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Full Length Research Paper

Mineral profile of cagaita (*Eugenia dysenterica*), mangaba (*Harconia speciosa*), and mama-cadela (*Brosimum gaudochaudii* Trecul) seed flours subjected to different drying temperatures and times

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ABSTRACT

Of the many native species of economic and nutritional importance found in the Savannah Brazilian, we highlight the cagaiteira (*Eugenia dysenterica*) mangaba (*Harconia speciosa*) and mama-cadela fruit (*Brosimum gaudochaudii*), whose fruits and seeds have excellent amount of biocompounds as minerals. The minerals may have significant roles in human metabolism, acting on bone formation, chemical constituents, can play antioxidant, among other functions that can be performed by them. Therefore, the aim of this study was to analyze chemically the flour of cagaita, mangaba and mama-cadela seeds. The seeds were dried at 60 °C and roasting at 110 °C and 130 °C for 10, 20 and 30 minutes compared to the seed in nature. After, was carry out analysis of mineral content in each treatment applied being evaluated by atomic absorption spectrometry minerals: calcium copper, sodium, iron, potassium, phosphorus and magnesium. Analyzing the flour obtained from the seeds of the fruits, it was observed that the applied treatments compared to the control, significantly influenced the content of minerals present in flour, with emphasis the high levels detected for potassium, phosphorus and magnesium, and flour a good way to use and add value to the savannah fruits.

Keywords: Eugenia dysenterica, drying, roasting, Savannah Brazilian, bioactive compounds.

INTRODUCTION

Native fruit species of the Cerrado are considered good sources of vitamins and minerals, and can contribute not only to the availability of essential nutrients, but also as revenue resources, assisting in the socio-economic development of the region (Silva et al., 2014). Brazilian Cerrado is the second largest biome in South America, second in size to the Amazon rainforest (Cardoso et al.,2011), considered the richest savanna in the world due to its vegetation biodiversity (Mendonça et al., 2008).

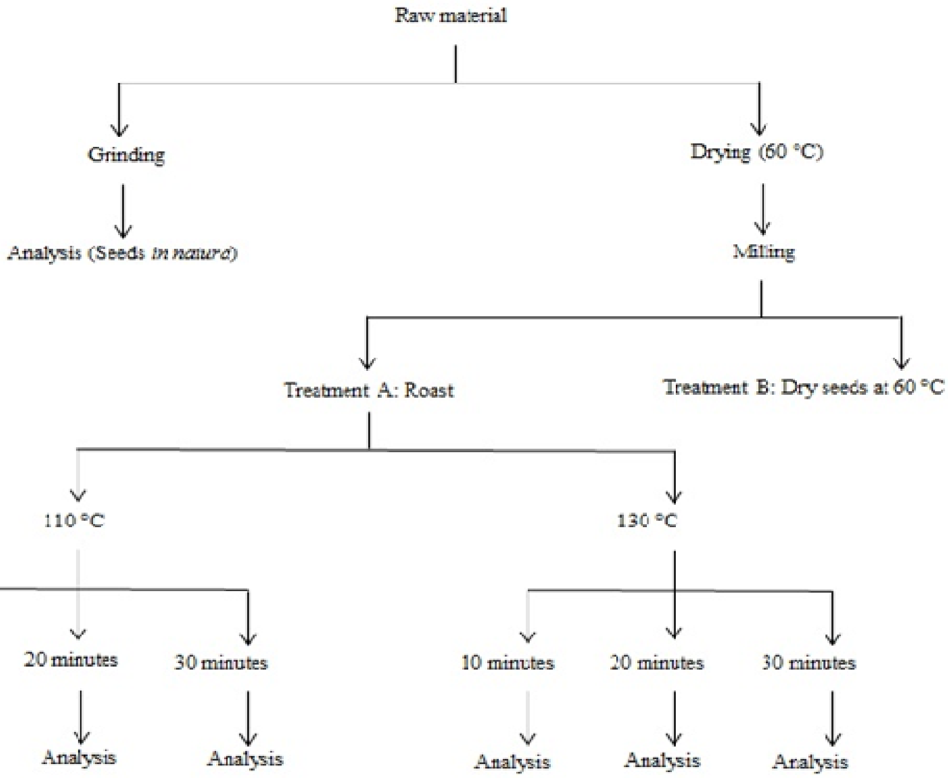

Figure 1. Manufacturing process of *cagaita, mama cadela,* and *mangaba* seed flours

Fruits are a source of functional compounds with beneficial properties, including minerals, which contributes to their application in the food industry, focusing on developing new products and promoting the sustainability of regions with predominance of Cerrado physiognomies (Roesler et al., 2008; Rocha et al., 2013).

