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Development of a mixed drink made from hydrosoluble soybean extract, coconut water and umbu pulp (*Spondias tuberosa*)

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ABSTRACT. The food sector depends on consumers and their social behavior. Since currently more and more consumers seek healthy products, exotic fruits have been increasingly on demand, with great opportunities for innovation. Current study developed a ready-to-drink mixed beverage made from hydrosoluble soybean extract, coconut water and umbu pulp. Four formulations were prepared with two proportions of umbu pulp (25 and 30%) and soluble solids (17 and 25º Brix). Formulations were submitted to chemical, physicochemical, microbiological and sensory analyses. The beverage was prepared with 25% of umbu pulp and the soluble solids were standardized to 25º Brix with commercial sugar for the highest scores in sensory attributes, overall impression and purchase intent. The four formulations presented pH, acidity, moisture, total sugar, vitamin C and microbiological results in accordance with current legislation.

Keywords: innovation, mixture, mixed drink, physicochemical, microbiological, sensory acceptance.

Desenvolvimento de uma bebida mista à base de extrato hidrossolúvel de soja, água de coco e polpa de umbu

RESUMO. O setor alimentício é regrado pelo seu mercado consumidor e seu comportamento social. Hoje em dia, cada vez mais os consumidores buscam produtos saudáveis e os frutos exóticos estão sendo cada vez mais utilizados, visando uma oportunidade de inovação. O trabalho objetivou desenvolver uma bebida mista à base de extrato hidrossolúvel de soja feito com água de coco e polpa de umbu 'pronta para beber'. Foram preparadas quatro formulações com duas proporções de polpa de umbu (25 e 30%) e sólidos solúveis (17 e 25º Brix). As formulações foram submetidas à caracterização química, físico-química, microbiológica e avaliação sensorial. A bebida elaborada com 25% de polpa de umbu e 25º Brix obteve as maiores notas nos atributos sensoriais, assim como na impressão global e intenção de compra. As quatro formulações apresentaram pH, acidez, umidade, açúcares totais, vitamina C e resultados microbiológicos de acordo com a legislação vigente.

Palavras-chave: inovação, mistura, bebida mista, físico-química, microbiológica, aceitação sensorial.

Introduction

Recent studies have shown that more and more consumers are seeking healthier foods. In fact, pressure is put on industries to manufacture and commercialize products based on nutrients or foods that in addition to providing basic nutrients also meet consumers´ tastes (Ribeiro, Andrade, Daniels, & Seibel, 2014).

The habit of consuming processed fruits has increased in Brazil and even worldwide, motivated by the lack of time people have to make juices from fresh fruit, the convenience of products, and the replacing of carbonated beverage consumption due to their nutritional value, since processed fruits are a source of vitamins, minerals and soluble carbohydrates, and due to the concern of consuming foods with healthier characteristics (Matsuura & Rolim, 2002).

Ready juice has an interesting and growing market in Brazil. In fact, Brazil is the third largest producer of fruit in the world and the industries, knowing the country´s capacity, are benefiting from technology to invest in this market (Monteiro, 2006).

Therefore, the formulation of ready-to-drink beverages may be an alternative to improve offer and the nutritional characteristics of certain juices by nutrient complements from various sources. According to Pereira et al. (2009), mixed fruit drinks may provide many advantages, such as different aromas, flavors and the sum of their nutritional

components, such as soybean mixture as hydrosoluble extract, coconut water and fruit pulp. Further, the development of these products may trigger the development of new products, stimulating small agro-industries, increasing production capacity and promoting the development of other companies (Zotarelli, Zanatta, & Clemente, 2008).

