



Physicochemical characteristics and sensory acceptance of a mixed beverage based on organic apple juice and cardamom tea (*Elettaria cardamomum*) with allegation of functional properties

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Abstract

This study aimed to develop and characterize mixed beverages (suchás) formulations based on organic apple juice and cardamom tea (F1 = 50:50 vv⁻¹, F2 = 60:40 vv⁻¹ and F3 = 70:30 vv⁻¹). The formulation (F3) presented the highest total phenolic compounds content (31.79 mg EAG g⁻¹), antioxidant activity (50.04 µg mL⁻¹), total soluble solids (5.1 °Brix), acidity (pH 4.17 and total acidity 0.15 g malic acid 100 mL⁻¹) and sensory acceptance (flavor and overall impression). Furthermore, it presented important volatile compounds (2-methyl-1-butanol, formic acid butyl ester, acetyl pentyl acetate, and α-terpinolene). A synergistic effect of apple juice and cardamom tea was observed for the antioxidant activity and number of volatile compounds, demonstrating the potential of this mixed beverage as a functional food. In conclusion, it was possible to develop a mixed beverage with suitable nutritional, physicochemical and sensory properties using 70% of organic apple juice and 30% of cardamom tea.

Keywords: mixed beverage; *Malus domestica*; total phenolics; antioxidant capacity; volatile compounds; sensory analysis.

Practical Application: This is the first study that evaluated the development of a mixed beverage containing apple juice and cardamom tea. The association of 70% of organic apple juice and 30% of cardamom tea demonstrated synergistic effect (twice the antioxidant activity compared to the apple juice and tea individually) and improved physicochemical characteristics, nutritional properties (higher TPC and antioxidant activity) and sensory acceptance (flavor and overall impression). Furthermore, it presented some important volatile compounds, which contributed to sweet, fruit, floral, berry and almond notes.

1 Introduction

Scientific evidences relating good nutrition and reduction of diseases have awoken an interest for healthier nutrition and lifestyles and have boosted the market of new products. Thus, the functional foods are reaching more consumers due to the high aggregated value (Huang et al., 2019). Apple and cardamom are examples of foods with bioactive compounds and functional potential (Daneshi-Maskooni et al., 2018; Alongi et al., 2018). Recent studies indicate that organic foods have higher nutritional value than the conventional foods. Furthermore, the utilization of organic ingredients can result in less exposure to resistant micro-organisms, activation of the natural defense system of the plants, certification with rigorous standard, and use of an environmentally friendly system (Popa et al., 2019; Abreu et al., 2019).

Apple juice is a versatile product, which allows its utilization in many beverages. It has accessible cost of acquisition and high nutritional value, mainly due to the richness in phenolic compounds and sugars of easy digestion. The presence of sugars contributes to the degree of sweetness of the product, allowing the reduction or exclusion of the addition of sugar, which contributes to a greater biodisponibility of the bioactive compounds (Chiusano et al., 2015). The presence of organic acids, aromatic substances and phenolic compounds is associated to

the reduction of the risk of non transmissible chronic diseases, such as cancer, Type II diabetes and cardiovascular diseases, as well as to anti-allergenic activities (Shahidi 2012; Yao et al., 2012; Ferretti et al., 2014; Quan et al., 2017). Thus, apple juice can be a good option to combine with tea in a formulation of mixed beverage.

Spices have pleasant flavor, colour and aroma, as well as antioxidant functions and action as natural preservatives (Srivastava, 2012). Cardamom (*Elettaria cardamomum*) is a spice of indian origin with greenish fruits, which protect the dark coloured seeds. The seeds are slightly spicy and highly aromatic. Cardamom is used in culinary and medicinal applications, in the development of chemopreventives, for antifatulent and diuretic functions, and in the treatment of cramps, digestive disturbs, headaches, cardiovascular diseases, among others (Majdalawieh & Carr, 2010; Qiblawi et al., 2015). It contains proteins, essential oil, carbohydrates and fiber, and is rich in starch and fatty acids. However, the majority of the studies that were carried out using cardamom report that the health benefits are due to its volatile composition (Qiblawi et al., 2015; Daneshi-Maskooni et al., 2017). Therefore, the cardamom tea can have an important role in the consumer health (Ahmad et al., 2016).