Therefore, the study of Cerrado fruits assumes a prominent position, once they contain significant amounts of these nutrients (Rigo et A., 2000; Silva et al, 2016), whether in the peel, pulp, or seeds. The industrialization of these fruits, in turn, generates significant amounts of these compounds that can be used as ingredients in new food formulations as a source of minerals. After dried and roasted, Cerrado fruit seeds can be transformed into flour, and be consumed.

Given the importance of minerals in human metabolism, including calcium and phosphorus, which are important constituents in bone mineralization, the search for new raw materials, rich in mineral compounds is needed, making them available to the population, decreasing the large intake deficits of these important nutrients.

Given the above, this study aimed to evaluate the effect of different drying temperatures and times in the mineral content of *cagaita, mama cadela,* and *mangaba* seed flours.

MATERIAL AND METHODS

Raw materials

Cagaita, mama cadela, and *mangaba* seeds, harvest 2014, were donated by the company Frutos do Brazil, located in Goiania - GO. The samples were cleaned prior to flour manufacture in the Vegetable Processing Plant, at the Food Engineering Sector of the School of Agronomy of the Federal University of Goiás in Goiânia.

Processing of the raw materials

Seeds were washed in running water to eliminate fruit residues, and immersed in 200 ppm chlorine solution for 15 minutes to complete cleaning. Then, they were frozen in fast freezer (IRINOX, M.HCM 141/50), and frozen-stored until flour manufacture. Figure 1 shows the drying

Table 1. Mineral profile of *cagaita* seeds flour subjected to different drying temperatures[1].

Sample	Minerals (mg/100 g sample)						
	Calcium	Lead	Iron	sPhosphorus	Magnesium	Potassium	Zinc
Control	16.1 ± 0.5 a	1.0 ± 0.6 ab	0.08 ± 0.2 a	26.7 ± 1.2 a	12.3 ± 0.4 a	82.0 ± 0.6 a	0.6 ± 0.7 a
T1	32.2 ± 0.8 b	1.4 ± 1.0 ab	0.07 ± 0.6 b	100.0 ± 0 .4 b	34.3 ± 0.7 c	221.1 ± 0.8 b	1.7 ± 1.1 b
T2	32.0 ± 0.3 b	1.4 ± 0.7 ab	0.07 ± 0.1 b	99.0 ± 0.0 b	31.3 ± 1.1 bc	223.0 ± 0.8 b	1.7 ± 0.6 b
T3	35.87 ± 0.7 b	1.8 ± 0.0 b	0.07 ± 0.6 b	92.0 ± 1.5 b	30.0 ± 0.8 b	219.0 ± 0.5 b	1.7 ± 0.4 b
T4	33.8 ± 0.5 b	1.1 ± 0.4 ab	0.06 ± 0.5 b	92.0 ± 0.7 b	30.0 ± 0.5 b	219.0 ± 0.6 b	2.0 ± 0.7 b
T5	35.0 ± 0.1 b	0.6 ± 0.9 a	0.06 ± 0.0 b	94.0 ± 0.3 b	30.0 ± 0.4 b	228.0 ± 1.3 b	1.6 ± 1.4 b
T6	34.0 ± 0.0 b	1.3 ± 0.8 ab	0.06 ± 0.7 b	93.0 ± 0.0 b	30.0 ± 0.1 b	227.0 ± 0.5 b	1.6 ± 1.1 b
T7	34.0 ± 0.2 b	1.1 ± 0.3 ab	0.06 ± 0.0 b	104.0 ± 0 .2 b	30.0 ± 0.8 b	239.0 ± 0.3 b	1.7 ± 0.6 b

[1] Values represent mean ± standard deviation; different letters in the same column differ by Tukey`s test at a 5% significance level (p <0.05).

Table 2. Mineral profile of *mama cadela* seeds flour subjected to different drying temperatures[1]..