Among the vegetable products with great potential for the development of new beverages is (1) soybean hydrosoluble extract (watery substance extracted from soybean after hydration and crushing) due to its chemical and nutritional characteristics that qualify it as a functional food. In fact, it is rich in high quality protein, has low saturated fat and no cholesterol (Branco et al., 2007). However, its acceptance is rather negative since it tastes like raw beans; the addition of fruit pulp is a way for solving the problem (Silva, Prudencio, Felberg, Deliza, & Carrão-Panizzi, 2007); (2) due to its capacity to replace electrolytes, coconut water is a rival product to sport drinks; in fact, it has a broad commercial potential; it is nutritive and natural, with a mild aroma and flavor, significant amount of minerals, and consumed by people of all ages (Carvalho, Maia, Sousa, & Maia Junior, 2006); (3) the umbu has an exotic and distinctive flavor, highly appreciated by Brazilian people. Recent studies emphasize some characteristics of umbu which are not well explored and studied; it is a source of vitamins C and A, and rich in antioxidant compounds (Santos, Cardoso, Fonseca, Conceição, & Neto, 2013).

The development of a mixed beverage comprises research on its chemical and physicochemical characteristics, or rather, the contributions of the mixture´s components and the nutritional characteristics of the final product, coupled to their acceptance by consumers through sensory tests.

Current study develops formulations of ready-to-drink mixed beverages made from hydrosoluble soybean extract, coconut water and umbu pulp.

Material and methods

Hydrosoluble soybean extract with coconut water

Soybeans were obtained at a local supermarket and taken to the Fruit and Vegetables Processing Unit at the Federal Institute of Pernambuco (IFPE), campus Afogados da Ingazeira, Pernambuco State, Brazil. The soybeans were washed in fresh water and, after selection, they were weighed and macerated by soaking in a solution at 0.5% sodium bicarbonate at a ratio of 1 : 5 (soybean : water) for 12 hours. The beans were then cooked (70 – 80°C) for 5 – 10 min, cooled in running water, and ground in a gristmill until dough was obtained. The dough was placed in a homogenizer and coconut water at the ratio of 1:8 (soybean: coconut water) was added. The ingredients were homogenized for a maximum time of 1 min, which was controlled to prevent the oxidation of the coconut water.

The preparation of the mixed beverage

Four mixed beverage formulations were prepared with two pulp concentrations. Further, two concentrations of soluble solids were tested for each pulp concentration studied, as observed in Table 1. Pulp and sugar were added to the hydrosoluble soybean extract with coconut water until the product was obtained. After formulation, the beverages were submitted to thermal treatment (hot fill process), heated at 90°C for 60 s; still hot, they were placed in 500 mL-glass bottles which were closed with a metal stop.

Table 1. Delineation for the formulation of the mixed beverages.

Treatment	Pulp concentration (%)	Concentration of soluble solids (ºBrix)
F1	25	17
F2	25	25
F3	30	17
F4	30	25

Physicochemical and microbiological analysis.

All physicochemical determinations were performed in triplicate, comprising moisture (%), total solids (g 100 g^{-1}), total acidity (g 100 g^{-1}), reducing sugars (%), total sugars (%), non-reducing sugars (%), pH, total soluble solids (°Brix), and vitamin C (mg 100 g^{-1}) (Instituto Adolfo Lutz, 2008).

The microbiological analyses performed for the mixed beverages were counts of molds and yeasts; coliform determinations, at 35 and 45°C; detection of *Salmonella* sp., according to methodologies described in Apha (American Public Health Association, 2001).

Sensory analysis

Acceptance tests were conducted in individual booths with 120 non-trained panelists. Beverage samples were served to the panelists at consumption temperature (16 – 18°C) in acrylic glasses (50 mL), with guidance to complete the answer sheet. Sensory acceptance tests for color, flavor, aroma and overall acceptance were applied, using a 9-point hedonic scale from 'I disliked extremely' (score 1) to 'I liked extremely' (score 9); a 5-point hedonic scale from 'I certainly would not buy the product' (score 1) to 'I certainly would buy the product' (score 5) was used to evaluate purchase intention

(Dutcosky, 2007). Current assay was approved by the Committee for Ethics in Research of the Catholic University of Pernambuco – UPE (Approval # CEP 687.015/2014).

