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Production of healthy mixed vegetable beverage: antioxidant capacity, physicochemical and sensorial properties

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Abstract

The present study aimed to develop and perform physicochemical and sensory analyses of new vegetable beverage with cashew nuts (C), brown rice, and prunes (P). Four formulations (F) were developed: F1: 3% C + 9% P; F2: 6% C + 9% P; F3: 3% C + 12% P; F4: 6% C + 12% P. All formulations had good acceptance with grades ranging from 6.14 to 7.23. Among formulations, F3 showed more promising from a functional and sensory point of view, since presented a higher content of oleic acid and antioxidant activity, and showed lower values for calories, lipids and viscosity compared to all other formulations. It was concluded that it was technically possible to develop an alternative vegetable beverage for those allergic to cow's milk, those with lactose intolerance, and people with obesity or cardiovascular and digestive problems.

Keywords: vegetable beverage; cashew nuts; brown rice; prunes.

Practical Application: Development of a healthy mixed vegetable beverage.

1 Introduction

Non-dairy plant-based beverage markets have evolved significantly in recent years, in part due to the conditions of lactose intolerance, cow's milk allergy in consumers (Aydar et al., 2020). The global plant-based beverages market was estimated to be US$ 247.8 billion in 2018, and expected to reach US$ 474.6 billion by 2028, with a CAGR of 6.7% during 2018-2028 (ReportBuyer, 2018). These beverages result from the maceration of plant material, such as cereals, nuts, and legumes, extraction in water, and further homogenization (Munekata et al., 2020). They can be potentials for improving general health and decreasing the risk of chronic diseases such as cardiovascular disease, cancer, and obesity, as they contain a variety of biologically active components, such as phytosterols, isoflavones, unsaturated fatty acids, fermentable fiber, vitamins, minerals, phenolic compounds, and antioxidants (Aydar et al., 2020).

Cashew nuts (*Anacardium occidentale*) are consumed globally for their taste, texture, and other attributes. They are an oleaginous fruit rich in monounsaturated lipids and phytosterols, such as β-sitosterol, and present a good protein nutritional quality, containing all the essential amino acids for humans (Freitas et al., 2012; Das et al., 2014; Derewiaka et al., 2014). The consumption of these nuts can promote health effects, such as an increase in HDL cholesterol and a decrease in systolic blood pressure (Mohan et al., 2018). During commercial processing, up to 40% of kernels are broken, and considered by-products, and these could present an alternative for the production of nut-based beverages (Lima et al., 2017).

Rice (*Oryza sativa* L.) is cultivated in many locations worldwide and represents one of the most important and stable human food crops. The widespread acceptance of rice as a non-allergenic cereal, as well as its texture and nutritional and functional qualities, favored the development of rice milk by the beverage industry (Sethi et al., 2016). Brown rice has a higher nutritional quality compared to white rice because it contains more protein, fat, vitamins, minerals, and bioactive compounds such as phenolic compounds, flavonoids, and phytosterols (Saleh et al., 2019). The bioactive compounds and nutritional quality of brown rice are responsible for their beneficial effects on human health, such as antioxidant, antidiabetic, antiobesity, anticancer, and anti-inflammatory activities (Saleh et al., 2019).

Plums (*Prunus domestica*) are one of the most important stone fruit crops in the world. Plums are a rich source of carotenoids, phenolic acids, flavonoids, pectin, aromatic substances, minerals, and vitamins. Their dried versions are known as prunes, which have a laxative effect, attributed to their high fiber content and the presence of phenolics and sorbitol. Other health effects that have been reported are antioxidant, anti-cancer, anti-ulcerogenic, anti-adipogenic, and anti-inflammatory activities (Igwe & Charlton, 2016).

The demand for natural health products is promoting the development of non-dairy plant-based beverages, making it an enticing area for research. Sensory tests are carried out in order to help develop new food products, allowing to attract and understand

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consumer preferences (Costa et al., 2020; Nascimento et al., 2020). Despite the importance of these tests, there is a growing need for studies that aim to understand consumers' food preferences. Given the growing consumer interest in healthy foods, and the increase in innovation in the beverage sector, the aim of the present study is to develop and perform physico-chemical and sensory analyses of new functional plant-based beverage using rice, cashew nuts, and prunes.

2 Materials and methods

2.1 Raw material

Roasted cashews, classified according to the legislation as bung (Brasil, 2017), brown rice type I, stabilizer xanthan gum, sugar, sodium chloride, and prunes, were purchased from local markets in the city of Fortaleza, Ceará State, Brazil.

