

# Elaboration of a water-soluble extract of soybean flavored with brazilian native fruits

## Elaboración de un extracto hidrosoluble de soya aromatizado con frutas nativas de Brasil

Thales Henrique Barreto Ferreira<sup>a</sup>; Isna Nogueira Faria<sup>b</sup>; Rita de Cássia Avellaneda Guimarães<sup>b</sup>; Cláudia Leite Munhoz<sup>a</sup>

### ABSTRACT

**Background:** Studies have shown the functionality of soybeans, when is added fruits, especially brazilians native fruits. **Objetivo:** The objective of the present work was to develop a drink based on water-soluble soybean extract flavored with two native fruits from Brazil: bocaiuva and genipapo. **Methods:** The experimental development was carried out in stages: obtaining soybean extract, adding bocaiuva pulp and genipapo, and physical, chemical and sensorial analyses. The extract was obtained from the soybean and water mixture in a proportion of 1: 2 and subsequent heat treatment. The physical and chemical analyses were acidity, pH, soluble solids, moisture, ashes, carbohydrates, proteins, lipids, fibers, sodium, potassium, calcium, iron, phosphorus, manganese. Sensory analysis of beverage acceptability was also performed. **Results:** The means found in the characterization of the beverages flavored with bocaiuva and genipapo were, respectively, acidity 0.26% and 0.51%, pH 6.6 and 5.7, soluble solids 4° Brix and 5° Brix, moisture 90.03% and 91.31%, proteins 2.66% and 3.56 %, lipids 2.13% and 1.09%, ash 0.23% and 0.20%, fibers 0.97% and 0.93%, carbohydrates 3.98% and 3.09%, minerals, in mg.100g<sup>-1</sup>, sodium 51.77 and 58.31, potassium 49.66 and 36.30, iron 3.21 and 7.55, manganese 2.44 and 19.03, phosphorus 21.17 and 10.12, and calcium 13.19 and 9.09. The beverages have received good sensory acceptance, with notes for attributes in the majority above 6. **Conclusion:** Drinks can be considered as food: of high protein content, of iron, and of manganese, and can be considered of nutritive value.

**Keywords:** Bocaiuva, genipapo, functional drink, minerals

**Antecedentes:** Estudios han demostrado la funcionalidad de la soja, cuando se le añaden frutas, especialmente frutas nativas de Brasil. **Objetivo:** desarrollar una bebida a base de extracto de soja hidrosoluble saborizada con dos frutas nativas de Brasil: bocaiuva y genipapo. **Métodos:** El desarrollo experimental se realizó en etapas: obtención del extracto de soja, adición de pulpa de bocaiuva y genipapo, y análisis físicos, químicos y sensoriales. El extracto se obtuvo a partir de la mezcla de soja y agua en una proporción de 1:2 y posterior tratamiento térmico. Los análisis físicos y químicos incluyeron acidez, pH, sólidos solubles, humedad, cenizas, carbohidratos, proteínas, lípidos, fibras, sodio, potasio, calcio, hierro, fósforo y manganeso. También se realizó análisis sensorial de aceptabilidad de la bebida. **Resultados:** Las medias encontradas en la caracterización de las bebidas saborizadas con bocaiuva y genipapo fueron, respectivamente, acidez 0,26% y 0,51%, pH 6,6 y 5,7, sólidos solubles 4° Brix y 5° Brix, humedad 90,03% y 91,31%, proteínas 2,66% y 3,56%, lípidos 2,13% y 1,09%, cenizas 0,23% y 0,20%, fibras 0,97% y 0,93%, carbohidratos 3,98% y 3,09%, minerales, en mg.100g<sup>-1</sup>, sodio 51,77 y 58,31, potasio 49,66 y 36,30, hierro 3,21 y 7,55, manganeso 2,44 y 19,03, fósforo 21,17 y 10,12, y calcio 13,19 y 9,09. Las bebidas han recibido una buena aceptación sensorial, con notas de atributos en su mayoría superiores a 6. **Conclusión:** Las bebidas pueden considerarse alimentos: de alto contenido proteico, de hierro y de manganeso, y pueden considerarse de valor nutritivo.