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Mixed beverages show an advantage of allowing the adjustments of the formulations aiming to increase the consumer acceptability and the potential health benefits (Ogundele et al., 2016). As far as the authors know, there is no study that evaluated the development of a mixed beverage containing apple juice and cardamom tea. Considering this scenario, the present study aimed to evaluate the physicochemical characteristics and the sensory properties of a mixed beverage containing organic apple juice with cardamom tea, known in Brazilian market as “Suchá” (a combination of the words “Suco” - Juice and “Chá” - Tea).

2 Materials and methods

2.1 Preparation of the suchá formulations

The tea was prepared by infusion of the cardamom fruits and seeds (smashed with gral and pistil, 4% wv⁻¹) in water for 10 min, under stirring, using a heating plate Arsec model AGM5AQ – Brazil. This infusion time was based on preliminary tests, which indicated that higher infusion times resulted in higher total phenolic compounds, however, a greater extraction of tannins was also observed, resulting in astringent and bitter tastes in the beverages (Nishiyama et al., 2010). After the infusion, the tea was filtered in a nylon sieve, and cooled at room temperature.

For the organic apple juice preparation, apples from the Gala variety and with organic seal were bought from the local supermarket. The fruits were selected, sanitized in a chlorinated solution, cut and immersed in lemon juice. Lemon juice was used in the product as a natural component to retard the enzymatic browning of the apple juice. Then, about 150 g of apple (with the husk) was beaten in the blender with 200 mL of filtered water, and the juice was strained in a nylon sieve. Finally, the *suchás* were prepared (Table 1). The formulations were based on a previous study (Alvarenga et al., 2016). The physicochemical analyses (antioxidant activity, total soluble solids, pH, total acidity and volatile compounds) were conducted on the *suchá* formulations, cardamom tea, and apple juice. The total phenolic compounds and the sensory acceptance were performed on the *suchá* formulations.

2.2 Determination of total phenolic compounds

The total phenolic compounds (TPC) were determined by the *Folin-Ciocalteu* methodology (adapted from Przygodzka et al., 2014). A curve with gallic acid pattern was constructed with 6 points, in the range of 12 to 96 µg mL⁻¹. The samples were centrifuged at 5000 rpm (Excelsa 4, model 280-R, Fanem, Brazil) for 5 minutes and filtered in syringe filters with 0.45 µm. The TPC was determined in the *suchás* (1:4). The measurements were made in a spectrophotometer (Model SP 220, from the brand Biospectro - Brazil) at 740 nm.

Table 1. Apple juice and cardamom tea proportions (g 100 g⁻¹) in *suchá* formulations.

Formulation	Apple juice	Cardamom tea
Formulation 1 (F1)	50	50
Formulation 2 (F2)	60	40
Formulation 3 (F3)	70	30

2.3 Antioxidant capacity

The antioxidant capacity was determined by the method of 2,2-diphenyl-1-picrylhydrazyl (DPPH) in the dilutions 1:2, 1:5, 1:10 and 1:20. Aliquots of 500 µL of these dilutions were added to 1000 µL of DPPH solution 0.004% w/v and kept in rest for 30 minutes. Then, the absorbances, in the wavelength of 515 nm, were measured (adapted from Brand-Williams et al., 1995).

2.4 Determinations of total soluble solids (°Brix), pH and total acidity

The content of total soluble solids was determined by a direct reading of the samples, using a portable digital refractometer (Atago pal-3-, Japan). The pH was directly determined in the samples, utilizing a digital pH meter (Quimis, model Q400 MT, Brazil), previously calibrated with pH buffers 4.0 and 7.0. The total acidity was determined by titration with NaOH 0.01 mol L⁻¹ and expressed in % w/v of malic acid.

