Centesimal composition and antioxidant compounds of two fruits from the *Cerrado* (Brazilian Savannah)[1]

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ABSTRACT

This study presents data on the centesimal composition and antioxidant compounds content of two Brazilian Cerrado fruits: *Bromelia balansae* Mez (*gravata*) and *Inga laurina* (Sw) Willd (*inga*). The centesimal composition followed the methodology recommended by the Adolfo Lutz Institute, except for lipids in which the method proposed by Bligh and Dyer was used. The dosage of vitamin C was performed by the spectrophotometric method and the Folin-Ciocalteu method was used for the phenolic compounds. In relation to the centesimal composition, both fruits presented high moisture content. Regarding proteins and lipids, the values found in the experiment were low, as well as the ashes in *Inga laurina* (Sw) Willd. *Bromelia balansae* Mez presented a considerable amount of ashes, on the carbohydrates both fruits are approximate the content found in fruits such as apple (15.2%). As for the antioxidant compounds, the fruits stood out when compared with others of this same biome, especially the phenolics. The selected fruits present considerable phenolic contents. Regarding the nutritional composition, both fruits presented low protein, lipids and caloric content, and the ashes, moisture, and carbohydrates were the most important when compared to other fruits of the same biome. The presence of phenolics and vitamin C make this fruit a promising source of antioxidant compounds whose cultivation should be stimulated.

Keywords: *Bromelia balansae* Mez; gravatá; *Inga laurina* (Sw) Willd; ingá; micronutrients.

RESUMO

Composição centesimal e compostos antioxidantes de dois frutos do Cerrado brasileiro

Este estudo apresenta dados da composição centesimal e de compostos antioxidantes de dois frutos do Cerrado brasileiro: *Bromelia balansae* Mez (gravatá) e *Inga laurina* (Sw) Willd (ingá). A composição centesimal seguiu a metodologia preconizada pelo Instituto Adolfo Lutz, exceto para lipídeos em que foi utilizado o método proposto por Bligh e Dyer. A dosagem de vitamina C foi realizada por método espectrofotométrico e a de compostos fenólicos foi realizada pelo método de Folin-Ciocalteu. Em relação à composição centesimal, ambas as frutas apresentaram elevado teor de umidade, quanto às proteínas e lipídios os valores encontrados foram baixos, assim como as cinzas no ingá. O gravatá apresentou um valor importante de cinzas e sobre os carboidratos, ambos os frutos se aproximaram do teor encontrado em frutas como a maçã (15,2%). Quanto aos compostos antioxidantes, os frutos destacaram-se quando comparados com outros desse mesmo bioma, especialmente os fenólicos. Os frutos selecionados apresentam teores elevados de fenólicos. Quanto à composição nutricional, ambos os frutos apresentaram baixo teor de proteínas, lipídios e valor calórico e ganharam destaque para as quantidades de cinzas, umidade e carboidratos quando comparados com outros frutos do mesmo bioma. A presença de fenólicos e vitamina C fazem deste fruto uma fonte promissora de compostos antioxidantes cujo cultivo deveria ser estimulado.

Palavras-chave: *Bromelia balansae* Mez; *Inga laurina* (Sw) Willd; micronutrientes; ingá; gravatá.

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INTRODUCTION

A few decades ago, the Brazilian Cerrado was considered as unproductive land, destined only for the extraction of firewood and charcoal, in addition to extensive cattle ranching (Durigan *et al.*, 2011). Recently high-technology livestock farming has taken over the already devastated areas, causing a great impact on the local ecosystem (Durigan *et al.*, 2011).

At the same time, incentives to reduce deforestation have increased. However, most of them are faced with the need to move the economic sector so that these areas remain preserved. Thus, the economic application of the flora of this biome is a biodiversity conservation strategy, since the *Cerrado* stands out as the richest savannah in the world, in addition to its potential of contributing to the pharmaceutical and food industries (Myers *et al.*, 2000; Durigan *et al.*, 2011).

The Brazilian savannah is the second largest Brazilian vegetal formation. In addition, it stands out for its variety in fruit species widely used by the local population as the primary ingredient in recipes of ice cream, syrups, sweets and jam (Silva *et al.*, 2008; Lopes *et al.*, 2012).

Information on the physic-chemical characterization and nutritional value of the fruits of this biome represent a stimulus to the knowledge, the consumption and the application in the pharmaceutical and food industries, besides contributing to the conservation of the Cerrado, since predatory and unsustainable exploitation stands out in the local, threatening the survival of the species (Silva *et al.*, 2008; Alves *et al.*, 2014).

Among the studies carried out, some species show less recognition as is the case of *gravatá* (*Bromelia balansae* Mez), also known as *caraguatá*. It is an herbaceous plant that can reach 0.9 m in height. Its fruiting occurs in bunches, it presents hard leaves with thorns on the sides and violet flowers. The skin of the fruits is thin, rough and yellow, the pulp is characterized as white and fibrous with the presence of black and small seeds (Tavares & Ramos, 2010). Another fruit little explored and characterized, but abundant in this biome, is the *ingá* (*Inga laurina* (Sw) Willd), *ingá-mirim* or *ingá-do-cerrado*. It is a legume with rare abundance, its tree can reach 20 m height with dense leaves (Leão *et al.*, 2012; Durigan *et al.*, 2011). Its flowering occurs from August to September and fruiting occurs in November. Its fruit is a slightly curved pod, with a fine peel in a yellowish green shade, varying according to the maturation point (Schulz *et al.*, 2014).

As a result, the objective of this study was to characterize the nutritional composition and determination of antioxidant compounds of two fruits native to Brazilian cerrado (*gravatá* and *ingá*) in order to verify their nutritional potential for possible economic exploitation.

MATERIAL AND METHODS

Material

For the accomplishment of this study, the fruits were collected in the period from May to June 2015. Ripe *Bromelia balansae* Mez fruit bunches were collected in a rural estate in Monte Alto, São Paulo (21º26'S; 48º49'W) and the mature *Inga capitata* fruits were collected from a tree in the city of Jaboticabal, São Paulo (21º25'S; 48º16'W).

As for *Bromelia balansae* Mez, two bunches were collected, one of each plant, with approximately fifty fruits in each of them. In relation to *Bromelia balansae* Mez, 40 fruits were harvested from a single tree. For both fruits, the collection, removal of dirt and packaging in transparent plastic bags were carried out.

The fruits were transported to the bromatology laboratory of the Department of Nutrition of the Universidade Federal do Triângulo Mineiro the day after the harvest in a thermal box containing blocks of artificial ice. In the same laboratory, the fruits (each species separately) were separated from their seeds, decorticated, the resulting pulps were homogenized in a food processor and then stored in 200-g portions in transparent plastic bags for freezing in a freezer and subsequent analyses.

Methods

The centesimal composition of the fruits was determined by means of triplicate analyses of moisture, ashes, total nitrogen, for calculation of crude protein, and total lipids. The methodologies used in the experiment were those recommended by Instituto Adolfo Lutz (2008) except for lipids in which the method proposed by Bligh & Dyer (1959) was used. Total carbohydrates were estimated by difference, subtracting from one hundred the values obtained for moisture, proteins, lipids, and ashes. By means of the centesimal composition, it was possible to estimate the energy value of the samples, considering the Atwater conversion factors of 4; 4 and 9 kcal g^{-1} for protein, total carbohydrates, and lipids, respectively.

The dosage of vitamin C was carried out by colorimetric reaction (Bessey, 1960). In summary, samples of 1 g of fruit were added with 6 mL of 5% trichloroacetic acid (TCA) at 4 °C, homogenized with ultra-turrax and then centrifuged at 1500 rpm for 5 minutes. After aliquots of 0.6 mL of the supernatant were withdrawn in triplicates and 200 µL of a solution of the DTC color reagent were added to them. The DTC solution is prepared using solutions of 2,4-dinitrophenylhydrazine, thiourea and copper sulfate, in the ratio of 20:1:1 (v:v:v). After the addition of the reagent, the samples were placed in a 70 °C water bath for 30 minutes. When the time was over, 1 mL of 65% H_2SO_4 was added to disrupt the reaction. After 15 minutes of the sample kept in the dark, readings were done in a spectrophotometer at

520 nm. The concentration of vitamin C was calculated by a calibration curve of ascorbic acid.

The total phenolic dosage was done by the Folin-Ciocalteu method (Lin & Lai, 2006). Samples of 1 g of fruit were added from 100 mL of 80% ethanol and these were triturated in ultra-turrax keeping on an ice bath. Then, 2.5 mL of a 10% solution of the Folin-Ciocalteu color reagent (Sigma-Aldrich) were added. After being left for a stand for 3 minutes at room temperature, the medium was made alkaline with 2 mL of 7.5% Na_2CO_3 aqueous solution. After the addition of the reagent, the samples were placed in a 50 °C water bath for 5 minutes. The samples were read in a spectrophotometer at 760 nm and the results calculated from a standard curve of gallic acid (GA) and expressed in mg GA 100 g^{-1} sample.

All analyses were performed in triplicate and the results were presented as mean±standard deviation and tabulated using the Excel® 2010 software.

RESULTS AND DISCUSSION

Table 1 shows the values of chemical analysis on a humid basis of the analyzed *Cerrado* fruits.

The results obtained by means of the analyzes of the centesimal composition of the two fruits (Table 1) show that both fruits present high moisture content, as well as that found by Aguiar (1996) for *Inga capitata* Desv. (84.69 g 100 g^{-1} of pulp) and by Tavares & Ramos (2010) for *Bromelia balansae* Mez .(79.42 ± 0.24 g 100 g^{-1}).

The values found for the ashes in *Bromelia balansae* Mez suggest that this fruit is a good source of minerals, the opposite occurs with *Inga capitata*. However, according to Bortolatto & Lora (2008), the values found for ashes may vary according to the locality where the fruits were collected. Since both fruits were from trees that did not receive fertilizers, it is expected that when cultivated and fertilized, they present even more minerals in their composition.

The protein levels found in both fruits demonstrate that they do not excel as major suppliers of such a component as that found by Krumreich *et al.* (2015) for *Bromelia antiacantha* Bertol (0.62 ± 0.15 g 100 g^{-1}).

Table 1: Centesimal composition (g 100 g^{-1} of pulp) and total energy value (kcal 100 g^{-1}) of two Cerrado fruits, on a wet basis

Composition	*Bromelia balansae* Mez	*Inga Laurina*
Moisture[1]	77.74±0.21	85.39±0.24
Ashes[1]	0.94±0.03	0.14±0.017
Protein[1]	0.15±0.01	0.13±0.002
Lipíd[1]	0.0015±0.0001	0.0007±0.0001
Carbohydrates[1]	17.89±0.33	13.52±0.14
Total energy value	108.25	81.91

[1]Values presented as mean ± standard deviation of three replicates/ sample

In relation to the lipid content, the results were close to those found by Aguiar (1996) for the *Inga capita* Desv (0.00 g 100 g^{-1}). On the other hand, the value found by Krumreich *et al.* (2015) (5.07 ± 0.4 g 100g^{-1}) and Santos *et al.* (2009) (18.2 g 100 g^{-1}) for *Bromelia antiacantha* Bertol were greater than the value found in this study for *Bromelia balansae* Mez. According to Krumreich *et al.* (2015) fruits usually have low lipid contents (0.1 to 0.6 g 100 g^{-1}), with the exception of some species, such as avocado (8.4 g 100 g^{-1}). Thus, the analyzed fruits have low lipid content.

By considering the carbohydrate content found by Silva *et al.* (2008) for other Cerrado fruits such as araticum (12.78 ± 0.67 g 100 g^{-1}), *gabiroba* (10.57 ± 0.16 g 100 g^{-1}), *mangaba* (10.02 ± 0.22 g 100 g^{-1}) and *pitomba* (12.51 ± 0.69 g 100 g^{-1}), the content found in the studied fruits is greater, approaching the value found for fruits routinely consumed as apple (15.2 g 100 g^{-1}) (Universidade Estadual de Campinas, 2011).

As for the energy density of the fruits, it can be said that both present low caloric value as well as those found by Silva *et al.* (2008) for other fruits of the *Cerrado*, such as *araca* (37.09 kcal 100 g^{-1}), *araticum* (90.47 kcal 100g^{-1}), *cagaita* (20.01 kcal 100 g^{-1}) Cerrado cashew (38.27 kcal 100g^{-1}), *gabiroba* (47,36 kcal 100g^{-1}), *mangaba* (66,21 kcal 100 g^{-1}), *murici* (46.43 kcal 100g^{-1}), *pitomba* (56.35 kcal 100 g^{-1}), and *puçá* (34.15 kcal 100 g^{-1})

Table 2 presents the values of phenolic compounds and vitamin C of the two *Cerrado* fruits analyzed.

According to Haminiuk *et al.* (2011), bioactive compounds are found in abundance in fruits and vegetables. In addition, the frequent consumption of these food groups is associated with the reduction of the risk of chronic diseases such as cancer, chronic and cardiovascular inflammatory diseases, so, the analysis of phenolic compounds in the diet is paramount. In relation to this compound, the analyzed fruits stand out in relation to others already studied in this same biome, such as *baru* (*Dipteryx alata* Vog.) (6 ± 0 mg 100 g^{-1}), *guariroba* (Syagrus oleracea (Mart.) Becc.), *jatobá* (*Hymenaea stigonocarpa* Mart.) (5 ± 1 mg 100 g^{-1}) and *jurubeba* (*Solanum paniculatum* L.) (94 ± 9 mg 100 g^{-1}) (Siqueira *et al.*, 2013). However, *Bromelia balansae* Mez and *Inga capitata* are the best alternatives to complement the daily consumption of bioactive compounds.

Regarding vitamin C contents, both fruits had low levels, contrary to that found by Rocha *et al.* (2013) for other Cerrado frutis such as *cagaita* (126.3 ± 45,8 mg 100 g^{-1}), *chicha* (89.3 ± 9.8 mg 100 g^{-1}), *cajui* (500.0±89.7 mg 100 g^{-1}), *jatoba* (330.4 ± 61.5 mg 100 g^{-1}) and *macauba* (185.1±14.8 mg 100 g^{-1}), which presented higher levels than the daily intake recommendation for adults (45 mg) (Brasil, 2005).

Table 2: Content of phenolic compounds and vitamin C of two Cerrado fruits, expressed as equivalent of gallic acid (GA) and ascorbic acid (AA).

Fruit	Phenolic compounds (mg GA 100 g^{-1})[1]	Vitamin C(mg AA 100 g^{-1})[1]
Bromelia balansae Mez	148.57±0.59	3.53±0.05
Inga Laurina	110.67±0.40	1.60±0.00

[1]Values obtained by means of a mean ± standard deviation of a triplicate of samples.

Characterizing as good suppliers of ash, carbohydrates, water, and phenolics, the fruits analyzed surpassed many others in this biome. With the elucidation of the composition of these fruits, it is expected that they can be used, promoting the socioeconomic and environmental interest of this biome, through the valorization of the native fruit trees.

CONCLUSIONS

The selected fruits have high phenolic contents.

Both fruits presented low contents of protein, lipids and caloric value, and stood out for the amount of ash, moisture, and carbohydrates when compared to other fruits of the same biome.

The presence of phenolics and vitamin C make this fruit a promising source of antioxidant compounds whose cultivation should be stimulated.

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