

Full Length Research Paper

Nutritional characterization pulp of *Chrysobalanus icaco* L.

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After Southeast Asia, Brazil is the second largest producer of tropical fruits having more than 500 species, and many of these have high potential regarding nutritional content that can be marketed. Among them, *Chrysobalanus icaco* L., which can be found in abundance in several countries of South America stands out. Among its nutritional profile, it had low value of titratable acidity ($0.41 \pm 0.02\%$) and lipid value of $0.71 \pm 0.02\%$, and is very notable for its minerals content such as calcium ($0.74 \pm 0.02 \text{ g } 100 \text{ g}^{-1}$), potassium ($1.38 \pm 0.12 \text{ g } 100 \text{ g}^{-1}$), iron ($0.14 \pm 0.03 \text{ g } 100 \text{ g}^{-1}$), and copper ($0.04 \pm 0.01 \text{ g } 100 \text{ g}^{-1}$). By identifying the functional groups using IR, the characteristic peaks of fatty acids were identified.

Key words: Amazon, bromatology, minerals, sustainability.

INTRODUCTION

Brazil presents an extensive area of biological biodiversity, with approximately 3.6 million square kilometers, being a source and habitat of incalculable resources such as minerals, plant and animal species (Marinelli et al., 2008). 20% of the existing biodiversity on the planet is found in Brazil and it is estimated that of the 500,000 different plant species that exist on the planet, 16% is in the Brazilian Amazon (Barbosa, 2001). Within the plant biodiversity, the native fruits of Brazil stands out, which according to Carvalho and Müller (2005), places them worldwide as the epicenter of tropical fruits by its outstanding applications in products for agribusiness

opportunities. The fruits have different nutritional properties based on their concentrations in minerals, sugars, vitamins, and antioxidant properties that help prevent and combat certain cardiovascular diseases and those related to oxidative stress (Costa and Müller, 1995; Carvalho, 2000).

In the Amazon region, there are many fruits that are practically only consumed locally (without being exported) and it can be considered as new alternatives in the local and international market. On the other hand, the availability of food on the market requires that their production, distribution and legislation guarantee safety

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Figure 1. *Chrysobalanus icaco* L.

from a microbiological, chemical and physical point of view (Marsh, 2012). In addition, another drawback of the Amazon region is that its fruits are subject to regional development restrictions since it is a region that, as Pallet (2002) affirms, is ecologically sensitive, with limited studies of many of its fruits. On the other hand, the great distances between collaborators, producers and clients in order to open markets outside the region implies the development of specific strategies.

Within this biodiversity, there is a fruit with expansion in diverse regions of South America, called icaco, guajurú or Abajurú *Chrysobalanus icaco* L. (Figure 1) belonging to the family of the *Chrysobalanaceae*. Little et al. (1974) defines it as a small dark green tree, with oval leaves, perennial with great habitat in different regions of America from South Florida to the Caribbean Bahamas, being found in Central America and in the South America as well as in tropical regions in Africa. Its properties are also attributed to fight diabetes, due to the phytoconstituents found in its leaves (Silva and Peixoto, 2008). The objective of this research was to analyze the proximate, energetic, mineralogical composition of the pulp obtained from *C.s icaco* L. (*Chrysobalanaceae*), developed in Boa Vista-RR (Brazil). Also, the objective was to characterize the functional groups present in the hexane extract of the pulp, given the importance of knowing the properties of this tropical fruit, since like other tropical fruits, they are included in the diet providing beneficial pharmacological properties for the body in order to enhance its desirable characteristics and hence its consumption.

METHODOLOGY

Material collection

The fruits were collected in the city of Boa Vista-RR (Brazil) in accordance with the technical standard NTON 17002-02 (2002), where 1 kg of fresh icaco was taken, brought to the Laboratory of the Research Center in Agronomy (NUPAGRI), from the Agricultural Sciences Center of the *Cauamé* Campus of the Federal

University of Roraima (Brazil), and were washed with sodium hypochlorite solution at 1% and with distilled water. Subsequently, the pulped fruits were frozen in an ultra-freezer at -80°C , and, subsequently, it was taken to lyophilization in Liotop L 101 Freeze Dryer for 48 h until the material was completely dried. After lyophilization, the samples were crushed in a mill and sieved between 30-40 Mesh, being stored in hermetic bags and kept protected from light and moisture until the time of carrying out the different analyzes.