2.5 Volatile compounds analysis

The volatile compounds were analyzed by Solid Phase Micro Extraction followed by gas chromatography coupled to mass spectrometry SPME-GC-MS (Agilent, 7890), with an automatic injector CTC CombiPal, sampler type XYZ with temperature control and agitation. Around 10 mL from the samples were transferred to the headspace bottles containing 3 grams of NaCl. The extractions were made with 50/30 µm Divinylbenzene/Carboxen/Polydimethylsiloxane fiber (DVB/CAR/PDMS) (Supelco, Bellefonte, PA, EUA). After the balancing from 20 minutes at 40 ± 1.0 °C and agitation at 750 rpm, the fiber was exposed to the sample for 30 minutes, extracting the volatile compounds. The analysis was performed with column CP-Wax 52 CB 60m, 0.25mm, 0.25 µm, carrier gas helium (1 mL min⁻¹ flow), mass spectrometry detector (Agilent, 5975) in the scan mode and total time of 88.5 minutes. The injector's temperature was kept at 240 °C. The oven temperature was kept at 45 °C for 5 min, increased to 80 °C at a rate of 10 °C min⁻¹ and increased to 240 °C at 2 °C min⁻¹. The components were identified according to the NIST library and with the linear retention index (LRI) of the components.

2.6 Sensory analysis

This study was approved by the Research Ethics Committee of Centro Universitário Luterano de Ji-Paraná/ULBRA/RO (CAAE: 67449317.8.0000.5297). The *suchá* sensory acceptance was evaluated through an affective test. The test was made with 60 consumers, from both genders, being students, teachers and staff members from the academic community of Rio de Janeiro state. A hedonic scale of nine points was utilized, which varied from “extremely liked” (maximum score) to “extremely disliked” (minimum score) (Borrin et al., 2018; Jahromi & Niakousari, 2018; Mituniewicz-Małek et al., 2019). The attributes evaluated were appearance, aroma, flavor, and overall impression. The purchase intention was evaluated using a 5 point-scale (1 = certainly wouldn't buy, 5= would certainly buy). Acceptability index (%) was calculated according to Micheletti et al. (2018).

2.7 Statistical analysis

The experiment was repeated twice, and the analysis were performed in triplicates. The results were analyzed through the Analysis of Variance (ANOVA) in Excel 2013 and the averages compared by the Tukey's test ($\alpha=0.05$).

3 Results and discussion

3.1 Total phenolic compounds

The suchá formulations presented TPC in the range of 27.59 ± 2.49 , 29.13 ± 2.62 and 31.79 ± 0.72 mg EAG 100 g^{-1} for F1, F2 and F3 formulations, respectively (Table 2).

The increase in the apple juice concentration resulted in the increase in the TPC content ($p < 0.05$). This result could be related to the higher TPC content in the apple juices and also to the utilization of the apples with the husk during apple juice processing. In fact, the TPC content of apple juice was reported in the range of 4000-6000 mg EAG 100 g^{-1} (Persic et al., 2017), while the TPC of cardamom tea was 589.8 mg EAG 100 g^{-1} (Ahmad et al., 2016). Furthermore, the utilization of apple with the husk in the preparation of apple juices is proven to favor the concentration of total phenols and increase the antioxidant activities (Luo et al., 2016).

3.2 Physicochemical characteristics

The antioxidant activity of the suchá formulations, expressed in EC_{50} ($\mu\text{g mL}^{-1}$), is presented in Table 3 and correspond to the amount of extract needed to reduce the DPPH radical in 50%. In this way, the smallest the EC_{50} value, the highest is the antioxidant activity of the beverage. The EC_{50} values were in the range of 57.88 ± 1.52 (F1), 49.30 ± 1.72 (F2) and 50.04 ± 1.92 (F3) $\mu\text{g mL}^{-1}$. The formulations with the highest concentration of apple juice (F2 and F3) presented the highest antioxidant activity among the suchá formulations

Table 2. Total phenolics concentration to three suchá formulations (mg EAG 100 g^{-1}).

Formulation	Total phenolics (mg EAG 100 g^{-1})
F1	27.59 ± 2.49^b
F2	29.13 ± 2.62^b
F3	31.79 ± 0.72^a

Means \pm standard deviation followed by different lowercase letters differ in Tukey test ($p < 0.05$, $n=6$). Formulations (Apple Juice: Cardamom tea; g 100 g^{-1}): F1 (50:50), F2 (60:40) and F3 (70:30).

Table 3. Antioxidant capacity (EC_{50}), total soluble solids ($^{\circ}\text{Brix}$), pH and total acidity of the suchá formulations, cardamom tea and apple juice.