Sample	Minerals (mg/100 g sample)								
	Calcium	Lead	Iron	Phosphorus	Magnesium	Manganese	Potassium	Sodium	Zinc
Control	52.3 ± 0.0 a	1.0 ± 1.0 a	0.3 ± 0.6 a	43.0 ± 0.5 a	12.3 ± 0.1 a	0.3 ± 0.8 a	97.0 ± 0.5 a	39.0 ± 1.0 b	0.8 ± 0.9 a
T1	107.0 ± 0.3 b	1.6 ± 0.7 b	1.6 ± 0.5 b	200.0 ± 0.9 b	34.3 ± 0.0 c	1.4 ± 0.7 b	318.0 ± 0.6 b	34.2 ± 0.0 a	3.2 ± 1.0 b
T2	107.0 ± 0.3 b	1.6 ± 0.8 b	2.0 ± 0.5 b	199.0 ± 0.4 b	31.3 ± 0.2 bc	1.4 ± 0.7 b	321.2 ± 0.4 b	34.4 ± 0.4 a	3.1 ± 0.3 b
T3	106.3 ± 0.7 b	1.8 ± 0.3 b	1.3 ± 0.0 b	199.0 ± 0.7 b	30.0 ± 0.5 b	1.4 ± 0.0 b	329.0 ± 0.2 c	31.0 ± 0.4 a	2.4 ± 1.1 b
T4	105.0 ± 0.4 b	1.8 ± 0.3 b	1.3 ± 0.9 b	195.0 ± 1.2 b	30.0 ± 0.8 b	1.3 ± 1.0 b	327.0 ± 0.0 c	28.0 ± 0.2 a	2.2 ± 0.7 b
T5	107.0 ± 0.5 b	1.4 ± 0.0 b	1.3 ± 0.4 b	195.0 ± 1.0 b	30.0 ± 0.3 b	1.3 ± 1.2 b	329.0 ± 0.0 c	34.0 ± 0.0 a	2.5 ± 0.4 b
T6	102.0 ± 0.3 b	1.5 ± 0.1 b	1.3 ± 0.4 b	195.0 ± 0.9 b	30.0 ± 0.3 b	1.3 ± 0.3 b	329.0 ± 0.4 c	29.0 ± 0.7 a	2.7 ± 0.8 b
T7	101.0 ± 0.8 b	1.4 ± 0.4 b	1.1 ± 0.0 b	195.0 ± 0.3 b	30.0 ± 1.0 b	1.3 ± 1.0 b	330.3 ± 0.2 c	28.0 ± 0.7 a	2.4 ± 0.6 b

[1] Values represent mean ± standard deviation; different letters in the same column differ by Tukey`s test at a 5% significance level (p <0.05).

and roasting process at different temperature and time conditions.

Cagaita, mama cadela, and *mangaba* seeds were divided into two batches, for analyses of seeds *in natura* (control sample), and the production of roasted flour. Seeds were dried in an air circulation oven at 60 °C, and ground in an industrial blender after reaching 10% moisture (wet basis). Then, they were divided into two batches A and B, representing roasting at 110 to 130 °C, and drying at 60 °C, respectively. Roasting was carried out in domestic electric oven (Layr, New stylus, 2011). All seed flours were vacuum packed (LDPE / nylon / LDPE), repacked in metallic containers, and frozen-stored at -18 ° C until the time of analysis.

Table 3. Mineral profile of *mangaba* seeds flour subjected to different drying temperatures[1]..

Sample	Minerals (mg/100 g sample)						
	Calcium	Lead	Phosphorus	Manganese	Magnesium	Potassium	Zinc
Control	30.0 ± 0.0 a	1.0 ± 0.7 a	129.2 ± 0.8 a	0.53 ± 0.2 a	35.3 ± 0.9 a	167.0 ± 0.0 a	1.5 ± 0.8a
T1	81.2 ± 0.7 b	1.2 ± 0.0 b	236.0 ± 0.8 c	2.8 ± 0.6 bc	48.1 ± 0.3 b	264.2 ± 0.3 c	3.1 ± 0.4 b
T2	81.0 ± 0.9 b	1.2 ± 0.2 b	238.0 ± 0.4 c	2.8 ± 0.9 bc	48.2 ± 0.3 b	265.0 ± 0.0 c	3.5 ± 0.7 b
T3	81.0 ± 1.1 b	1.2 ± 1.1 b	224.3 ± 0.9 b	2.7 ± 0.7 b	46.6 ± 0.6 b	261.0 ± 1.0 c	3.3 ± 0.0 b
T4	80.2 ± 0.0 b	1.2 ± 0.7 b	223.0 ± 0.0 b	2.7 ± 0.3 b	46.0 ± 1.1 b	257.0 ± 0.2 b	3.4 ± 0.1 b
T5	80.1 ± 0.3 b	1.3 ± 0.0 b	241.1 ± 0.3 c	2.9 ± 0.7 cd	48.0 ± 1.1 b	269.0 ± 0.0 c	3.8 ± 0.7 b
T6	80.3 ± 0.8 b	1.2 ± 0.5 b	236.3 ± 0.0 c	2.9 ± 0.9 cd	47.0 ± 1.2 b	264.4 ± 0.3 c	3.0 ± 0.8 b
T7	81.2 ± 0.3 b	1.2 ± 0.1 b	240.3 ± 0.7 c	2.9 ± 0.7 d	47.0 ± 1.5 b	266.0 ± 0.7 c	3.0 ± 0.9 b

[1] Values represent mean ± . deviation; different letters in the same column differ by Tukey`s test at a 5% significance level ($p < 0.05$).