Statistical analysis

Significance analysis of the independent variable effects on the physical and physicochemical characteristics were analyzed by Statistical 7.0 (Statsoft Statistica for Windows, 2007) through the analysis of variance (ANOVA); Tukey´s test at 5% significance level was applied for score averages to identify significant differences between the samples tested and standard sample.

Results and discussion

Physicochemical and microbiological analyses

Since the mixed beverage made from umbu, coconut water, and hydrosoluble soybean extract is a new product, no reference on its physicochemical characterization occurs in the literature. Rates in Table 2 are among the estimated values for products from fruits, according to Nepa (Núcleo de Estudos e Pesquisas em Alimentação, 2006).

Table 2. Physicochemical and chemical characterization of the mixed beverage.

Parameter	Mixed drink			
	F1	F2	F3	F4
pH	3.06b+0.21	3.08b+0.15	3.26a+0.40	3.23a+0.20
Acidity (%)	1.05a+0.02	1.01a+0.04	0.89b+0.00	0.88b+0.02
Moisture (%)	83.47b+0.08	85.25a+0.12	74.75c+0.02	71.29d+0.38
Soluble solids (ºBrix)	17.08b+0.10	25.10a+0.00	17.20b+0.30	25.18a+0.00
Ascorbic acid	5.83c+0.26	4.29d+0.25	4.90a+0.28	5.17b+0.28
Total sugar (%)	11.06c+0.04	15.80b+0.01	10.44d+0.15	17.52a+0.02
Reducing sugars (%)	3.75a+0.05	3.74a+0.02	3.35c+0.00	3.50b+0.02
Non-reducing sugars (%)	7.31c+0.06	12.06b+0.03	7.09c+0.15	14.02a+0.03

Rates in the same row followed by the same letter are not significantly different by Tukey´s test at 5% probability ($p \leq 0.05$).

As observed by Lima, Maia, Sousa, Silva, and Figueiredo (2008), who developed a mixed drink made from coconut water and acerola (*Malpighia glabra*) juice, current authors verified that the formulations with the same concentration of pulp (F3 and F4) had the highest rates in total titratable acidity and vitamin C, whereas mixed beverages prepared from lower pulp concentrations (F1 and F2) had the lowest results in total titratable acidity.

The above contrast was expected since the high addition of hydrosoluble soybean extract with coconut water in the beverage formulations provided a higher dilution of organic acids from the pulp. In a study on nectars of graviola (*Annona muricata*), sweetened with honey, with pulp at different concentrations, Santos, Moreira, Oliveira, and Santos (2014) also observed the same behavior.

Although there is no legislation (Brasil, 2003) for mixed beverages with umbu, coconut water and hydrosoluble soybean extract, current authors reported that all formulations had more than 8.0% of total sugar, which is the minimum specified rate for the nectar of cajá (*Spondias mombin* L), since there is no specification for mixed beverages from umbu. In the case of sugars, the rates were close to those registered by Mattieto, Lopes, and Menezes (2007) for the development of mixed nectar made from umbu and cajá (respectively 14.15; 5.24; 8.91).

Further, pH rates lay between 3.06 and 3.26, higher than those for umbu pulp, reported by Carmo, As, Almeida, and Swarnakar (2012), 2.3, Santos et al. (2013), between 2.4 and 2.5, Oliveira, Borges, Furtado, Modesta, and Godoy (2011), who reported pH at 2.95. Results were higher than the ones reported by Lima, Mélo, and Maciel (2003) for mixed nectars of umbu-cajá (*Spondias* spp.) (2.29 to 2.41), but close to results registered by Silva, Prudencio, Felberg, Deliza, and Carrão-Panizzi (2007) for mixed nectars of mango (*Mangifera indica* L) and cajá (3.13 to 3.20). Although the prepared beverage has a pH rate higher than the rates reported by other authors and not regulated by Brazilian legislation, the product may still be considered safe for consumption, because *Clostridium botulinum* growth is not possible at the above pH rate.

Although all samples presented statistical difference at 5% significance level (Tukey´s test) for vitamin C, it was observed that for beverages with the same concentration of pulp, the rates were close as may be observed in F1 and F2, and F3 and F4. Reduction may be justified by the dilution of the pulp in its formulation and by temperature on the enzymatic inactivation during pasteurization.