Sample	EC_{50} ($\mu\text{g mL}^{-1}$)	Soluble solids ($^{\circ}\text{Brix}$)	pH	Total acidity (g malic acid 100 mL^{-1})
F1	57.88 ± 1.52^b	3.1 ± 0.43^c	4.48 ± 0.06^b	0.11 ± 0.01^b
F2	49.30 ± 1.72^c	3.6 ± 0.43^c	4.25 ± 0.01^c	0.13 ± 0.01^b
F3	50.04 ± 1.92^c	4.1 ± 0.43^b	4.17 ± 0.04^c	0.15 ± 0.02^{ab}
Apple juice	97.37 ± 1.88^a	5.1 ± 0.52^a	3.66 ± 0.02^d	0.18 ± 0.01^a
Cardamom tea	101.17 ± 1.36^a	0.7 ± 0.37^d	5.52 ± 0.10^a	0.03 ± 0.00^c

Means \pm standard deviation in the same column followed by different lowercase letters differ in Tukey test ($p < 0.05$, $n=6$). Formulations (Apple Juice: Cardamom tea; g 100 g^{-1}): F1 (50:50), F2 (60:40) and F3 (70:30).

($p < 0.05$), probably related to the higher TPC content (Table 2). It is important to note that the suchá formulations (F1, F2 and F3) presented higher antioxidant activity than the apple juice or cardamom tea separately, suggesting a synergistic effect among the juice and tea.

The total soluble solids content mainly indicates the presence of sugars in the beverages. The apple juice presented higher TSS content ($5.1\text{ }^{\circ}\text{Brix}$) than the cardamom tea ($0.7\text{ }^{\circ}\text{Brix}$) or the suchá formulations (F1= $3.1\text{ }^{\circ}\text{Brix}$, F2 = $3.6\text{ }^{\circ}\text{Brix}$ and F3 = $4.1\text{ }^{\circ}\text{Brix}$) ($p < 0.05$). Therefore, the formulation with the highest concentration of apple juice (F3) presented the highest TSS content ($p < 0.05$).

The pH values (Table 3) of the formulations of suchá were in the range of 4.48 ± 0.06 (F1), 4.25 ± 0.01 (F2) and 4.17 ± 0.04 (F3), while the total acidity values were in the range of 0.11 ± 0.01 (F1), 0.13 ± 0.01 (F2) and 0.15 ± 0.02 (F3) g malic acid 100 g^{-1} . The addition of higher concentrations of apple juice resulted in suchás with lower pH values and higher total acidity ($p < 0.05$), which was related to the lower pH (3.66) and higher acidity ($0.18\text{ g malic acid }100\text{ g}^{-1}$) of apple juice compared to cardamom tea (pH 5.52, $0.03\text{ g malic acid }100\text{ g}^{-1}$) ($p < 0.05$). The immersion of the apples in the lemon juice to retard the enzymatic darkening during apple juice processing could have contributed to increase the acidity of the apple juice. The pH is considered an important factor to the microbiological conservation (Santana et al., 2008). It can be highlighted that the pH found in all the suchá formulations were below 4.5, which allows to classify as an acid food, characteristic that disadvantages the microbial development. The high acidity can contribute to the flavor and palatability of juices, but, in excess, it can decrease the sensory acceptance, as consumers are not attracted to products with too high acidity (Porto et al., 2017).

The results of the physicochemical characteristics indicate that the formulation of suchá with the highest concentration of apple juice (F3) is probably sweeter, has higher acidity, and presents a higher nutritional value (TPC and antioxidant activity).

3.3 Volatile compounds

Table 4 presents the volatile compounds identified in the suchá formulations, apple juice and cardamom tea. A total of 46 compounds were identified, being 4 aldehydes, 14 alcohols, 3 ketones, 2 carboxylic acids, 10 esters, 2 ethers, 8 hydrocarbons, 1 amine, and 2 phenols. The number of volatile compounds was 24 in the cardamom tea, 25 in the apple juice, 40 in

Table 4. Volatile compounds identified in cardamom tea, apple and *suchás* formulations.

Compound	RT	LRI	Cardamom tea	Apple juice	F1	F2	F3
Aldehydes							
Hexanal	8,658	1061	x	x	x	x	x
E-(2)-Hexenal	11,845	1199	-	x	x	x	x
β-Citral	22,899	1668	x	x	x	x	x
α-citral	23,998	1716	-	x	x	x	x
Alcohols							
n-butanol	10,483	1135	-	-	x	x	-
2-methyl-1-butanol	11,653	1190	-	x	-	-	x
1-Hexanol	14,958	1334	-	x	x	x	x
6-methyl-5-hepten-2-ol	17,566	1442	-	x	-	-	-
β-Linalool	19,593	1526	x	x	x	x	x
4-terpineol	21,015	1587	x	x	x	x	x
p-menthol	21,859	1623	x	-	x	x	-
α-terpineol	22,143	1635	-	-	x	-	-
3,7-dimethyl-2-octen-1-ol	24,572	1741	-	x	x	x	x
(z)-5-decen-1-ol	25,235	1771	-	-	x	-	-
cis-geraniol	25,317	1775	x	x	x	x	x
Geraniol	26,324	1824	x	-	x	x	x
1-undecanol	28,906	1949	-	x	x	x	x
E-Nerolidol	30,3	2016	x	-	x	x	x
Ketones							
6-methyl-5-heptene-2-ona	14,63	1409	x	-	x	x	x
D-carvona	24,101	1724	x	-	x	x	x
α-pinocarvona	34,637	2247	x	-	-	-	-
Carboxylic Acids							
Octanoic Acid	30,607	2031	-	-	x	x	x
N-decanoic Acid	34,577	2244	-	-	x	-	-
Esters							
Butyl Ethanoate	8,445	1052	x	x	x	x	x
2-methyl-1-butyl acetate	9,448	1095	-	x	x	x	x
Formic acid, butyl ester	10,454	1134	-	x	-	-	x
acetyl pentyl acetate	10,579	1141	-	x	-	x	x
n-hexyl acetate	12,995	1249	-	x	x	x	x
5-hexano-1-ol acetate	14,276	1304	-	x	x	x	-
2-hydroxy-3-methylpentanoate	18,351	1475	x	-	x	x	x
α-terphenyl acetate	23,33	1680	x	x	x	x	x
geranyl acetate	24,412	1734	x	x	x	x	x
3,7-dimethyl-2,6-octadiene-1-ol acetate	23,759	1705	-	x	x	x	x
Ethers							
Eucalyptol	11,602	1181	x	x	x	x	x
6-isopropenyl-3-methoxy methoxy-3-methyl-cyclohexene	24,36	1732	-	-	x	x	-
Hydrocarbons							
α-terpinene	10,577	1143	x	-	x	x	x
D-Limonene	11,0136	1160	x	x	x	x	x
α-felandreno	11,275	1173	x	-	x	x	x
γ-terpinene	12,015	1206	x	-	x	x	x
o-cimol	12,855	1242	x	x	x	x	x
α-terpinolene	13,126	1257	-	-	x	-	x
1,3,8-p-Menthatriene	23,43	1692	-	-	x	x	x
β-Selenium	24,059	1718	x	-	-	-	-
Amines							
2,6-octadiene-3,7-dimethyl-amine	19,844	1537	-	-	x	-	-
Phenols							
2-nitrophenol	25,765	1795	x	x	x	x	x
2,4-bis-(1,1-dimethylethyl)-phenol	35,248	2281	x	x	x	x	x
TOTAL			24	25	40	36	35

(RT) Retention Time. (LRI) Linear Retention Index. (X) Substance found in the sample. (-) Substance not found. Formulations (Apple Juice: Cardamom tea; g 100 g⁻¹): F1 (50:50), F2 (60:40) and F3 (70:30).

the F1 formulation, 36 in the F2 formulation, and 35 in the F3 formulation. Therefore, mixed beverages presented a higher number of volatile compounds than the raw materials. All products had as predominant compounds the esters (30.1-41.09%), and ethers (36.74-45.67%), which are related to sweet and fruit odors (Braga et al. 2013).

Some volatile compounds were presented in all formulations and in the raw ingredients (apple juice and cardamom tea), such as hexanal, β -linalool, β -citral, 4-terpineol, eucalyptol, cis-geraniol, D-limonene, o-cimol, butyl-ethanoate, α -terphenyl acetate, genanyl acetate, 2-nitrophenol, and 2,4-bis-(1,1-dimethylethyl)-phenol. Hexanal contributes to the aroma of fresh and cut grass (Ayseli & Ayseli 2016). Terpineol and β -linalool are associated to floral and fruity notes and have antimicrobial properties against cariogenic bacteria (Perestrelo et al., 2019). Limonene has an important role in the reduction of the risk of breast cancer, reduces the stress related to oxidative processes, decreases the lipid peroxidation, and spares the activity of antioxidant enzymes (Perestrelo et al., 2019). Cis geraniol is related to the floral aroma and has anti-inflammatory properties in neurodegenerative diseases (Ayseli & Ayseli 2016). The presence of butyl-ethanoate is associated to fruit and floral aromas (Braga et al., 2013). The compound 2,4-bis-(1,1-dimethylethyl)-phenol has antifungal activity, and can be used to produce stabilizers and antioxidants (Gao et al., 2017). The compounds α -terphenyl acetate and eucalyptol are related to the typical aroma of cardamom oil (spicy, herbaceous, and sweet) and present anti-inflammatory properties (Ashokkumar et al., 2019).

The apple juice contributed to the presence of some volatile compounds on the suchá formulations, such as E-(2)-Hexenal, α -citral, 1-hexanol, 6-methyl-5-hepten-2-ol, 3,7-dimethyl-2-octen-1-ol, 1-undecanol, 2-methyl-1-butyl acetate, n-hexyl acetate, and 3,7-dimethyl-2,6-octadien-1-ol acetate. These components are responsible for the woody and floral (1-hexanol), fruit and sweet (butyl acetate, hexyl acetate, 2-methyl-1-butyl acetate), and green and leafy (E-(2)-Hexenal) notes of the apple juices (Ayseli & Ayseli 2016; Maragó et al., 2016; Espino-Díaz et al., 2016).

The cardamom tea contributed to the presence of some volatile compounds on the suchá formulations, such as geraniol, E-nerolidol, 6-methyl-5-heptene-2-ona, D-carvona, 2-hydroxy-3-methylpentanoate, α -terpinene, α -phelandrene, and γ -terpinene. These compounds were previously reported in cardamom oil, contributing with its typical aroma (Ashokkumar et al., 2019). The compound E-nerolidol can contribute to a pleasant, camphoraceous, fresh and cool aroma to the products (Baby & Ranganathan, 2016).

Some compounds were presented only on the suchá formulations, such as octanoic acid (F1, F2 and F3), and 1,3,8-p-Mentatrien (F1, F2 and F3). The octanoic acid can contribute to the fresh aroma of the products (Ye et al., 2016), and the 1,3,8-p-Mentatrien can be found in essential oils (Tongnuanchan & Benjakul, 2014). The formulation F1 presented some extra compounds, such as n-butanol, α -terpineol, z-5-decene-1-ol, N-decanoic acid, and p-menthol. Terpineol is associated to floral and fruity notes and have antimicrobial properties against cariogenic bacteria (Perestrelo et al., 2019). Butanol is associated to the typical apple aroma (Ayseli & Ayseli 2016), and the N-decanoic acid can contribute to the fresh aroma of the products (Ye et al., 2016). The formulation F3 presented the compounds 2-methyl-1-butanol, formic acid butyl ester, acetyl pentyl acetate, and α -terpinolene. The compound 2-methyl-1-butanol is associated to sweet and almond notes, while the pentyl acetate is related to notes of fruit, sweet and berry (Tauber et al., 2016). The compound α -terpinolene has sweet, pine-like and floral notes (Lalel et al., 2003).

Several works indicate the importance of the volatile compounds in the preference of the products by consumers, once the volatile compounds characterize species through aromas. Furthermore, some volatile compounds can show medicinal properties, as anti-hypertensive, anti-inflammatory, anti-bacterial, and anti-cancer activities, among others (Braga et al., 2013; Alberti et al., 2016). The results of the present study indicate that the suchá formulations based on organic apple juice and cardamom tea have different volatile profiles than the raw materials, with the appearance of volatile compounds important to the aroma of the products, mainly in F1 and F3 formulations.