The physicochemical determinations were performed in the following treatments:

- Control: seeds *in natura*;
- T1 – Treatment 1: drying at 60℃;
- T2 – Treatment 2: roasting in an electric furnace at 110℃ for 10 minutes;
- T3 – Treatment 3: roasting in an electric furnace at 110℃ for 20 minutes;
- T4 – Treatment 4: roasting in an electric furnace at 110℃ for 30 minutes;
- T5 – Treatment 5: roasting in an electric furnace at 130℃ for 10 minutes;
- T6 – Treatment 6: roasting in an electric furnace at 130℃ for 20 minutes;
- T7 – Treatment 7: roasting in an electric furnace at 130℃ for 30 minutes.

Mineral contents

Minerals were determined by Inductively Coupled Plasma Optical Emission Spectrometry, using the software Expert ICP II, according to the methodology described by AOAC (2012). Sample preparation was carried out by nitric-perchloric digestion, by weighting 0.5 g of sample in digestion tube, followed by addition of 6 mL of a mixture of 2: 1 HNO_3 and $HClO_4$ (v / v). The tube was led into the digestion block, and temperature was gradually increased until reaching 210 ° C, presenting a colorless content.

The concentrations of calcium, copper, iron, sodium, potassium, magnesium, and phosphorus were determined by flame emission using an atomic absorption spectrophotometer, Varian SpectrAA 110, calibrated in specific conditions of wavelength, slit, and mixing of the gases for each element. Merck standards for atomic absorption were properly diluted with deionized water, and used for the construction of calibration curves. The analyses were performed in triplicate, and results were expressed as mg / 100 g sample.

Statistical Analysis

A completely randomized design (CRD) with seven treatments and the control was performed. Each treatment was performed in triplicate.
Data were subjected to analysis of variance (ANOVA) at 5% significance level, and means were compared by Tukey`s test. All analyses were performed using the statistical software SISVAR (FERREIRA, 2000).

RESULTS AND DISCUSSION

Tables 1, 2 and 3 show the mineral profile of *cagaita, mama cadela,* and *mangaba* seed flours subjected to different drying temperatures and times. Although different heat treatments have been used for the production of flour from the Brazilian Cerrado fruit seeds, no significant differences were observed among flours, except when compared to the control. An increase in the concentration of all minerals was observed when compared with the control flours. Potassium, calcium, and phosphorus contents stood out in *cagaita, mama cadela,* and *mangaba* flours, with values of 193.87 mg / 100g; 105.04 mg / 100g; and 234.142 mg / 100g, respectively. Minerals have several essential functions in the body, including regulating enzyme activitiy, maintenance of osmotic pressure, transport of nutrients, as constituents of body tissues such as bone and teeth, besides contributing to growth, immune function, and cognitive development (Siqueira et al., 2013; Anderson, 2005). As reported by Rigo et al., (2000), calcium (Ca) and phosphorus (P) are important to fetal and postnatal bone mineralization. The period of greater skeletal development and bone mineralization occurs in the third trimester of gestation when the fetus incorporates large amounts of calcium and phosphorus, on average 120 to 140 mg/kg/per day and 60 to 75 mg/kg/ day, respectively. The Recommended Daily Intake for calcium, phosphorus, and potassium (RDI) for adults is 1000, 700, and 2000 mg, respectively (Brasil, 2005), thus a portion of 100 g of heat-treated *cagaita, mama cadela* and *mangaba* seed flours can contribute to 10.3%, 16.38%, and 3.78% of RDI for adults, respectively.

CONCLUSION

The use of *cagaita, mangaba,* and *mama cadela* seed flours can contribute to minerals availability, such as calcium, phosphorus, and potassium, thus being a viable alternative to complement minerals in human nutrition.

No statistical differences were observed among the samples of this study regarding the heat treatment, thus simple drying under milder temperatures, or the use of intense heat treatment and roasting can provide significant amounts of minerals.

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