**Palabras clave:** Bocaiuva, genipapo, bebida funcional, minerales

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University of Antioquia  
Medellin, Colombia

### Affiliations

<sup>a</sup>Federal Institute of Mato Grosso do Sul (IFMS), Coxim campus, Street Salime Tanure. Santa Teresa. CEP: 79.400-000 - Coxim, MS, - Brazil.

<sup>b</sup>Federal University of Mato Grosso do Sul (UFMS), Faculty of Pharmaceutical Sciences, Food and Nutrition (FACFAN), Campo Grande/MS – Brazil

### \*Corresponding

Thales Henrique Barreto Ferreira  
[thales\\_barreto25@hotmail.com](mailto:thales_barreto25@hotmail.com)

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## INTRODUCTION

The growing consumer concern about changing their eating habits, seeking products that offer health benefits, requires the development of new product lines with nutritional characteristics. Foods made from soybeans make important contributions to a healthy diet, as they are rich in high-quality proteins, have low saturated fat content, and are cholesterol-free (1). Currently, there are several studies about the use of soy in the preparation of food products such as beverages based on flavored soy extract, fermented beverages, and ice creams (2, 3).

The addition of water-soluble soy extract in fruit juices is becoming increasingly frequent in the international market, and indicates a change in the attitude of consumers towards products that, consumed in this way, little resemble the original taste of soy milk (4). Fruit juices added with soy have great potential for growth, as it reconciles desirable sensory characteristics of fruits with functional properties of soybean (5).

Currently, the biodiversity of plant resources is considered a strategy for food, economic, and ecological security for humanity. Thus, it is imperative to study the biodiversity of Brazil, especially the fruit species, in order to know the nutritional, genetic, and technological potential of those fruits, which will certainly contribute to the preservation and sustainable use of the species (6, 7).

Among the native fruits that present potential for technological use of food bocaiuva (*Acrocomia aculeata* (Jacq.) Lodd ex Mart.) and genipapo (*Genipa americana* L.), this is due to the fact that both present sensory characteristics of interest to consumers, in addition to a nutritional composition rich in nutrients and compounds beneficial to the body (8, 9).

The species *Acrocomia aculeata* (Jacq.) Lodd ex Mart. is a palm native to tropical forests widely distributed in Brazil. The pulp has high nutritional value due to its high lipid content, carbohydrates, fiber, and proteins, which are also sources of vitamin A, carotenoids, fatty acids, and antioxidant properties; these are important for human health as they confer resistance to the immune system against infections and diseases in general. (10, 11, 12, 13, 14, 15).

The genipapo (*Genipa americana* L.) is a native plant from Brazil. It has a juicy pulp with a pronounced,

characteristic flavor, and fibrous, flattened seeds with high antioxidant activity, calcium, and iron; these characteristics of the fruit can contribute to the reduction of infant malnutrition (16, 17, 18, 19, 20). The fruits are rich in genipin, a low-toxicity iridoid compound that can develop blue coloration (9).

The objective of this work was to develop water-soluble soybean beverages flavored with fruits of the Brazilian Cerrado biome, to ally the potential beneficial effects of soybean with the nutrients of bocaiuva and genipapo fruits.

## MATERIALS AND METHODS

The experimental tests were carried out at the Food and Chemistry Laboratory of the Federal Institute of Mato Grosso do Sul (IFMS).

The fruits of bocaiuva and genipapo were collected in the municipality of Coxim, State of Mato Grosso do Sul, Brazil, between September and October, 2016. The fruits were harvested at the appropriate stage of ripeness, as observed by the fruit's sensory characteristics, such as peel color and firmness. After the fruits were washed, they were sanitized by immersion in sodium hypochlorite solution at 200 ppm for 10 min. Then the fruits were manually pulped with the use of stainless steel knife. The bocaiuva and genipapo pulps were packed separately in polyethylene packages, hermetically sealed, and kept under refrigeration (-18 °C) until use.

