that in order to be able to use PANC flours with less acceptance, it is necessary to investigate processes for obtaining flours that minimize undesirable sensory characteristics. In this way, it is possible to take advantage of the full potential of these low-valued plants in human feeding. It is important to highlight that, besides their importance for human health and the environment, once they allow the diversification of the diet (Brazil, 2014), PANC are promising species in the area of food technology, for the formulation of new products, and may help in demand for functional and nutraceutical foods for the production of different plant enzymes, such as papain and bromelain, important in the food industry (Kinupp and Lorenzi 2014; Fleck *et al.* 2015). Thus, investing in technologies that allows the use of PANC on a large scale can contribute to the reduction of waste and food insecurity.



**Figure 4. Influence of the sensory attributes evaluated on CATA in the acceptance of cookies enriched with PANC flours**

The fortification of cookies with flour from PANC proved to be a viable strategy to increase their consumption by population. However, the level of acceptance of the product depends of the type of PANC used, since the sensory characteristics are very different, depending on the species to be used. The flours of *ora-pro-nobis*, anise and peppermint are PANC flours that can be used more easily ones that added more characteristics that increased the acceptance. Further studies should investigate new pathways of processing lemongrass and banana plant Inflorescence flours, in order to minimize the occurrence of unpleasant attributes to the consumer, increasing their acceptance.

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