2.2 Experimental design and beverage production

A total of 4 formulations of plant-based beverages (F1: prunes 9%, cashew nuts 3%; F2: prunes 9%, cashew nuts 6%; F3: prunes 12%, cashew nuts 3%; F4: prunes 12%, cashew nuts 6%), were defined using the Complete Factorial Planning methodology 2^2, in the Statistica 10.0 software (Table 1) (Box et al., 1978).

The processing of plant-based beverages (patent application BR 102019016050 with the National Patents Institute (INPI) on August 20, 2019) was performed at the Nutrition Laboratory of the Department of Food Engineering at UFC. The stipulated quantities of each ingredient (sugar 5%, sodium chloride 0.1%, xanthan gum 0.1%, cooked brown rice 5%, prunes (9% and 12%) and cashew nuts (3% and 6%) were weighed on an analytical balance and processed in a blender (Philco, PLQ1400, Brasil) with water, for approximately 10 minutes. The plant-based beverages were then pasteurized and refrigerated at 4 °C to 5 °C.

2.3 Physicochemical analysis of raw materials and formulations

The cashew nuts, prunes, brown rice, and all formulations were subjected to moisture removal by oven drying (Procedure 012/IV) and converted to ashes in a muffle at 550 °C (Procedure 018/IV), according to the Instituto Adolfo Lutz (2008). Proteins were identified according to the technique of Kjeldahl (1883), and the method described by Bligh & Dyer (1959) was used for lipids. The carbohydrate content in the samples was calculated as the difference after moisture, ash, protein, and lipid analysis, and the caloric value was determined according to the ATWATER coefficient (Atwater & Woods, 1896). All formulations were subjected to crude fiber (Procedure 044/IV), acidity (procedure 016/IV), pH to pHmeter (DLA-PH, DEL LAB) (procedure 017/IV), total soluble solids (refractometry with the Grandindex Benchtop Digital Refractometer, model RSG-100ATC (Procedure 315/IV)), reducing sugar (Procedure 038/IV), and non-reducing sugar (Procedure 039/IV) analyses according to the Adolf Lutz Institute (Instituto Adolfo Lutz, 2008). Total sugar was determined by the 3.5-dinitrosalicylic acid (DNS) method (Miller, 1959). Physico-chemical analyses were performed in triplicate.

Table 1. Complete Factorial Planning 2^2.

Formulations (F)	Coded Levels		Real levels (%)	
	Cashews	Dried plum	Cashews	Dried plum
F1	-1	-1	3	9
F2	1	-1	6	9
F3	-1	1	3	12
F4	1	1	6	12

2.4 Carotenoids and ABTS assays

Carotenoids were determined according to the method of Higby (1962). The reading was performed on a spectrophotometer (Shimadzu UV-1800, Tóquio, Japão) at 450 nm. The carotenoid content was determined using the equation: abs450 x V / 125 x P = mg 100 g^{-1} of carotenoids. Where: abs450 = absorbance value of drinks, P = weight of drinks, and V = volume used (mL). ABTS + assay were performed according to the methodology of Re et al. (1999). The samples were read at an absorbance of 734 nm. As a standard, Trolox (100-2.000 µM) was used. The percent inhibition of absorbance at 734 nm was calculated according the following Equation 1:

$$ABTS\cdot + \; elimination\ effect\ (\%) = (AB - AA)\,AB^{-1}) \times 100 \quad (1)$$

where AB is the absorbance of the ABTS radical + ethanol, and AA is the absorbance of the ABTS radical + sample/standard extract.

2.5 Viscosity

The mixed juices were subjected to viscosity analysis using a rotary viscometer, according to methods previously reported Association of Official Analytical Chemists (1990). The vegetable beverage was transferred to a 50 mL beaker and stirred under a viscometer (Thermo Cientific, Haake Visco Tester 6L, MA, EUA) at 20 °C using Spindle L3 at 60 rpm. The relative viscosity result was given in cP (centipoise).

2.6 Rheological analysis

The rheological parameters were determined in a Searle type rotational rheometer with concentric cylinders (Brookfield, R/S plus SST 2000, Stoughton, MA, USA), using the methodology proposed by Silva et al. (2019). Two continuous curves (ascending and descending) were created, varying from 0 to 200 s^{-1}, in order to eliminate thixotropy. The ascending curve data were used in the statistical analysis, and the tests were performed in triplicate at a temperature of 6 °C. The experimental data were then applied to the Herschel-Bulkley rheological model, represented by the equation $\tau = \tau 0 + K\gamma n$, where τ is the shear stress (Pa), $\tau 0$ is the initial shear stress (Pa), γ is the shear rate (s^{-1}), K is the consistency index (Pa · sn), and n is the behavioral index (dimensionless).