The water-soluble soy extract was elaborated from the de Ferreira et al. (5). The previously selected soybeans grains were submitted to thermal treatment in boiling water for three minutes for inactivation of the enzyme lipoxygenase, responsible for the flavors described as bitter, astringent and rancid. After the treatment, the peels were removed manually by friction of the grains. The peeled soybean grains were ground with potable water in a household blender in a soybean: water ratio of 1 2 (m/v). The mixture was again subjected to the heat treatment (90°C) for 60 min to reduce the activity of trypsin inhibitors. After the treatment time, the filtration was carried out by separating the water-soluble extract from the residual pie. The water-soluble soybean extract prepared was flavored with genipap pulp and bocaiuva in a 1:5 (pulp:extract) ratio and sweetened with crystal sugar (3%). After homogenizing the water-soluble extract with the pulps and sugar, the beverage was pasteurized for one minute at 100°C.

## NUTRITIONAL COMPOSITION

The extracts were evaluated, and moisture was determined by drying the sample in an air-circulation oven (Tecnal, model TE-394/L) at 105°C to constant weight. Moisture was calculated as the difference in mass of the sample before and after drying, and the result was expressed as a percentage of moisture. Ash was determined by incineration in a furnace at 550°C until constant weight. These analyses were performed in triplicate according to the method described by (21). Proteins were determined using the Micro Kjeldahl method with a factor of 6.25. Lipids were analyzed using the Soxhlet method according to AOAC protocols (21). Total dietary fiber was obtained according to the enzymatic-gravimetric method (21). Total carbohydrate was determined by the difference method: 100 - (weight in grams [moisture + ash + protein + total fat + total dietary fiber in 100 g of food]). The total energy was calculated from the nutrient energy results using the Atwater conversion factors, as described by Merrill & Watt (22), with 4 kcal/g for carbohydrate, 4 kcal/g for protein, and 9 kcal/g for lipids.

## PHYSICAL AND CHEMICAL ANALYSIS

Acidity was determined by titration with 0.1 N NaOH, and the results were expressed in grams of citric acid per 100g.<sup>-1</sup> The pH was determined by direct reading on the potentiometer, calibrated in standard solutions of pH 4.0 and 7.0. The total soluble solids content was determined at 20 °C using a manual refractometer, and the results were expressed in °Brix.

## COMPOSITION OF MINERALS

The mineral content was determined from the fixed mineral residue in a dry sample by acid digestion with concentrated nitric acid according to Salinas and Garcia (23). The levels of sodium, potassium, iron, manganese, phosphorus, and calcium were determined in an atomic absorption spectrophotometer (Shimadzu, model AA-7000 Series).

## SENSORY EVALUATION

The study was authorized by the Ethics Committee for Humans (CAAE: 57301715.1.0000.5162, Opinion Number: 1.628.085), the consent form was made available to the judges, and the analysis was

performed only after their agreement. Acceptance tests were performed with 60 untrained judges. The acceptability of the samples was evaluated by means of a hedonic scale of 9 points ranging from 1 (greatly disliked) to 9 (liked it very much). Attributes evaluated were appearance, color, aroma, texture, flavor, fruit flavor, sweetness, and overall quality. Each judge should also indicate the purchase intention for the samples evaluated, on a five-point scale ranging from "certainly buy" to "certainly not buy" and how often the product is consumed (Dutcosky, 2013). Drinks with a mark equal to or greater than six points (liked it slightly) are considered accepted.

## STATISTICAL ANALYSIS OF RESULTS

The results were evaluated through descriptive statistics (mean and standard deviation) and difference test (Tukey  $p < 0.05$ ). For analysis, Variance Analysis ( $p < 0.05$ ) was applied.

## RESULTS AND DISCUSSION

The physical and chemical characterizations of the water-soluble extracts of soybean with bocaiuva pulp and of genipap are in Table 1.

**Table 1.** Physical and chemical characterization of water-soluble soybean extracts flavored with bocaiuva and genipapo.

Analyzes	EHS	EHSB	EHSG
pH	6.8 ± 0.1	6.6 ± 0.2	5.7 ± 0.1
Soluble solids (°Brix)	4.0 ± 0.1	4.0 ± 0.2	5.0 ± 0.1
Acidity (g of citric acid 100g <sup>-1</sup> )	0.1 ± 0.01	0.26 ± 0,05	0.51 ± 0.03

EHS: water-soluble soybean extract; EHSB: water-soluble soybean extract flavored with bocaiuva; EHSG: water-soluble soybean extract flavored with genipapo.