Table 3 show the results of the microbiological analyses for the four formulations.

Table 3. Results of microbiological analysis for mixed nectar samples.

Analysis	Results			
	F1	F2	F3	F4
Coliforms 35ºC (NMP g^{-1})	1 x 10	1.5 x 10	2.2	2 x 10
Thermotolerant coliforms at 45ºC (NMP g^{-1})	0	0	0	0
Molds and yeasts (UFC g^{-1})	2 x 10	1.0 x 10	1.5 x 10	1.2 x 10
Salmonella sp.	Absent	Absent	Absent	Absent

According to RDC no. 12 published on January 2, 2001, the Brazilian National Health Surveillance Agency (Anvisa) regulated the microbiological standards for non-alcoholic beverages and determined coliforms at 45ºC and *Salmonella* as standard analysis. Decree n. 451 published on September 19, 1997, determines the maximum

number of molds and yeasts for juices and soft drinks *in natura* (Mattieto, Lopes, & Menezes, 2007).

Mixed beverages, evaluated prior to sensory analyses, presented mold and yeast counts lower than 2 x 10 UFC g^{-1}, coliform rates at 35ºC, lower than 2.2 MPN g^{-1}, and no coliforms at 45ºC. *Salmonella* sp was not detected. The product complies with federal legislation.

The microbiological quality of the samples indicated that the hygiene-sanitary conditions of processing were satisfactory and that thermal treatment was effective to preserve the products, which were kept under refrigeration (5 – 9°C) due to coconut water in the formulation.

Sensory analysis

Figure 1 shows the panelists' profile (55 female and 45% male) with regard to age, educational level and consumption frequency.

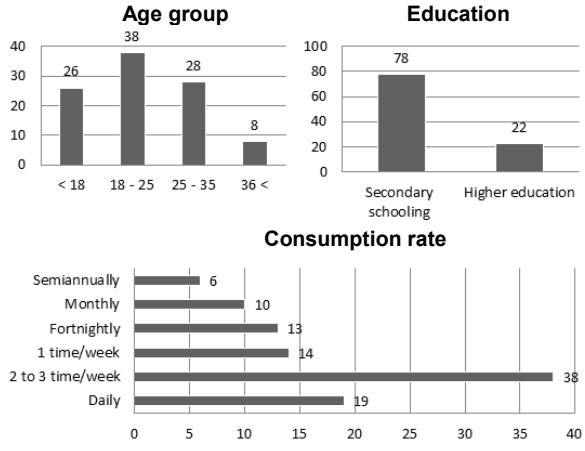

Figure 1. Results of the evaluation of panelists' profile with regard to age, educational level, and consumption frequency, expressed in percentages (%).

The predominant age ranged between 18 and 25 years old (38%), followed by the 25 – 35 year-old bracket (38%). The above data are excellent since people at these age brackets seek new products and consume them. Panelists in a high school course predominated (78%), and their highest consumption frequency was 2 to 3 times a week. Although umbu is a seasonal fruit, its consumption by the panelists was considered high, possibly due to the availability of the product as pulp.

Table 4 presents results for the evaluated attributes, namely, color, aroma, sweetness, flavor, appearance and overall impression.

Average scores for all attributes varied between 5.96 and 7.57, and demonstrated that the panelists liked all the juice formulations provided. With regard to the overall impression on the samples, there was no significant difference at 5% significance level. All samples lay within the approved scale (% of scores between 6 and 9), following Borges, Prudêncio, Roberto, and Assis (2011).

Table 4. Averages, standard deviations and Tukey´s test ($p \leq 0.05$) for the four mixed beverage samples.