2.7 Color

The color of the mixed juices was determined by CIE-LAB coordinates using a colorimeter (Color Quest XE, Hunter Lab, USA), which determines the: *a** (green/red), *b** (blue/yellow),

c^* (chroma), h^* (hue), and L^* (lightness) values (Commission Internationale de l'Eclairage, 1986).

2.8 Analysis of fatty acid methyl esters by gas chromatography

The esterification reaction was performed using the methodology described by International Union of Pure and Applied Chemistry (1987). Each formulation (100 mg) was dissolved in 3 mL hexane and 0.2 mL KOH (0.2 N). The solution was stirred vigorously for 30 s, and then a saturated NaCl solution was added. The hexane fraction was then separated, dried with sodium sulfate, and subsequently analyzed using gas chromatography coupled to mass spectrometry (GC-EM) according to Adams (2007).

Analysis of the methylic esters was performed using a GC-EM (Shimadzu QP2010 SE, Quioto, Japão), with an Equity-tm5 column. Helium gas was used as the carrier gas with a flow of 1 mL min^{-1}, and the analysis was conducted in split mode at a ratio of 1:10. The injector temperature was 220 °C, and the total time of chromatographic analysis was 62 min. The column temperature began at 60 °C and was increased to 240 °C at a rate of 3 °C min^{-1}. Mass spectra were operated in the electron ionization mode at 70 eV at 240 °C.

2.9 Microbiological analysis

Salmonella spp. and coliforms were analyzed at 35 °C and 45 °C (NMP mL^{-1}) (UFC mL^{-1}) according to American Public Health Association (2013).

2.10 Sensory analysis and acceptance index of beverages

Sensory analysis was performed on all formulations, using 77 students from the Federal University of Ceará (63.63% female, mean age 24.95 years, S.D. = 8.32 years, and 36.36% male, mean age 24.07 years, S.D. = 10.04 years). The project was reviewed and approved by the Committee of Ethics in Research Involving Human Subjects at the Federal University of Ceará (protocol number 19338619.5.0000.5054). Fifty milliliters of each beverage was shaken and served monadically, in glass cups with three-digit codes at 8 ± 1 °C (MacFie et al., 1989). The preference and acceptance test was applied using a 9-point hedonic scale ranging from 1 (extremely disliked) to 9 (extremely liked) for the parameters color, flavor, mouthfeel, smell, and overall acceptance. The purchase intent of the product was assessed using a 5-point scale (5 corresponds to certainly would buy and 1 means certainly would not buy) (Mäkinen et al., 2015).

The acceptance index (AI) of all formulations was calculated for each of the evaluated attributes (color, flavor, mouthfeel, smell, and overall impression) using the following Equation 2:

$$AI\ (\%) = A\ B^{-1} x\ 100 \quad (2)$$

where A is the average grade obtained for the product and B is the maximum grade given to the product. For a product to be accepted by the tasters, it must reach a percentage greater than or equal to 70%.

2.11 Statistical analysis

All results were expressed as the mean ± standard deviation (SD). Statistical comparisons were performed via one-way analysis of variance (ANOVA) followed by a Tukey test for multiple comparisons at a significance level of 5%, using the Statistica software, version 10 (Statsoft, Oklahoma, EUA), *P*-values of less than 0.05 were considered significant.

3 Results and discussion

3.1 Physicochemical characterization of raw materials and vegetal beverages

The results of the physicochemical characterization of cashew nuts, brown rice, and prunes were similar to those found in other studies (Rico et al., 2016; Freitas et al., 2012; Saleh et al., 2019; Igwe & Charlton, 2016). The cashew nuts presented reduced amounts of moisture (2.47 ± 0.08%) and ash (2.55 ± 0.06%), and high amounts of proteins (23.47 ± 0.22%), lipids (34.95 ± 0.82%), carbohydrates (36.56 ± 0.94%) and energy (554.65 ± 3.82 kcal 100 g^{-1}). Brown rice had a moisture content of 65.42 ± 0.44%, ash of 0.97 ± 0.30%, proteins of 2.44 ± 0.18%, and lipids of 4.25 ± 0.14%, as well as high amounts of carbohydrates (80.34 ± 0.12%) and energy (369.01 ± 4.57 kcal 100 g^{-1}). For prunes, reduced amounts of ash (1.92 ± 0.12%), proteins (0.97 ± 0.16%) and lipids (0.56 ± 0.27%) and high moisture (31.07 ± 0.96%), carbohydrates (65.66 ± 0.57%), and energy (269.90 ± 1.71 kcal 100 g^{-1}) were obtained.