3.4 Sensory analysis

Table 5 presents the results of the sensory acceptance. The suchá formulations presented acceptance scores in the range of 5.28-6.90 in a 9-point hedonic scale, suggesting that the consumers were indifferent to some formulations and liked moderately others. All suchá formulations presented similar scores for the appearance and aroma attributes ($p > 0.05$). Therefore, the differences in the aroma profile of the products determined by the instrumental analysis (Table 4) did not result in different consumer acceptance.

The suchá formulations with higher concentration of apple juice (F3) presented the highest acceptance scores for the attributes of flavor and overall impression ($p < 0.05$). These results could be related to the higher sweetness of this product (higher TSS values, Table 3) and higher acidity (lower pH and higher total acidity, Table 3), which contributed to the higher scores. This

Table 5. Sensory acceptance of the suchá formulations.

Attributes	F1	F2	F3
Appearance	6.20 \pm 1.41 ^a	6.23 \pm 1.44 ^a	6.07 \pm 1.30 ^a
Aroma	6.90 \pm 1.51 ^a	6.73 \pm 1.45 ^a	6.80 \pm 1.45 ^a
Flavour	5.28 \pm 1.87 ^c	6.03 \pm 1.74 ^b	6.63 \pm 1.75 ^a
Overall Impression	5.98 \pm 1.46 ^c	6.40 \pm 1.22 ^{bc}	6.82 \pm 1.42 ^{ab}
Acceptability Index (%)	66%	71%	76%

Means \pm standard deviation in the same line followed by different lowercase letters differ in Tukey test ($p < 0.05$, $n = 60$). Formulations (Apple Juice: Cardamom tea; g 100 g⁻¹): F1 (50:50), F2 (60:40) and F3 (70:30). Hedonic scale for appearance, aroma, flavor and overall impression (9= liked extremely, 1= disliked extremely).

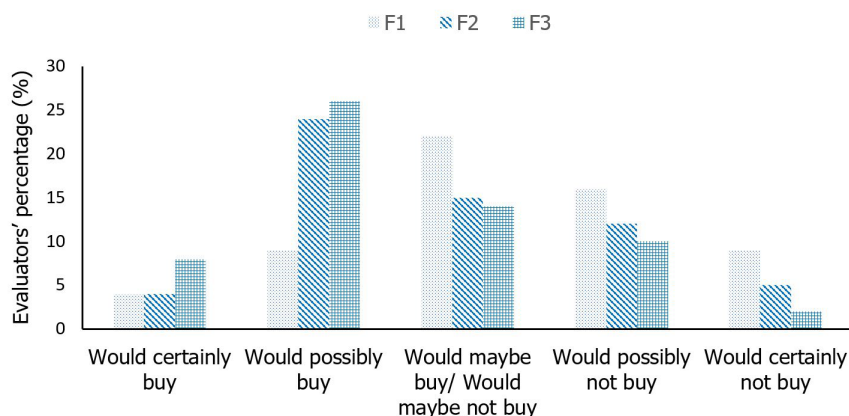


Figure 1. Purchase intention for the suchá formulations.

product also provided higher acceptability index (76%) and purchase intention (Figure 1).

It is worth to mention that the application of this test occurred in the academic community, being the group of volunteers composed mainly by young high school students (between 15 to 25 years old). Therefore, good purchase intention values were obtained, mainly thinking in the multiple choices of beverages in the market, as well as to the fact that the offered product is new and deprived of better nutritional information and pricing, which in thesis modifies, influences or still is a determining factor for the products choice at the purchase time (Barcellos et al., 2015). Future studies should evaluate the suchá formulation using descriptive tests with trained assessors (Torres et al., 2017; Judacewski et al., 2019).

4 Conclusion

This is the first study that evaluated the applicability of a mixed beverage based on organic apple juice and cardamom tea. The results indicate that a formulation with 70% of organic apple juice and 30% of cardamom tea would be the most suitable, presenting improved physicochemical characteristics (higher total soluble solids and acidity), nutritional properties (higher TPC and antioxidant activity) and sensory acceptance (flavor and overall impression). Furthermore, it presented some important volatile compounds (2-methyl-1-butanol, formic acid butyl ester, acetyl pentyl acetate, α -terpinolene), which contributed to sweet, fruit, floral, berry and almond notes. The suchá beverages presented about twice the antioxidant activity compared to the apple juice and tea individually, demonstrating the synergistic effect.

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