Attribute	Mixed Drink			
	F1	F2	F3	F4
Color	6.57 + 1.73b	6.86 + 1.69ab	7.17 + 1.69ab	7.25 + 1.40a
Appearance	6.55 + 1.77a	6.78 + 1.81a	7.12 + 1.44a	7.05 + 1.48a
Aroma	6.36 + 1.92a	6.46 + 1.91a	6.78 + 1.54a	6.90 + 1.57a
Honey	5.83 + 1.31b	6.32 + 1.17b	6.26 +1.99b	7.57 +1.01a
Flavor	6.01 + 1.20b	7.54 +1.16a	6.42 +1.02b	6.95 +1.18ab
Overall impression	6.18 +1.16a	6.96 +1.97a	6.36 +1.18a	6.38 +1.90a

Rates in the same row followed by the same letter are not significantly different by Tukey´s test at 5% probability ($p \leq 0.05$).

According to the analysis of variance results, there was a significant difference ($p < 0.05$) with regard to the degree of liking or disliking the mixed beverages. It is common in tests with consumers that they differ on the degree of liking or disliking an evaluated sample (Valim, Marcellini, Cavalheiro, Demarchi, & Serafim, 2011). Samples with the worse results were those that had the lowest content of pulp and the lowest concentration of soluble solids, with no significant difference when compared to the other samples.

The color of a product is important because it is related to attractiveness highly appreciated by consumers (Matsuura & Rolim, 2002). In the case of color, F1 (6.57) was the only sample that differed significantly from the others, but with rates close to those of F2 (6.86), both with the same concentration of pulp, which may be an influencing factor in the given average score. Similar rates for color (6.96) were reported by Mattieto, Lopes, and Menezes (2007) in their study with mixed nectar of cajá and umbu. The above demonstrated that the use of hydrosoluble soybean extract does not influence color acceptance by the consumer.

In the case of sweetness, there was a significant difference between samples F4 (7.57) and F1, F2 and F3, perhaps due to the fact that F4 contains the highest concentration of soluble solids and pulp in its formulation. Similar results were observed in a study by Branco et al. (2007), who developed a drink made with hydrosoluble soybean extract, strawberry pulp and sucrose, and noticed that the higher the concentration of sucrose, the higher the influence in flavor acceptance of the product with lower pulp concentrations.

In the case of flavor, F2 (7.94) had the highest rate when compared to the other samples, lying between the hedonic terms 'I liked slightly' and 'I liked a lot'. According to variance analysis, there was a significant difference in flavor between samples

F2, and F1 and F3, at a significance level of 5%. Similar results were evidenced by Torrezan et al. (2004), who reported averages between 7 and 8 in studies performed with soybean beverage with orange flavor. Studying the sensory evaluation of beverages with different proportions of rice-soy extract. Although there was no significant difference among the samples with regard to overall impression, the highest score for F2 may be confirmed by the result observed for flavor attribute.

There was no significant difference among samples with regard to appearance and aroma parameters.

The results obtained for purchase intention are shown in Table 5.

Table 5. Average scores for purchase intent of mixed beverage from hydrosoluble soybean extract, coconut water, and umbu pulp.

Attribute	Mixed beverage			
	F1	F2	F3	F4
Purchase intent	2.52 +1.85b	3.92 + 1.77a	3.07 +1.55b	3.16 +1.49b

Rates in the same row followed by the same letter are not significantly different by Tukey´s test at 5% probability ($p \leq 0.05$).

F2 formulation had a higher score for acceptance when compared to that of other samples, differing from them at a significant level of 5%. It confirmed the greater acceptance of this formulation by the panelists, with regard to color and overall impression. Percentages of all formulations stood within the approval of the product.

Conclusion

Physicochemical and microbiological rate indicated that the four developed formulations comply with current legislation, prepared under good hygienic-sanitary conditions, with effective thermal treatment.

The mixed beverages, made from hydrosoluble soybean extract, coconut water and umbu pulp, had a good sensory acceptance, in which the beverage with the lowest concentration of pulp (25%) and the highest soluble solids (25º Brix) was the best accepted by the panelists. The addition of hydrosoluble soybean extract to the coconut water did not reduce consumers´ approval. The above mixture of ingredients may have a good market potential which should be explored.

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