Proximal analysis

The bromatological analyzes conducted including determination of moisture by drying the samples in an air circulation oven at 105°C until maintaining the constant weight, determination of ash in the muffle model FDG 3P-S EDG, the total proteins by Kjeldahl distillation method and total lipid content by hexane extraction in Soxhlet extractor and carbohydrates by difference according to the methodology described by IAL (2008). With the bromatological parameters, the total energy value was calculated according to Equation 1, according to the methodology described by Mendes-Filho et al. (2014). The analyses were done in triplicates.

$$\text{Energetic value (kcal } 100 \text{ g}^{-1}) = (P \times 4) + (L \times 9) + (C \times 4) \quad (1)$$

Where: P = protein value (%), L = lipid value (%), C = carbohydrate value (%), 4 = conversion factor in kcal determined in calorimetric pump for proteins and carbohydrates and 9 = conversion factor in kcal determined in calorimetric pump for lipids.

Physicochemical analyses

The physicochemical parameters determined in this work were the total soluble solids, pH and titratable acidity according to the methodology described by IAL (2008). To determine the total soluble solids, a digital refractometer was used, and the result is expressed by °Brix, which previously calibrated with distilled water. To carry out the pH determination, 5 g of the fresh tissue were macerated and diluted with 100 mL of distilled water until the particles were suspended. Finally, the analysis of the titratable acidity was carried out by 10 g of fresh sample, which was weighed and 100 mL of water added. The assessment was made with 0.1 M sodium hydroxide using phenolphthalein indicator, being expressed in citric acid concentration per kg of fresh tissue. The analyses were done in triplicates.

Table 1. Proximate composition and physiochemical analysis.

Physico-chemical characteristics			%					Kcal 100 g ⁻¹
pH	Titrate acidity (%)	Soluble solids ^o Brix	Moisture	Ash	Carbohydrate	Lipids	Proteins	Energy
5.34 ± 0.12	0.41 ± 0.02	10.3	79.41 ± 0.12	0.58 ± 0.17	18.71 ± 0.17	0.71 ± 0.12	0.59 ± 0.21	83.59

Table 2. Mineralogical composition.

Mineral	g 100 g ⁻¹
Ca	0.74 ± 0.02
Mg	0.17 ± 0.03
K	1.38 ± 0.12
Na	0.71 ± 0.03
Fe	0.14 ± 0.03
Cu	0.04 ± 0.01
Zn	0.003 ± 0.00
Mn	0.072 ± 0.002
B	0.05 ± 0.00

Mineral analysis

To carry out the mineral determination, the methodology described by EMBRAPA (2009) was used, where the samples were subjected to nitric-perchloric digestion (3:1) in the TECNAL digester block model TE 0079. The determination of calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn) were obtained by atomic absorption flame spectroscopy (FAAS) in Shimadzu AA-equipment 7000, coupled with ASC-7000 auto injector. Recording were performed with pre-calibration using commercial Qhemis High Purity PACU 1000-0125 standards, at specified wavelengths (Ca (248.33 nm), Zn (248.33 nm), Mn (248.33 nm), Na and K using flame photometry in a previously calibrated Digimed DH-62 flame photometer. Finally, to carry out the Boron (B) determination, a UV-visible molecular absorption spectrophotometry of Shimadzu model UV-1800 equipment was used by the colorimetric reaction with azometin-H, being previously calibrated with standard boron solution and taking the readings at $\lambda = 460$ nm. The analysis was done in triplicates.

Identification of functional groups by IR

The lipid fraction extracted by Soxhlet was used for the identification of the functional groups by IR Prestige-21 with the Fourier transform brand Shimadzu having the following conditions; Mode: absorbance; Number of scans: 10; Resolution: 16%; Wavelength reading range: 400-4000 cm⁻¹.

RESULTS AND DISCUSSION

Table 1 presents the results of the energetic content, as well as the physical and chemical characteristics for the pulps of *C. icaco* L.

It can be observed in Table 1 that the moisture content in the sample were very high (79.41 ± 0.12) in

comparison with the other parameters, and this leads to a low ash content and therefore a low caloric value of 83.59 Kcal 100 g⁻¹. The pH value of the samples was 5.34, and is considered according to Franco and Landraf (1996) as low acidity foods. Saying that, this fruit is susceptible to microbial spoilage and pathogenetic contamination. The titratable acidity obtained was 0.41, a low value related to the fact that it is a fruit that can be consumed raw (Nascimento et al., 1998). Table 2 showed the mineral composition for the pulp of *C. icaco* L.

Among the major concentration of minerals, potassium stood out first with a value of 1.38 ± 0.12 g 100 g⁻¹, followed by calcium with a value of 0.74 ± 0.02 g 100 g⁻¹. