SWEETNESS LEVELS AND EFFECTS ON CATA SENSORY PROFILE AND ACCEPTANCE OF PEACH NECTAR

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Fruit nectars are beverages consisting of important nutrients, with a good extension of shelf life and are well accepted by consumers. Aiming to further enhance their positive characteristics, this study aimed to discuss the reduction of the sugar content present in peach nectar from the sensory analysis of commercial samples. Ranking, acceptance, just-about-right scale and check-all-that-apply (CATA) tests were performed, allowing to observe the effect of different sensory attributes on the acceptance of nectars and to define the ideal sugar content. It was found that some commercial samples did not present the ideal sweetness and that the sweetness is not the main attribute on the acceptance of peach nectar, demonstrating the complexity of its food matrix. This complexity seemed to divide consumer preference and it was possible to identify groups that differ regarding the acceptance of the samples. The sample A has always been in the group of the most accepted samples and, depending on the attribute, it did not differ significantly from the other samples ($p>0.05$). The ideal sweetness sample was less accepted due to the strong influence of herbal flavor and herbal aroma in the pulp used in its preparation.

KEY-WORDS: FRUIT NECTARS; SENSORY EVALUATION; JUST-ABOUT-RIGHT SCALE; ACCEPTANCE TESTING; CATA; MULTIPLE FACTOR ANALYSIS.

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1 INTRODUCTION

Brazil is regarded worldwide as an important producer and exporter of fruits. With a population of approximately two hundred million inhabitants that is changing eating habits and seeking convenience and healthier foods, processed fruits in the form of nectar with low levels of added sugar is an alternative that accompanies the prospects of this new healthy generation. Aiming at the consumption of healthier foods with higher nutritional value and functional properties that assist in preventing diseases, the greatest growth is the non-alcoholic beverages, especially “ready to drink” juices and nectars (MORZELLE *et al*., 2009). The fruit nectars are obtained by the homogenization of the entire fruit, or of its pulp, with the addition of water and sugar, and in some cases, citric acid and ascorbic acid. The percentage of fruit in the final product is 25 to 50 %, being regulated in each country (BELITZ & GROSCH, 1997).

According to the Brazilian identity and quality standard of this beverage, the minimum quantity of pulp to be added for the production of peach nectar is 40 g of peach juice or pulp for 100 g of final product. This value varies according to the flavor of the nectar, for example, 10 g per 100 g for passion fruit nectar and 35 g per 100 g for papaya nectar (BRASIL, 2003). The state of Rio Grande do Sul is the main producer of peaches, with about 55 % (130 thousand tons) of the national production, covering an area of 14 thousand hectares. With this amount of production offer of this fruit, the peach juice and nectar industry becomes attractive to increase the shelf life and add value to the fruit.

Sensory analysis is very important in the food industry to evaluate marketing acceptance and product quality, and is part of the plan for quality control on an industry. Through sensory evaluation it is possible to propose changes on the formulation, evaluate raw materials, process, products shelf life and ensure that no sensory deficits lead failures through final consumers (STONE & SIDEL, 2004).

The amount of sugar added varies according to the fruit nectar. In Brazil, the amount of total sugars in nectars should be 7g per 100g of beverage (BRASIL, 2003). The most often added sugar is sucrose syrup, due to the greater facility of being transported by the industry. Sucrose syrup has a content of soluble solids near 67 ° Brix, and has the same taste profile and sweetness of solid sugar (BIANCHINI & ASSUMPÇÃO, 2002).

This study aimed to determine, through several sensory tests, if the concentrations of sugar used in the formulations of peach nectars are within the ideal sweetness desired by consumers, so it would be possible to determine sugar reductions without affecting consumption. Sensory tests were also used to verify the sensory attributes and their effects on the acceptance of nectars in order to better map their importance in the consumer perception.

2 MATERIALS AND METHODS

Six commercial brands of peach nectar, which were purchased at markets in the city of Rio de Janeiro were evaluated. The criteria for the selection of brands were the frequency of brands on grocery shelves, the high consumption peach nectars and their varying sweetness between brands, in preliminary tests. Consumers of peach nectar (at least once a month) were randomly chosen at the Federal University of Rio de Janeiro, at the School of Chemistry. Depending on the test, the number of participants ranged from 100 to 120 volunteers and the samples were served at 8 ± 2 ° C in white plastic cups.

2.1 RANKING TEST

The ranking test was conducted with commercial samples (A, B, C, D, E, F) to evaluate if there was significant sensory difference ($p < 0.05$) between the brands’ sweet tastes. The samples (20 mL)

were presented at 8 ± 2 ° C in white plastic cups (50 mL) coded with three-digit numbers. According to Macfie *et al*. (1989), the order of presentation was properly balanced (MEILGAARD *et al.*, 2007).

The ranking test was conducted with 100 untrained assessors. Each participant was asked to evaluate the samples from left to right and sort them in ascending order of sweetness. Values from 1 to 6 were given to the samples according to the position indicated by the participant. The samples' rank sums were compared following Friedman's test at the 5 % significance level.

2.2 ACCEPTANCE TEST

The same commercial brands of peach nectar (A, B, C, D, E, F) were subjected to the acceptance test among consumers of this beverage (at least once a month). In this test, 120 assessors rated their liking for the attributes appearance, aroma, flavor, texture and overall impression. A hedonic 9cm unstructured scale was used for each attribute, anchored at the extremes by "dislike extremely" on the left and "like extremely" on the right (MEILGAARD *et al*., 2007). The samples were presented monadically, following the balanced design (MACFIE *et al*., 1989). The acceptance test results were evaluated by univariate statistical analysis (ANOVA) followed by Tukey's test, both at the 5 % significance level.

2.3 JUST-ABOUT-RIGHT SCALE

Five different concentrations of sucrose were defined at 4.0 %, 6.5 %, 9.0 %, 11.5 % and 14 % relative to the total volume of water and pulp (2:1) and the samepeach frozen pulps were used. The panel had 106 untrained assessors among students and others. The samples were served at 8 ± 2 ° C in white plastic cups (50mL), and were presented in a sequential monadic, following the balancing Macfie *et al*. (1989). A 9-point structured scale was used, anchored at the extremes by "extremely less sweet than ideal" and "extremely sweeter than ideal" and "ideal" in the center (MEILGAARD *et al*., 2007).

For data analysis, the magnitude values of sweetness were converted to the values from one (1) to nine (9), with value five (5) as "ideal". The concentration curve follows the linear model $y = ax + b$, where Y is defined as the sweetness compared to the ideal X as sucrose concentration.

2.4 CHECK-ALL-THAT-APPLY

The use of the CATA methodology (check-all-that-apply) consists of a list of possible words that describe the sample, from which assessors can select the sensory attributes they consider appropriate to characterize it (as many as desired) (GIACALONE *et al.*, 2013). The development of descriptive terminology was used in accordance with Cardoso & Bollini (2008), in a Quantitative Sensory Analysis applied to peach nectars. The attributes are mentioned as follows: yellow color, opacity, brightness, visual viscosity, peach aroma, sweet aroma, herbal aroma, peach flavor, sweet taste, herbal flavor, bitter taste, acid taste, bitter aftertaste, sweet aftertaste, adstringent and viscous. Ballots with different orders of presentation were prepared to minimize the effect of attribute order on the responses of the assessors (ARES *et al*., 2013). A survey on the frequency of consumption of general fruit and peach nectars, an acceptance test with five commercial samples (A, B, C, D and F) and the sample with ideal sweetness (defined by the just-about-right scale) were also performed along with CATA test. For acceptance test, the data was analyzed with ANOVA followed by Tukey's test (both at the 5 % significance level), as well as cluster analysis and internal preference map. The CATA results were assessed by the frequency each attribute was indicated for each sample. Possible differences ($p<0.05$) in the frequencies of each attribute among samples were evaluated by the Cochran Q test (VARELA & ARES, 2012). Correspondence analysis and multiple factor analysis (ARES *et al*., 2013) were also applied to CATA data. Statistical analyzes were performed with STATISTICA 7.0 (StatSoft, Inc.) and XLSTAT 2013.4.07 (Addinsoft).

3 RESULTS AND DISCUSSION

3.1 RANKING TEST

For 100 assessors and 6 samples, the critical difference is 76 (MEILGAARD *et al*., 2007) and Table 1 presents the sweetness rank sums and the found significant differences ($p<0.05$). Results show different levels of sweetness suggesting that some industries do not apply sensory evaluation tests to determine the ideal amount of sugar to be added in their nectars. Alternatively, industries might be trying to achieve consumers with different preferences.

TABLE 1. RANK SUMS* OF SWEETNESS FOR THE COMMERCIAL SAMPLES

Sample	Sweetness rank sum
A	278 [a]
B	398 [c]
C	309 [a, b]
D	349 [a, b, c]
E	403 [c]
F	363 [b, c]

* Same letters indicate no significant difference ($p>0.05$) using Frieman´s test.

3.2 ACCEPTANCE TEST

The same six commercial samples were subjected to an acceptance test. Table 2 shows similar results for flavor and overall impression presented similar, suggesting a strong influence of flavor on the overall impression of peach nectars.

TABLE 2 - ACCEPTANCE MEANS* OF THE COMMERCIAL SAMPLES

Sample	A	B	C	D	E	F	p
Appearance	6.9 [c]	6.5[b,c]	5.4[a]	5.6[a]	5.8[a,b]	6.3[b]	<0.0001
Aroma	4.8[b]	4.8[b]	5.7[a]	4.3[b]	5.7[a]	4.8[b]	<0.0001
Flavor	5.3[a]	5.2[a]	5.2[a]	3.8[b]	4.1[b]	5.4[a]	<0.0001
Texture	6.3[b]	5.8[a,b]	5.3[a]	5.2[a]	5.0[a]	6.1[b]	<0.0001
Overall impression	5.8[a]	5.6[a]	5.2[a,b]	4.5[c]	4.8[b,c]	5.7[a]	<0.0001

* Same letters on a row indicate no significant difference ($p>0.05$) using Tukey´s test

3.3 JUST-ABOUT-RIGHT SCALE

Figure 1 shows the relation between ideal sweetness (y) and sucrose concentration (%) (x). The linear equation obtained was y = 0.377 x + 1.512. The coefficient of determination obtained (0.991) was satisfactory.

Assigning the value 5 on the y-axis, the sucrose concentration needed to achieve the ideal sweetness was found as 9.25 %. Similar studies with various fruit nectars suggest values close to 10 % for sucrose concentration. For pitanga nectar, the sucrose concentration to achieve ideal sweetness was 10 % (FREITAS *et al.*,2014); for mango nectar, this concentration was 6.84 % (CADENA & BOLINI, 2011); for two different blends from Amazon fruits (cupuassu-acerola-açai and soursop-camucamu-yellow mombin) the sucrose concentration was 9.5 % and 10.7 % respectively (FREITAS & MATTIETTO, 2013). So, the present study's result is according with the literature.

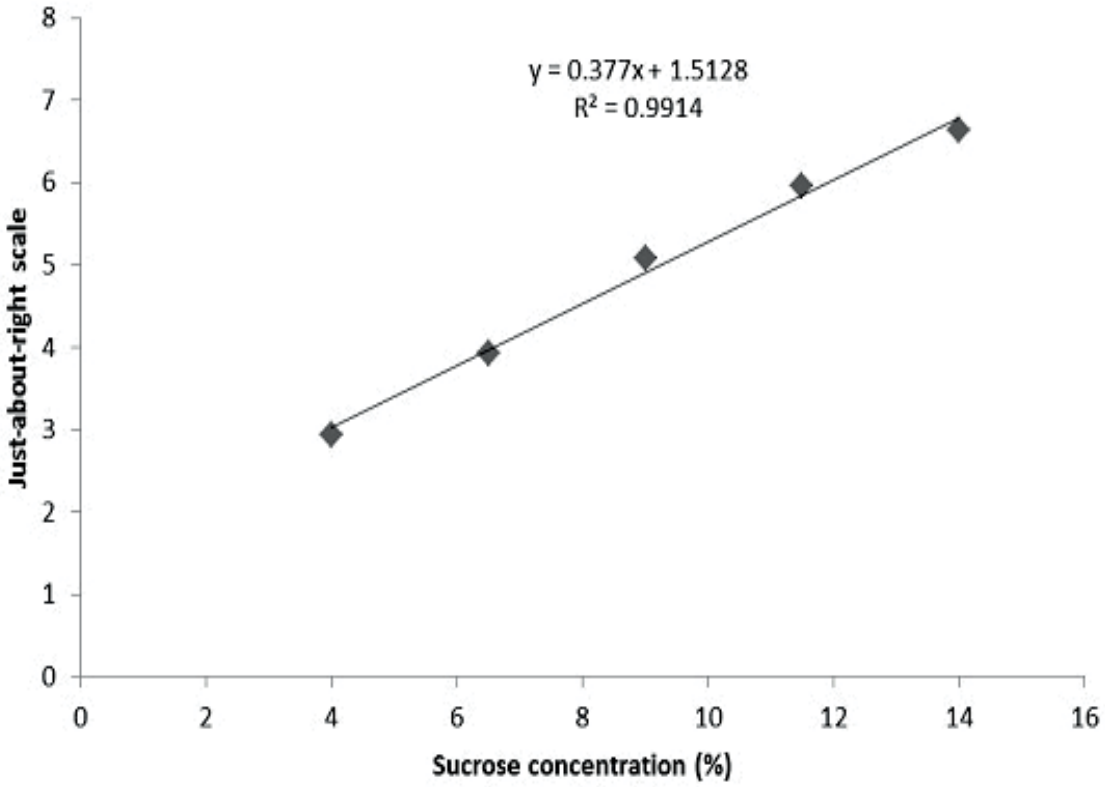

FIGURE 1 - LINEAR REGRESSION USED TO OBTAIN THE IDEAL SWEETNESS, CORRESPONDENT TO VALUE 5 ON THE JUST-ABOUT-RIGHT SCALE

3.4 ACCEPTANCE TEST AND CHECK-ALL-THAT-APPLY

These tests were conducted by a group of 119 untrained assessors, 54 % female and 46 % male, ages between 17 and 40 years, frequency of consume ranging from "once a month" to "at least four times a week". In this moment, the sample with ideal sweetness (called sample L, with 9.25 % of sucrose) was prepared and included in the acceptance test and check-all-that-apply, while "sample E" was removed to avoid sensory fatigue. Sample L (ideal sweetness) received the lowest acceptance means ($p<0.05$) for all attributes (Table 3). It is a very interesting result, because it suggests that the attribute sweet taste is not the most important for best acceptance. The internal preference map (Figure 2) shows the assessor´s preference on the samples.

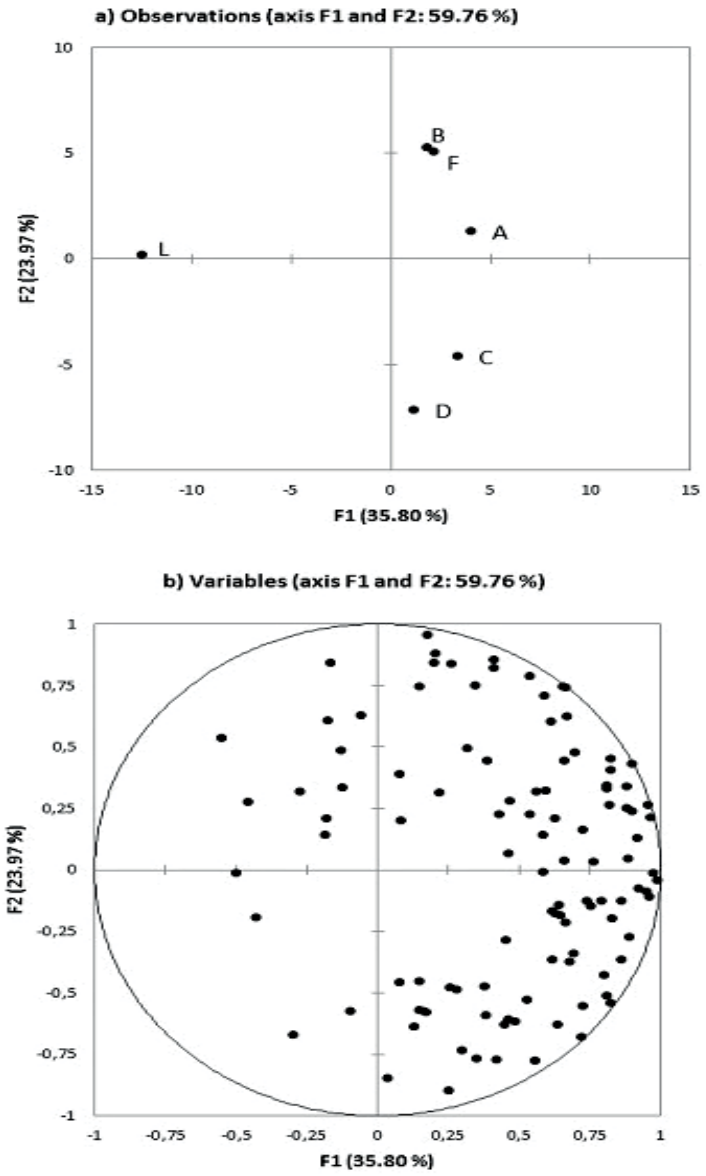

FIGURE 02 - INTERNAL PREFERENCE MAP OF SAMPLES (A) AND ASSESSORS (B) (N-119)

TABLE 3. ACCEPTANCE MEANS* OF THE COMMERCIAL SAMPLES (A, B, C, D, F) AND THE IDEAL SWEETNESS SAMPLE (L)

Sample	A	B	C	D	L	F	p
Appearance	6.,5[a]	5.4[b]	5.8[b]	5.6[b]	4.2[c]	5.8[a,b]	< 0.0001
Aroma	5.2[a,b]	5.5[a,b]	6.1[a]	5.3[a,b]	3.3[c]	5.2[b]	< 0.0001
Flavor	5.7[a]	5.1[a]	5.4[a]	4.9[a]	3.3[b]	5.6[a]	< 0.0001
Texture	6.2[a]	5.9[a]	5.7[a]	5.6[a]	4.5[b]	6.1[a]	< 0.0001
Overall impression	5.9[a]	5.4[a]	5.7[a]	5.3[a]	3.5[b]	5.8[a]	< 0.0001

* Same letters on a row indicate no significant difference (p>0.05) using Tukey´s test

In addition, sample L (ideal sweetness) showed different characteristics, and it was the least chosen of all. In comparison to other samples, A, B and F showed similar results, as well as C and D. It is important highlight that sample L might have been prepared with a different pulp than the commercial brands, possibly bringing some particular sensory charateristics. A cluster analysis was also performed, creating two distincts groups. Cluster 1 assessors was characterized by presenting similar results to the assessors in general, only with lower means. On the other hand, cluster 2 assessors could not differentiate the acceptance means ($p>0.05$) (except for aroma). The results of CATA were evaluated and some attributes must be highlighted: the sample L (ideal sweeness) had the lowest peach aroma, peach flavor and acid taste and the highest herbal aroma and herbal flavor ($p<0.05$). The full result can be seen at Table 4. These attributes have the potential to explain the lower acceptace of sample L, and apparently this attributes are more important than sweet taste for the acceptance.

TABLE 4. FREQUENCY OF EACH ATTRIBUTE INDICATED BY THE ASSESSORS IN CATA TEST

Sample	A	B	C	D	L	F	p
Yellow color	99 ^{b}	86^{a}	102^{b}	105^{b}	84^{a}	98^{b}	<0.0001
Opacity	44^{a,b}	64^{c}	45^{a,b}	34^{a}	69^{c}	50^{b}	<0.0001
Brightness	57^{b,c}	35^{a}	58^{b,c}	61^{c}	31^{a}	49^{b}	<0.0001
Visual Viscosity	59^{c}	53^{b,c}	24^{a}	42^{b}	51^{b,c}	48^{b,c}	<0.0001
Peach Aroma	77^{b,c}	90^{c}	78^{b,c}	68^{b}	33^{a}	88^{c}	<0.0001
Sweet Aroma	46^{a}	41^{a}	73^{b}	65^{b}	39^{a}	40^{a}	<0.0001
Herbal Aroma	5^{a}	12^{a}	7^{a}	14^{a}	58^{b}	12^{a}	<0.0001
Peach Flavor	95^{c}	93^{c}	81^{c}	64^{b}	39^{a}	92^{c}	<0.0001
Sweet Taste	52^{a}	53^{a}	70^{b,c}	80^{c}	62^{a,b}	61^{a,b}	<0.0001
Herbal Flavor	6^{a}	6^{a}	6^{a}	8^{a}	53^{b}	10^{a}	<0.0001
Bitter Taste	15^{b}	12^{b}	11^{b}	5^{a}	13^{b}	11^{b}	<0.0001
Acid Taste	18^{b,c}	31^{b,c}	14^{b}	19^{d}	3^{a}	26^{c,d}	<0.0001
Bitter Aftertaste	21^{b,c}	25^{c}	15^{a,b}	11^{a}	18^{a,b,c}	23^{c}	<0.0001
Sweet Aftertaste	33^{a}	36^{a,b}	40^{b}	40^{b}	35^{a,b}	31^{a}	<0.0001
Adstringent	11^{a,b}	22^{c}	8^{a}	7^{a}	6^{a}	16^{b,c}	<0.0001
Viscous	50^{c}	44^{b,c}	29^{a}	48^{c}	28^{a}	36^{a,b}	<0.0001

* Same letters on a row indicate no significant difference ($p>0.05$) using Q Cochran´s test

The correspondence analysis (Figure 3), a technique similar to the principal component analysis (MCEWAN & SCHLICH, 1992), illustrates how each sample is characerized by the sensory attributes. Figure 3 suggests a strong influence of herbal aroma and herbal flavor on sample L, while the commercial samples were characterized by peach aroma, peach flavor, viscosity and yellow color. The multiple factor analysis was included in order to put together quantitative data (from acceptance test) and binary data (from CATA test) (PARENTE *et al*., 2011). The results are presented in Figure 4. This Figure indicates that sample L (ideal sweetness) was rejected in the acceptance test due to its herbal aroma and herbal flavor, and that the commercial samples A, B and F were better accepted due to their peach aroma, peach flavor, acid taste and viscosity.

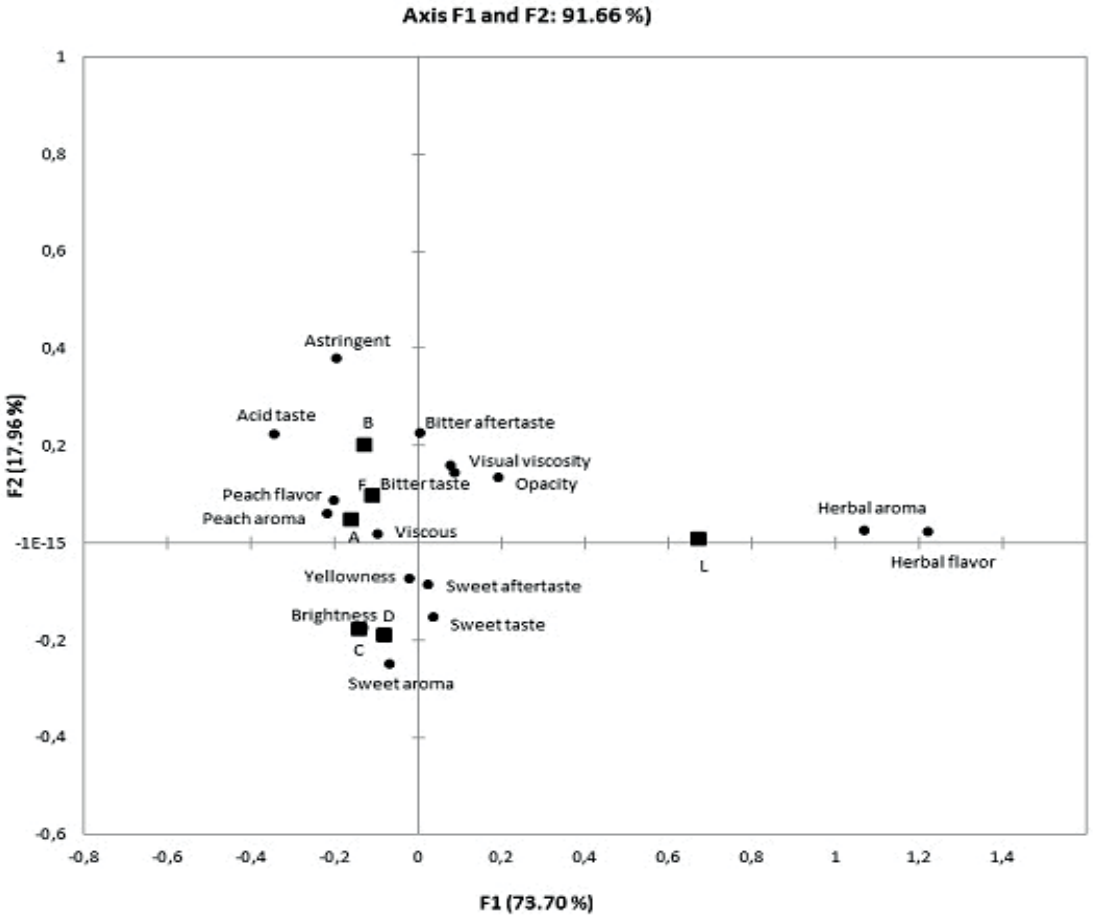

FIGURE 03 - CORRESPONDENCE ANALYSIS BETWEEN SAMPLES AND ATTRIBUTES

3.5 ACCEPTANCE TEST AND CHECK-ALL-THAT-APPLY WITHOUT SAMPLE L (IDEAL SWEETNESS)

Due to the disparity of sample L relative to all others samples, data of acceptance and CATA tests were reanalyzed, removing data from sample L, wich could increase the discrimination between the other samples. This disparity can be explained by use of untrained assessors, who cannot differentiate similar samples (KENNEDY & HEIMANN, 2009), and the consumer´s prefference, a CATA limitation (ARES *et al*., 2010). The results for acceptance test without sample L are shown in Table 5. Commercial samples differed ($p<0.05$) only for aroma and flavor. Comparing with first acceptance test (Table 2), with six commercial samples, the discrimination between the samples was higher in the first test. This corroborates the hypotesis that the presence of sample L disturbed the differentiation of commercial samples.

TABLE 5. ACCEPTANCE MEANS* OF THE COMMERCIAL SAMPLES (A, B, C, D, F)

Sample	A	B	C	D	F	p
Appearance	6.5[a]	5.4[b]	5.8[b]	5.6[b]	5.8[b]	< 0.0001
Aroma	5.2[b]	5.5[a,b]	6.1[a]	5.3[a,b]	5.2[b]	0.016
Flavor	5.7[a]	5.1[a]	5.4[a]	4.9[a]	5.6[a]	0.069
Texture	6.2[a]	5.9[a]	5.7[a]	5.6[a]	6.1[a]	0.099
Overall impression	5.9[a]	5.4[a]	5.7[a]	5.3[a]	5.8[a]	0.097

* Same letters on a row indicate no significant difference (p>0.05) using Tukey´s test

Comparing the internal preference map on Figure 4 with Figure 2 (internal preference map with sample L), it is possible to see that the assessors are better distributed between samples in Figure 5. The number of assessors targeted to each cluster was similar (60 and 51), against 86 and 25 from cluster analysis with sample L. The cluster 1 is characterized by assessors who can differentiate flavor and overal impression acceptances between samples, while cluster 2 cannot.

The CATA test results of were analysed without sample L (ideal sweetness), and a few attributes, like herbal aroma and herbal flavor, peach aroma and peach flavor were better discrimined between commercial samples. The full result can be seen at Table 6. The correspondence analysis is shown in Figure 6. Correspondence analysis without sample L (Figure 6) shows a better characterization of the attributes from the samples, while in Figure 3 (correspondence analysis with sample L) this was not clear. The multiple factor analysis is shown in Figure 7, explaining how the samples are characyerized by the attributes and their influence on overall impression. Figure 7, suggests that sample A presents the most adequated sensory profile to acceptance. However, the preference of assessors can be divided among a few groups, each characterized by differents attributes.