The physicochemical results of the formulations are summarized in Table 2. The results showed that the moisture value was inversely proportional to the concentration of cashew nuts and prunes. Formulations with higher proportions of cashew nuts (6%) and prunes (12%), such as F4, had lower moisture values, whereas formulations containing smaller proportions of cashew nuts (3%) and prunes (9%), such as F1, had higher moisture values. Similar moisture results were found for cashew nut milk (Tamuno & Monday, 2019). The ash values found in the formulations showed no differences, and were similar to those of plant-based beverages prepared with rice, sesame, or almond (Aydar et al., 2020).

The addition of different concentrations of cashew nuts significantly influenced the values of ash, protein, lipids, energy, and pH; where as these effects did not occur with prunes. The increased values were likely due to the fact that F2 and F4, which contained a higher cashew nut content (6%), showed higher levels of these compounds than F1 and F3. This was expected, since cashew nuts have a high proportion of protein, lipids, and energy, as shown in results of other studies (Freitas et al., 2012; Das et al., 2014; Derewiaka et al., 2014). The incorporation of prunes in the formulations did not influence the concentration of proteins, since formulations F1 and F3, which contained equal amounts of cashew nuts (3%) and different proportions of plum (9% and 12%), did not differ in protein content. The total proteins in the formulations used in the present study were similar to other studies on almond milk (0.8 -1.7%) (Aydar et al., 2020). The amount of lipids in the formulations was less than that found in cashew milk (3.30%) (Aydar et al., 2020). The energy values of the formulations were higher than those found in soy

Table 2. Physicochemical characterization, sensory attributes and fatty acids composition of the formulations.

Parameters	F1	F2	F3	F4
Moisture (%)	84.42^{a} ± 0.04	81.66^{b} ± 1.10	82.96^{b} ± 0.01	81.57^{b} ± 0.09
Ash (%)	0.30^{a} ± 0.01	0.37^{a} ± 0.01	0.31^{a} ± 0.02	0.40^{a} ± 0.05
Protein (%)	0.97^{c} ± 0.00	1.15^{a} ± 0.05	0.97^{c} ± 0.00	1.65^{b} ± 0.00
Lipid (%)	1.98^{a} ± 0.14	2.99^{a} ± 0.81	2.20^{a} ± 0.44	2.59^{a} ± 0.81
Fiber crude (%)	0.51^{b} ±0.01	0.93^{a} ± 0.01	0.60^{c} ±0.02	0.54^{d} ± 0.01
Carbohydrate (%)	11.27^{a} ± 0.10	10.41^{a} ± 2.46	11.35^{a} ±2.69	13.19^{a} ± 0.86
Energetic value (kcal 100 mL^{-1})	68.94^{a} ± 0.91	76.74^{a} ±7.44	69.14^{a} ± 7.17	80.80^{a} ± 4.12
Reduce sugar (%)	8.25^{b} ± 0.37	7.70^{b} ± 0.19	8.22^{b} ± 0.05	8.93^{a} ± 0.24
Non-reduce sugar (%)	1.47^{a} ± 0.17	1.64^{a} ± 0.04	1.54^{a} ± 0.02	1.53^{a} ± 0.02
pH	4.39^{a} ± 0.34	4.97^{bc} ±0.01	4.28^{a} ±0.24	4.61^{ab} ± 0.01
Acidity (% acid malic)	0.15^{a} ± 0.01	0.17^{a} ±0.01	0.22^{b} ± 0.01	0.20^{b} ± 0.01
SST (°Brix)	10.1^{d} ± 0.10	12.06^{c} ±0.11	15.63^{a} ± 0.05	15.96^{b} ± 0.05
Antioxidants (µM trolox mL^{-1})	Nd	Nd	3.67^{a} ± 0.12	2.71^{b} ± 0.05
Carotenoids (mg mL^{-1})	0.10^{a} ± 0.02	0.10^{a} ± 0.04	0.15^{a} ± 0.22	0.15^{a} ±0.21
Viscosity (cP)	429.75^{a} ± 0.50	540.00^{b} ± 0.81	470.25^{c} ± 0.50	589.75^{d} ± 0.50
L*	48.40^{b} ± 0.31	52.64^{a} ± 0.35	43.22^{d} ± 0.22	46.38^{c} ± 0.12
a*	9.77^{c} ± 0.05	8.59^{d} ± 0.10	11.46^{a} ± 0.03	10.73^{b} ± 0.05
b*	24.35^{c} ± 0.09	24.95^{b} ± 0.24	27.69^{a} ± 0.12	27.52^{a} ± 0.17
c*	26.23^{c} ± 0.10	26.39^{c} ± 0.26	29.75^{a} ± 0.12	29.54^{b} ±0.17
h*	68.13^{c} ±0.03	71.0^{a} ± 0.07	67.50^{d} ±0.07	68.69^{b} ±0.14
Sensory attributes				
Color	7.23^{a} ± 1.48	6.96^{a} ±1.45	6.93^{a} ±1.59	7.06^{a} ± 1.38
Smell aroma	6.53^{a} ± 1.42	6.54^{a} ±1.32	6.53^{a} ± 1.53	6.57^{a} ± 1.47
Mouthfeel	7.02^{a} ±1.46	7.16^{a} ±1.34	6.85^{a} ±1.69	6.68^{a} ± 1.97
Flavour	6.14^{a} ±1.84	6.16^{a} ±1.88	6.25^{a} ±1.98	6.33^{a} ± 1.87
Overall impressiom	6.54^{a} ±1.42	6.57^{a} ±1.39	6.50^{a} ±1.56	6.79^{a} ± 1.55
Fatty acid (%)				
Palmitic acid (C16:0)	19.73	32.48	26.5	26.18
Oleic acid (C18:1)	55.08	35.49	56.83	41.44
Stearic acid (C18:0)	14.62	21.94	14.63	23.12