The pH values found for soybean and fruit pulp beverages varied from 5.7 to 6.6 and were lower than that of pure soybean extract (6.8), probably due to the acidity of the fruit pulp. The values found were lower than those reported by Ferreira et al. (5), who analyzed soy-based drinks with tropical fruit trademarks, and these beverages contain acidulants, which justifies the difference in results. The acidity expressed as citric acid for the soy-based drinks made with bocaiuva and genipapo pulp was 0.26 and 0.51 g.100g<sup>-1</sup>, respectively. In contrast, for the soybean extract, the acidity was 0.10 g.100g<sup>-1</sup>, corroborating the observed pH values.

The beverages containing fruit pulp showed soluble solids content between 4 and 5 ° Brix, being lower than the levels found by Ferreira et al. (1).

Table 2 shows the nutritional composition of the soybean water-soluble extracts flavored with bocaiuva and genipapo. Products obtained by mixing soybeans with fruits are an excellent alternative for utilizing these raw materials, as they produce foods with added nutritional value and significantly improved sensory characteristics (24).

The carbohydrate content ranged from 3.09 to 3.98 g.100g<sup>-1</sup>. Abreu et al. (25) reported much higher values for soybean extracts with tropical fruits, and the samples used in their research were trademarks, which indicates the extensive use of sugars in industrial products. Rodrigues and Moretti (24) also found higher values for beverages flavored with peach pulp (13.18 %) the difference can be explained by the difference of sugars in the fruit pulp, in addition to the amount of sugar used in the formulation (10 % of sucrose).

Regarding protein content, the beverage with added genipapo pulp had higher values than those of bocaiuva. Rodrigues and Moretti (24) reported similar values for protein drink made with soybean and peach extract. Abreu et al. (25) found much lower values for commercial extracts (0.1-0.9 %).

**Table 2.** Nutritional composition of water-soluble soybean extracts flavored with bocaiuva and genipapo.

Components (g/100g <sup>-1</sup> )	EHSB	EHSJ
Moisture	90.03 ± 0.03 a	91.31 ± 0.01 a
Ash	0.23 ± 0.01 a	0.20 ± 0.02 a
Proteins	2.66 ± 0.01 a	3.26 ± 0.02 b
Lipids	2.13 ± 0.01 a	1.09 ± 0.02 b
Total dietary fiber	0.97 ± 0.02 a	0.93 ± 0.01 a
Carbohydrate	3.98 ± 0.02 a	3.09 ± 0.01 a
Total energy (kcal.100g <sup>-1</sup> )	45.73 a	35.21 a

EHSB: water-soluble soybean extract flavored with bocaiuva; EHSJ: water-soluble soybean extract flavored with genipapo. Data presented as mean ± standard deviation. Same letters in the row are not significantly different ( $p > 0.05$ ).

The lipids were higher in the bocaiuva extract, which was already expected since the bocaiuva fruit has a high amount of lipids in the pulp. Soares-Júnior et al. (26) presented a value for flavored extract with passion fruit (1.06 %), similar to that of genipapo. In the work of Felberg et al. (27), soybean extract with Brazil nut lipid contents of 4.18%, superior to those of this work.

The ash contents were similar for the two flavors, but were lower than those reported by other authors (27, 9). The total energy value was lower than that reported by Soares-Júnior et al. (26), 75 kcal.100 g<sup>-1</sup>. This is especially due to the higher amount of sugar used in the formulation.

The compositions of minerals are shown in Table 3. The composition of minerals between the flavored extracts with bocaiuva and genipapo was statistically different.

Felberg et al. (27) reported, for soybean extract with Brazil nuts, similar values of iron and manganese (3.12 and 2.07 mg.100g<sup>-1</sup>) to the flavored beverage with bocaiuva. Soares-Júnior et al. (26) reported that the passion fruit extract contains twice the amount of iron found in the extract with genipapo.

Furtado et al. (3) reported lower potassium, iron, and phosphorus values for soluble soy extracts (0.10, 1.27, and 0.07 mg.100g<sup>-1</sup>) than those in this study. The addition of bocaiuva and genipapo fruits contributed to the mineral enrichment of the beverages.