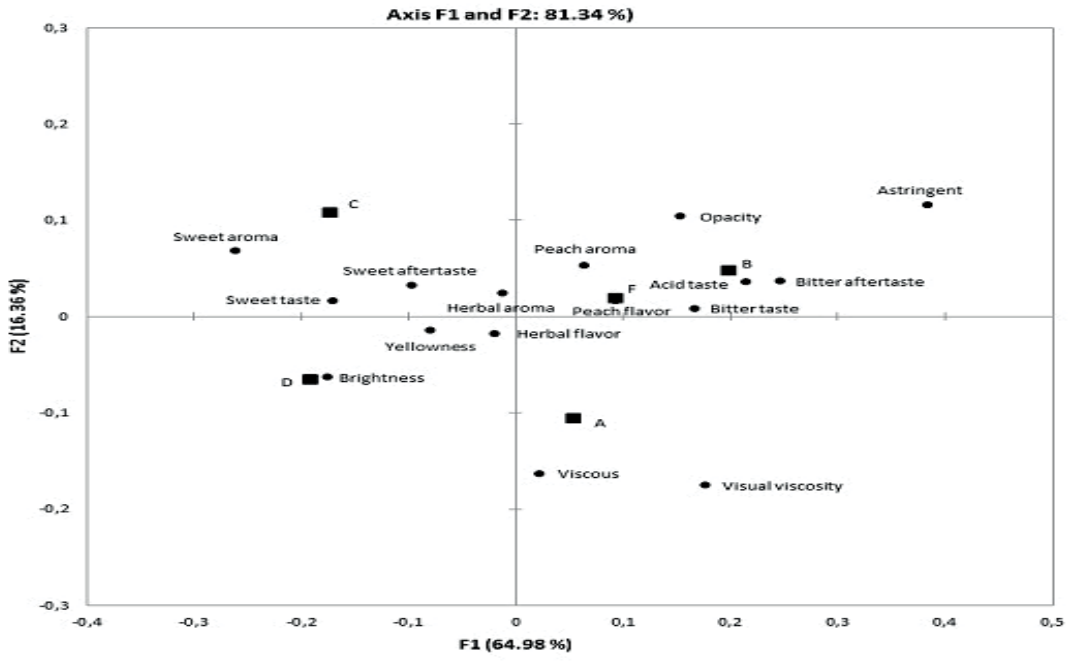

FIGURE 06 - CORRESPONDENCE ANALYSIS BETWEEN SAMPLES AND ATTRIBUTES WITHOUT SAMPLE L

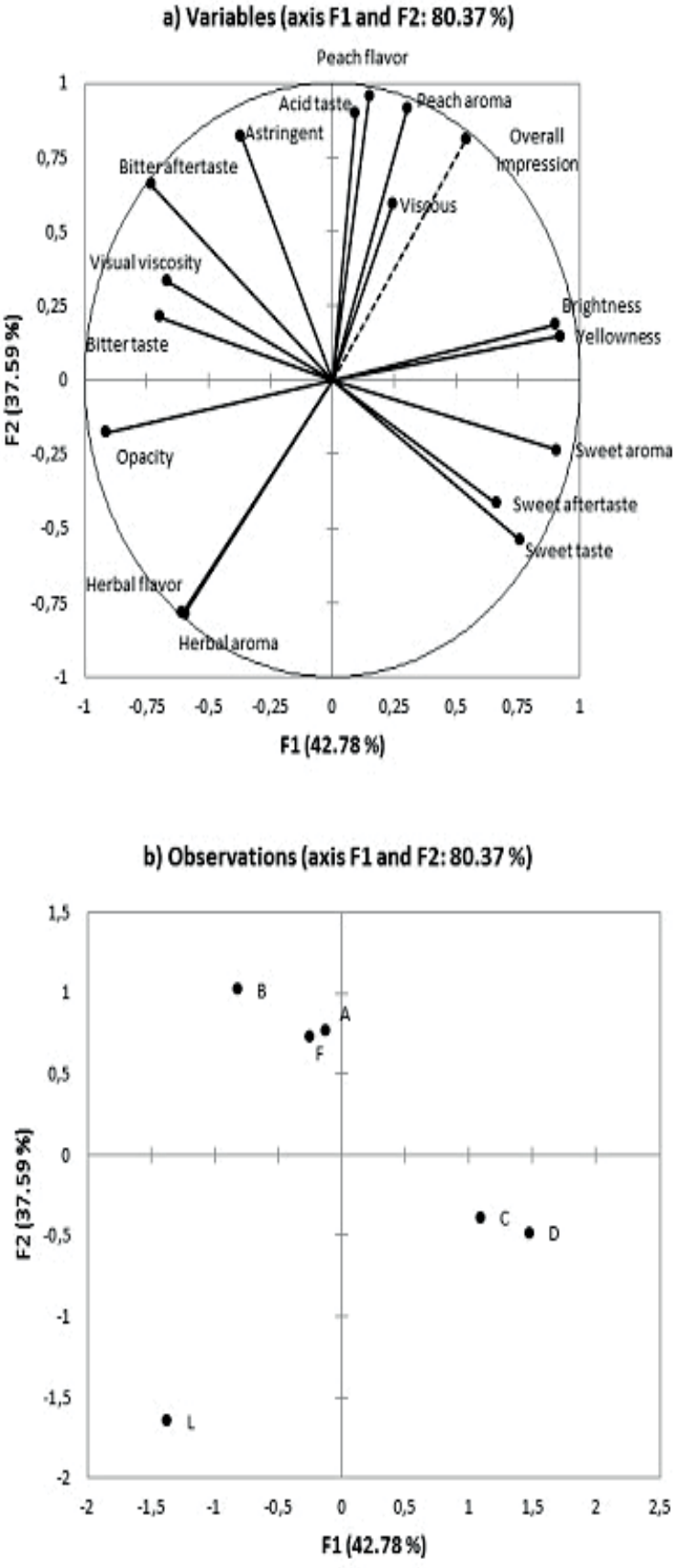

FIGURE 04 - MULTIPLE FACTOR ANALYSIS FOR COMMERCIAL SAMPLES AND IDEAI SWEETNESS SAMPLE ON ATTRIBUTES (A) AND SAMPLES (B)