The values were presented as mean ± standard deviation (SD), n=3. Means on the same line that have different letters differ significantly from each other using the Tukey test (p ≤ 0.05). F1: cashew nut 3% + prunes 9%; F2: cashew nut 6% + prunes 9%; F3: cashew nut 3% + prunes 12%; F4: cashew nut 6% + prunes 12%. Nd: Not detected.

(57.36 ± 0.2 kcal), almond (55.40 ± 0.45 kcal), and cashew milk (55.46 ± 0.45 kcal) (Alozie & Udofia, 2015; Manzoor et al., 2017). In other studies, the pH value of different plant-based beverages was higher than that of the present study (Aydar et al., 2020).

F4, which contained the highest amounts of prunes (12%) and cashew nut (6%), also contained high levels of carbohydrates, reducing sugar and total soluble solids. This result would be expected, since prunes are rich in carbohydrates, which are composed mainly of reducing sugars, primarily glucose and fructose (Igwe & Charlton, 2016). The amount of carbohydrate in the formulations was higher than that found in other plant-based beverages, such as cashew nut (4.38%), peanut (5.50-5.60%), almond (0.08-4.50%), and soy (4.78-5.00%), but less than that of rice milk (25.28%) (Aydar et al., 2020). The crude fiber content was similar to that observed in soymilk (0.70%) and lower than that of almond milk (1.25%) (Alozie & Udofia, 2015). The values of total soluble solids were similar to those of other vegetable drinks, such as rice, coconut, and sesame milk (Aydar et al., 2020). F3 and F4, which contained the highest amounts of prunes (12%), also contained high levels of acidity, which is possibly due to the high content of malic acid naturally present in the prunes (Bae et al., 2014).

3.2 Carotenoids

Carotenoids are natural pigments of great dietary importance. Studies have shown that the consumption of carotenoids within whole fruits and vegetables has been associated with a decreased risk of human diseases, including cardiovascular diseases, cancer, and photosensitivity disorders (Fiedor & Burda, 2014). In the present study, the amount of carotenoids detected in the formulations did not differ significantly (P <0.05) (Table 2). The magnitude of carotenoids in the formulations was directly proportional to the amount of prunes added. This result was expected since prunes are rich in carotenoids (Kaulmann et al., 2014).