The daily recommended portion for soybean extract is 200 mL (28). Thus, a portion of water-soluble soybean extract flavored with bocaiuva provides, according to Brazil (29), for children from 4 to 6 years: 28 % of proteins, 4,4 % of calcium, 107 % of iron, 8.5 % of phosphorus, and 325.3 % of manganese. In turn, the water-soluble extract of soybean flavored with genipapo provides, according to Brazil (29), for children from 4 to 6 years: 37.5% of proteins, 3.03 % of calcium, 251.7 % of iron, 4.1 % of phosphorus, and 2573.3 % of manganese. It emphasizes that these percentages are in accordance with the recommended daily values for children's diets, considering a total of 100% of each listed mineral.

**Table 3.** Composition of minerals (mg.100g<sup>-1</sup>) of water-soluble soybean extracts flavored with bocaiuva and genipapo.

Minerals	EHSB	EHSJ
Sodium	51.77 ± 0.12 a	58.31 ± 0.01 b
Potassium	49.66 ± 0,08 a	36.30 ± 0.04 b
Iron	3.21 ± 0.03 a	7.55 ± 0.01 b
Manganese	2.44 ± 0.07a	19.03 ± 0.01 b
Phosphorus	21.17 ± 0.17 a	10.12 ± 0.02 b
Calcium	13.19 ± 0.14 a	9.09 ± 0.01 b

EHSB: water-soluble soybean extract flavored with bocaiuva; EHSJ: water-soluble soybean extract flavored with genipapo. Data presented as mean ± standard deviation. Same letters in the row are not significantly different ( $p > 0.05$ ).

A food is considered to have a high protein content when it contains more than 12.0 g.100 g<sup>-1</sup> and as a source when its content is above 6.0 g.100 g<sup>-1</sup>. Therefore, the drink based on water-soluble soybean extract flavored with bocaiuva can be considered as a source of protein, and flavored with genipapo as high protein content (28).

About minerals, a food is considered to have a high mineral content when it contains at least 30% of the Recommended Dietary Allowance (RDA) of reference in 100g and as a source when its content is at least 15% (28). Thus, beverages flavored with bocaiuva and genipapo can be considered to have a high content of iron and manganese.

The results of the sensory evaluation are found in Table 4. It was observed that the samples differed statistically only in the attributes of overall appearance and quality, with the extract with bocaiuva having a slightly higher note than the drink with genipapo. Regarding the evaluated attributes, the majority obtained averages above 6, which is considered acceptable for consumption (30).

EHSB obtained an average overall score of 6.92 and an acceptability index (AI) of 77%, while EHSJ obtained an average overall score of 6.38 and an acceptability index (AI) of 77%. According to Ferreira et al. (2), products with an AI above 70% have positive effects and are considered acceptable by the tasters.

The frequency of consumption reported by 48% of the judges indicated that soy products were consumed rarely. The intention to purchase the bocaiuva drink was 40% for "Maybe I would buy / maybe not buy" and 22% indicated that if they found the product on the market they would buy.

**Table 4.** Acceptability means of water-soluble soybean extracts flavored with bocaiuva and genipapo.

Attributes	EHSB	EHSJ
Appearance	6.76 a	6 b
Color	6.72 a	6.34 a
Aroma	5.84 a	5.86 a
Texture	6.12 a	6.00 a
Flavor	5.62 a	5.58 a
Fruit flavor	6.02 a	5.34 a
Sweetness	6.96 a	6.34 a
Overall quality	6.92 a	6.38 b

EHSB: water-soluble soybean extract flavored with bocaiuva; EHSJ: water-soluble soybean extract flavored with genipapo. Data presented as mean ± standard deviation. Same letters in the row are not significantly different ( $p > 0.05$ ).

## CONCLUSION

Fruit drinks with soy products have much potential for growth because they combine the desirable sensory characteristics of the fruits with the functional properties of soy in proteins. The association between the soybean water-extract and the native fruit pulp, besides adjusting sensorial defects (taste, color, and viscosity) and correcting the juice composition (adjusting acidity, viscosity, and other properties), the mixtures can use juice as the vehicle of essential nutrients such as proteins, minerals, especially iron and calcium. These beverages can be an important key in combating malnutrition, especially child malnutrition.

Also, other studies could build on this one by including a more detailed analysis of the fruit itself and its direct relationship to the extract, in addition to chromatographic analyses.

**Conflicts of interest:** There is no conflict of interest in conducting this study.

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