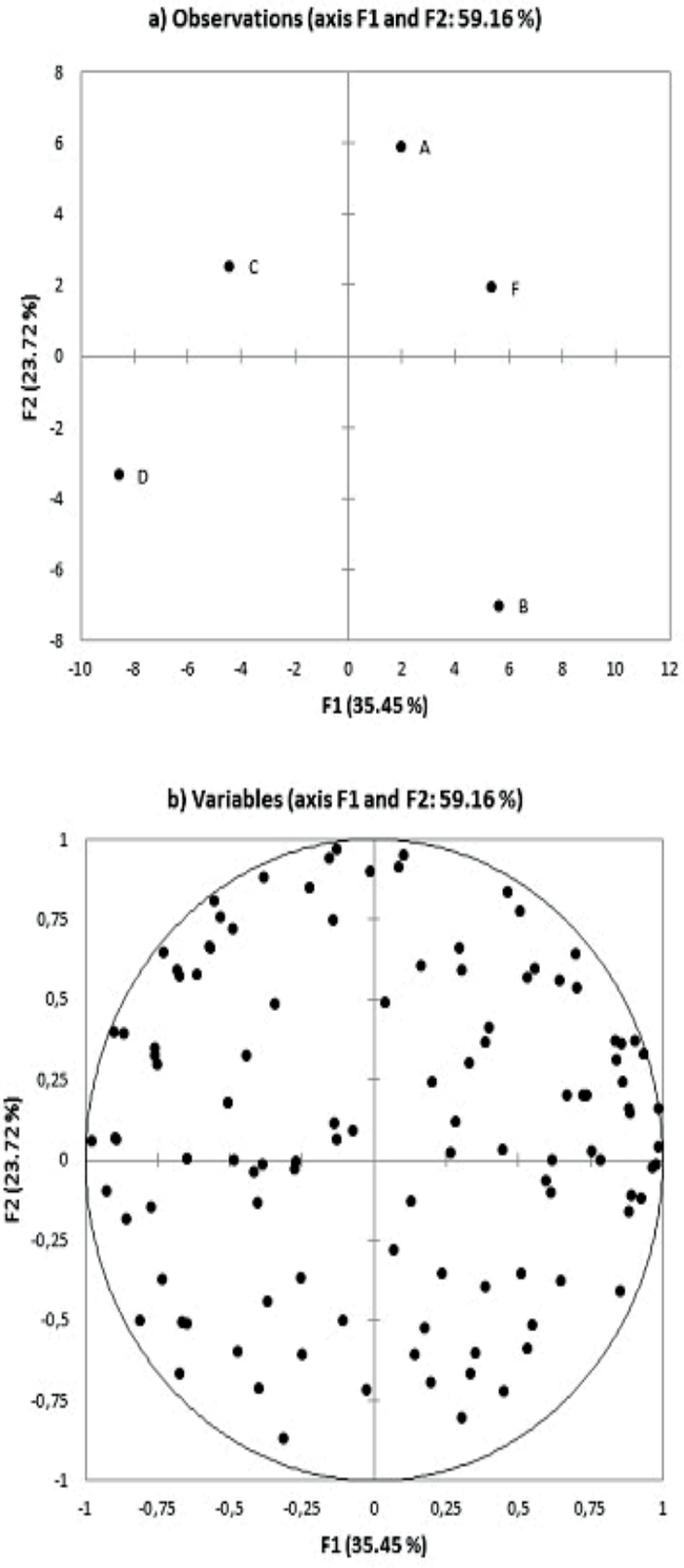

FIGURE 05 - INTERNAI PREFERENCE MAP OF SAMPLES (A) AND ASSESSORS (B) WITHOUT SAMPLE L (N=119)