3.3 ABTS assays

The antioxidant capacity was detected only in formulations F3 and F4 (Table 2), which contained a higher content of carotenoids, due to the greater amount of prunes present. These results are corroborated by others in terms of the antioxidant capacity of prunes, possibly due to their carotenoid content (Igwe & Charlton, 2016). These bioactive compounds play an important role in the prevention of inflammation and oxidative stress-related chronic diseases, due to their antioxidant capacity (Fiedor & Burda, 2014).

3.4 Viscosity

Viscosity is a physicochemical property associated with dietary fibers, particularly soluble dietary fibers (Dikeman & Fahey, 2006). The viscosity of the formulations showed a significant difference ($P < 0.05$) (Table 2). The results showed that the addition of prunes and cashew nuts proportionally increased the viscosity of the formulations. F2 and F4, which contained higher levels of prunes (12%), showed higher values for viscosity. These results are expected because prunes are rich in dietary fiber, with approximately 57% of soluble dietary fiber, which itself is rich in pectins (Fatimi et al., 2007). Regarding cashew nuts, there was a proportional increase in viscosity values between formulations F1 and F3, and between formulations F2 and F4, which contained the same amounts of prunes, but different levels of cashew nuts, which are rich in dietary fibers (Freitas et al., 2012).

3.5 Rheological analyses

The viscosity curves of the formulations are shown in Figure 1a and 1b. The results demonstrate that the viscosity of all formulations showed an initial increase which decreased as the shear rate increased (Figure 1a). There is also a non-linear relationship between shear rate and shear stress (Figure 1b). The rheological parameters were calculated using the experimental data of the shear stress as a function of the shear rate, and adjusted per the Herschel-Bulkley model, where the determination coefficient (R^2) was used (Table 3).

Formulations F3 and F4 exhibited higher values of initial yield stress ($\tau 0$) and parameter K (consistency index). The flow behavior index (n) had a minimum of 0.608 and a maximum of 1.009. The adjustment of the data generated coefficients of determination (R^2) between 0.947 and 0.959.

In the analyzed vegetable beverages, it appears that the viscosity of all samples decreased as the shear rate increased, which suggests non-Newtonian fluid behavior. Similarly, the data from the flow behavior index (n) indicates that all drinks had the characteristics of pseudoplastic fluid. The adjustment of the data-generated determination coefficients (R^2) indicates that the model adequately estimates the rheological parameters of the analyzed beverages.

3.6 Color

According to color results, formulations that contained more prunes and less cashew nuts showed a darker color, while formulations that contained higher cashew nut content and less prune were clearer. This result was expected, since prunes are rich in anthocyanins and carotenoids (Perera & Yen, 2007). Formulations that contained a higher content of prunes, and therefore anthocyanins and carotenoids, were intensified in color. In addition, it appears that the addition of cashew nuts gives a lighter color to the formulations, when comparing the formulations that contained the same prune content.

3.7 Analysis of fatty acids by gas chromatography

Table 2 shows the percentage values of the methyl esters present in each formulation. The most representative values were found for palmitic, stearic, and oleic acid (Figure 2).

The fatty acids detected in the formulations were the same as those present in greater proportions in the cashew nut. Among the detected acids, oleic acid was present in larger quantities in both the cashew nuts and the formulations. This acid is also present in a large proportion of olive oil and is known for its cardioprotective effects (Derewiaka et al., 2014).

Table 3. Adjustment parameters using the Herschel-Bulkley rheological model.

Formulations	$\tau 0$ (Pa)	K (Pa s^n)	n	R^2
F1	0.927	0.202	1.009	0.950
F2	0.974	0.354	0.908	0.947
F3	1.128	1.316	0.672	0.951
F4	1.235	1.890	0.608	0.959

$\tau 0$ = initial shear stress; K = consistency index; n = behavior index; R = coefficient determination.