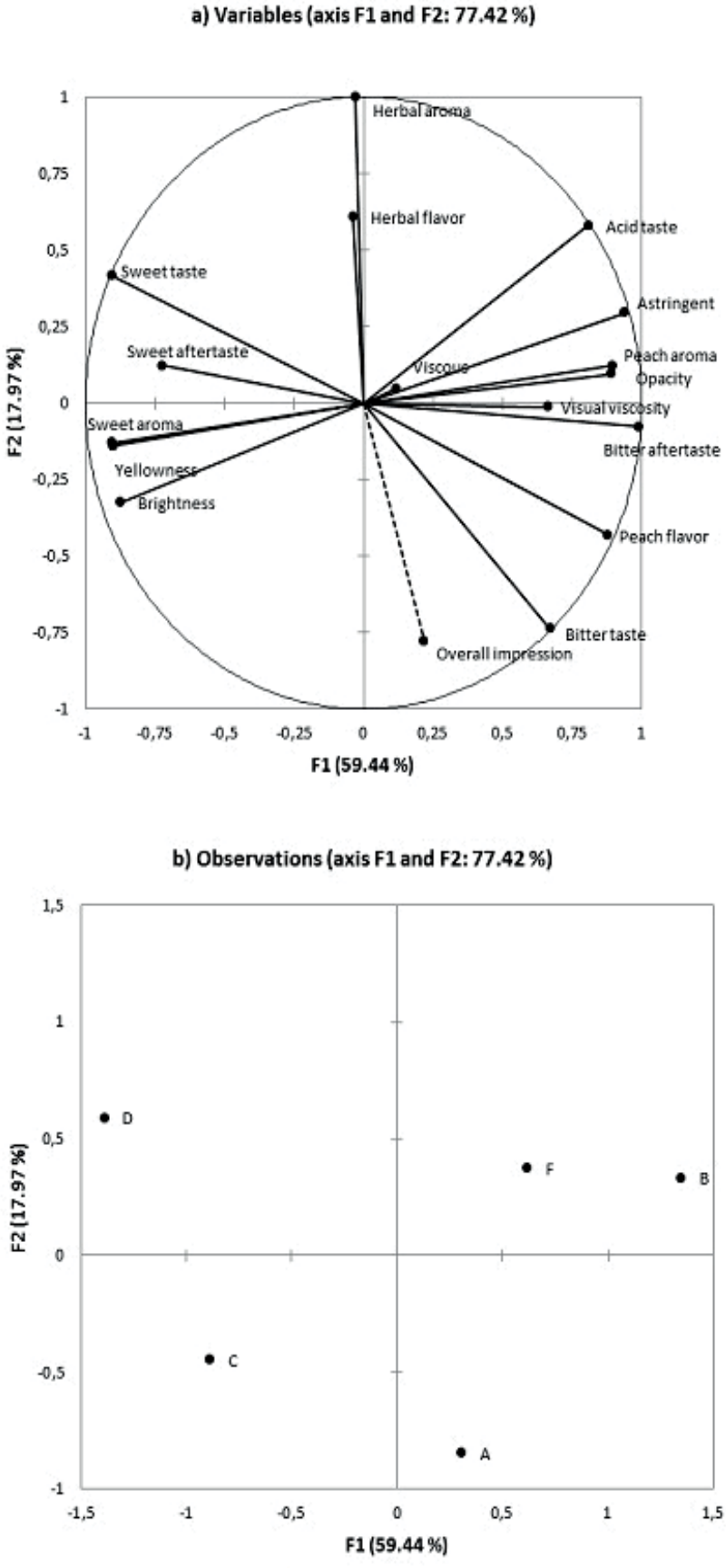

FIGURE 07 - MULTIPLE FACTOR ANALYSIS FOR COMMERCIAL SAMPLES ON ATTRIBUTES (A) AND SAMPLES (B)

TABLE 6. FREQUENCY OF EACH ATTRIBUTE INDICATED BY THE ASSESSORS IN CATA TEST (WITHOUT SAMPLE L)

Sample	A	B	C	D	F	P
Yellow color	99 [b]	86[a]	102[b]	105[b]	98[b]	0,0001
Opacity	44[a,b]	64[c]	45[a,b]	34[a]	50[b]	<0.0001
Brightness	57[b,c]	35[a]	58[c]	61[c]	49[b]	<0.0001
Visual Viscosity	59[c]	53[b,c]	24[a]	42[b]	48[b,c]	<0.0001
Peach Aroma	77[a,b]	90[c]	78[b]	68[a]	88[c]	<0.0001
Sweet Aroma	46[a]	41[a]	73[b]	65[b]	40[a]	<0.0001
Herbal Aroma	5[a]	12[b,c]	7[a,b]	14[c]	12[b,c]	<0.0001
Peach Flavor	95[c]	93[c]	81[b]	64[a]	92[c]	<0.0001
Sweet Taste	52[a]	53[a]	70[b,c]	80[c]	61[a,b]	<0.0001
Herbal Flavor	6[a]	6[a]	6[a]	8[a,b]	10[b]	0.012
Bitter Taste	15[b]	12[b]	11[b]	5[a]	11[b]	<0.0001
Acid Taste	18[a,b]	31[c]	14[a]	19[a,b]	26[b,c]	<0.0001
Bitter Aftertaste	21[b,c]	25[c]	15[a,b]	11[a]	23[c]	<0.0001
Sweet Aftertaste	33[a]	36[a,b]	40[b]	40[b]	31[a]	<0.0001
Adstringent	11[a,b]	22[c]	8[a]	7[a]	16[b,c]	<0.0001
Viscous	50[c]	44[b,c]	29[a]	48[c]	36[a,b]	<0.0001

* Same letters on a row indicate no significant difference (p>0.05) using Q Cochran´s test

4 CONCLUSIONS

There are sensory differences among the peach nectar commercial samples in relation to sweet taste, which suggests that some industries do not use the optimal concentration of sucrose for best consumer acceptance. The analysis of the sensory profile of the 6 samples of peach nectars concluded that the sweet taste attribute was not the only determinant for high acceptance of the samples.

Generally, it is possible to reduce the sucrose content in other nectars without decreasing their acceptances. However, simple reducing can affect many other attributes, for the food matrix is very complex. Other studies are needed to ensure that the acceptance of nectars will be not compromised.

RESUMO

NÍVEIS DE DOÇURA E EFEITOS SOBRE CATA PERFIL SENSORIAL E ACEITAÇÃO DE NÉCTAR DE PÊSSEGO

Néctares de frutas são bebidas constituídas de nutrientes importantes, com uma boa extensão de vida útil e bem aceitos pelos consumidores. Buscando melhorar ainda mais as suas características positivas, este estudo teve como objetivo discutir a redução do teor de açúcar presente no néctar de pêssego a partir da análise sensorial de amostras comerciais. Análises de ordenação, aceitação, escala do ideal e check-all-that-apply (CATA) foram realizadas, possibilitando observar o

efeito de diversos atributos sensoriais sobre a aceitação dos néctares e definir o teor ideal de açúcar. Foi possível verificar que algumas amostras comerciais não apresentaram a concentração de açúcar para doçura ideal e que a doçura não é o principal atributo na aceitação do néctar de pêssego, o que demonstra a complexidade de sua matriz alimentícia. Tal complexidade parece dividir a preferência dos consumidores e é possível identificar grupos que diferiram em relação à aceitabilidade das amostras. A amostra A esteve sempre no grupo das mais aceitas e, dependendo do teste, não diferiu significativamente das outras amostras ($p > 0,05$). A amostra de doçura ideal foi menos aceita devido à forte influência dos atributos sabor e aroma de ervas presentes na polpa usada em sua elaboração.

PALAVRAS-CHAVE: NÉCTARES DE FRUTA; AVALIAÇÃO SENSORIAL; ESCALA DO IDEAL; TESTE DE ACEITAÇÃO; CATA; ANÁLISE FATORIAL MÚLTIPLA.

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