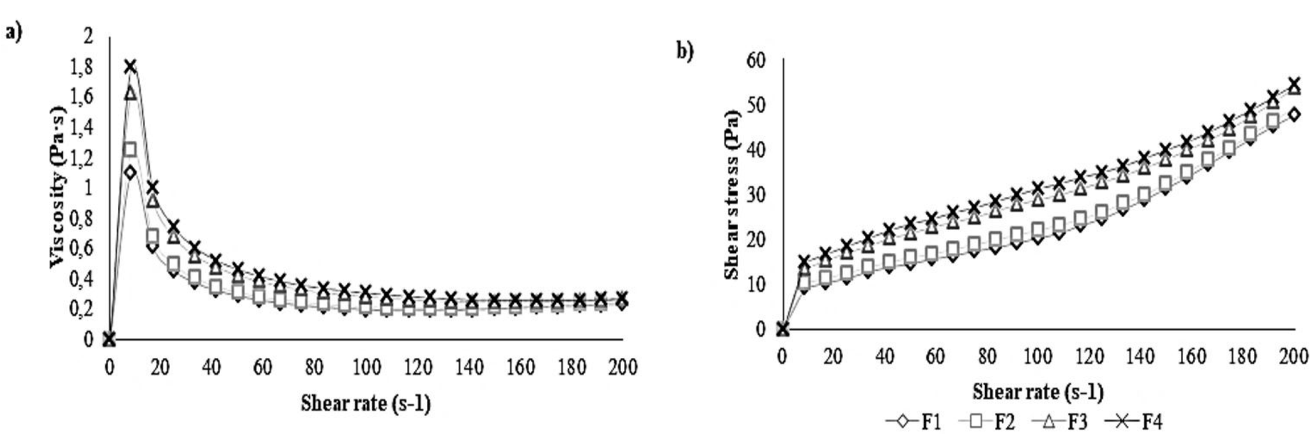

Figure 1. Flow curves of the viscosity (a) and shear stress and shear rate (b) of the formulations. F1: cashew nut 3% + prunes 9%; F2: cashew nut 6% + prunes 9%; F3: cashew nut 3% + prunes 12%; F4: cashew nut 6% + prunes 12%.

3.8 Microbiological analysis

According to the results of microbiology analyses, the count of total and thermotolerant coliforms was <3 NMP/mL, and there was an absence of *Salmonella spp*. in all formulations.

3.9 Sensory analysis and acceptance index of formulations

The results of the sensory analysis and acceptance index of the formulations are shown in Table 2 and Figure 3 and 4. According to the results, the formulations showed good acceptance and showed no significant difference ($p \leq 0.05$) in the evaluated attributes, possibly due to the concentration values of both the cashew nuts and prunes being similar, which provided a subtle difference between the evaluated attributes. Another factor could be that some of the tasters stated in the questionnaire distributed before the tasting that they preferred the cashew nut, while others preferred the prune, which could have balanced out the results. The evaluated attributes showed a higher acceptance than other beverages based on soy, oat, quinoa, and rice (Mäkinen et al., 2015).

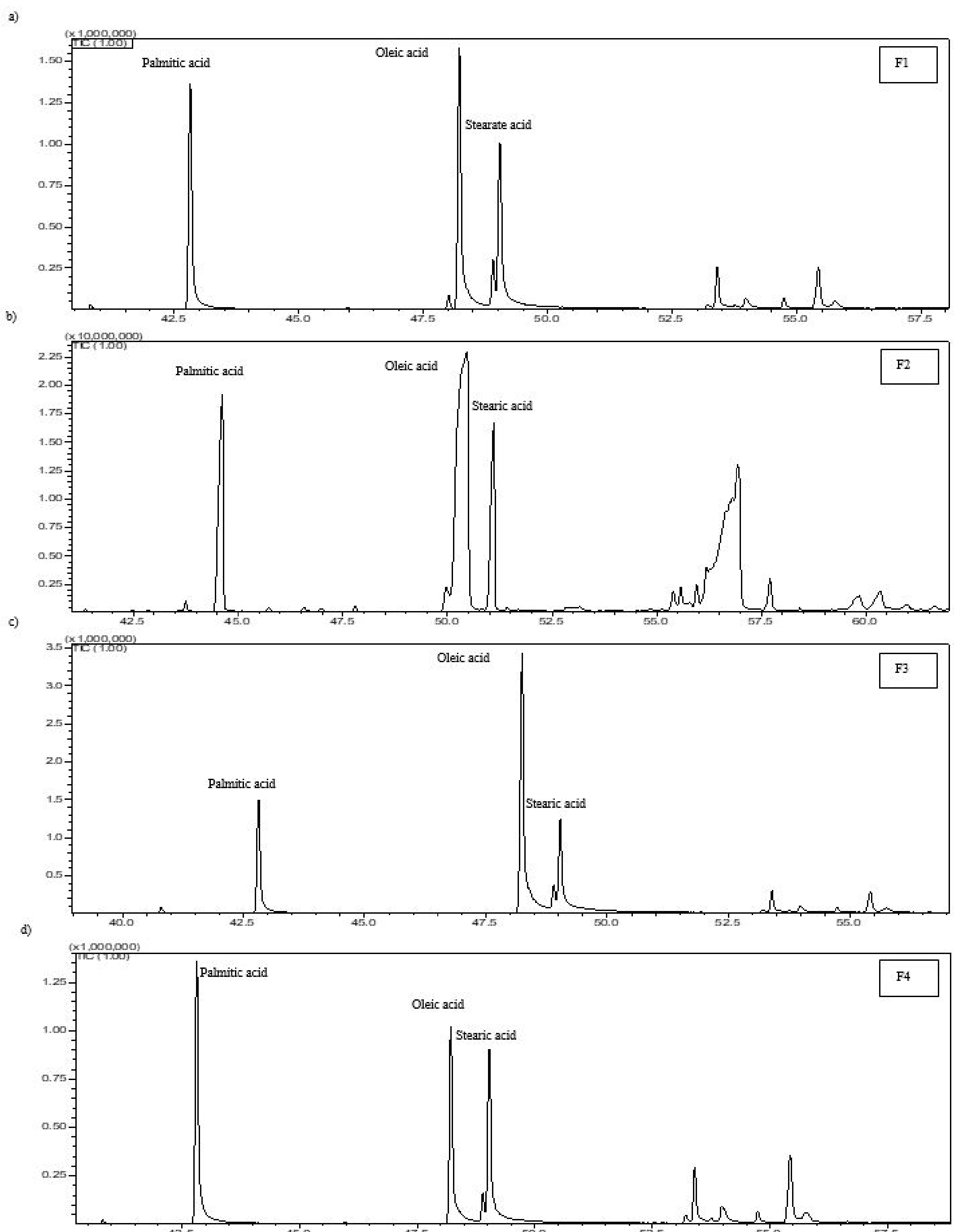

Figure 2. Fatty acids of formulations F1 (a); F2 (b); F3 (c); and F4 (d).

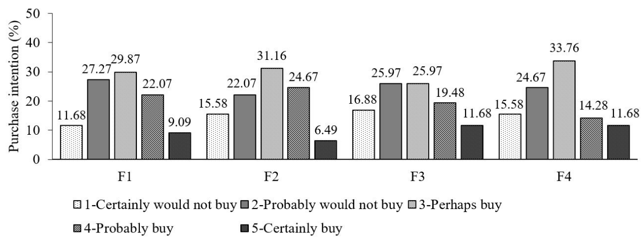

Figure 3. Histogram of the percentage of intention to purchase of the formulations. F1: 3% cashew nut + 9% plum; F2: 6% cashew + 9% plum; F3: 3% cashew nut + 12% plum; F4: 6% cashew nut + 12% plum.

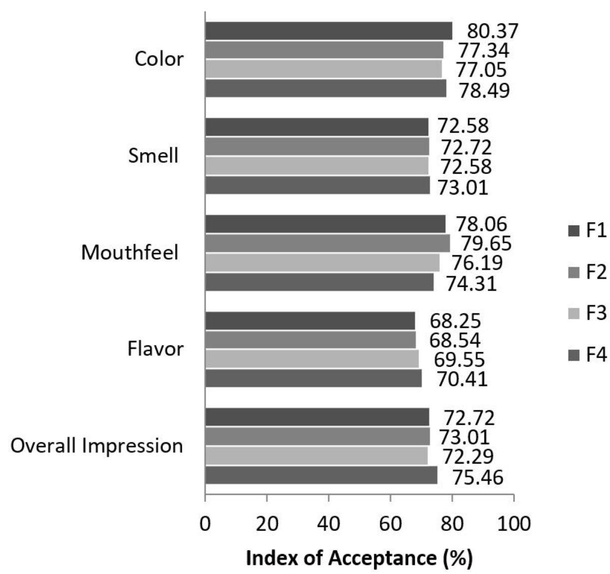

Figure 4. Histogram of the index acceptance of the formulations.

4 Conclusion

According to the present study, it was concluded that it was technically possible to develop an alternative vegetable beverage based on brown rice, prunes, and cashew nuts that with a high general acceptability. The importance of this work is to extend the associated benefits, by providing new and nutritious low-cost alternatives for those allergic to cow's milk, those with lactose intolerance, and people with cardiovascular and digestive problems. Among the formulations, F3 proved to have a higher oleic acid content and antioxidant activity, and showed lower values for calories, lipids and viscosity compared to all other formulations. Moreover, F3 and F4, have higher levels of carotenoids, compared to F1 and F2. These results suggest that F3 is more promising from a functional and sensory point of view.

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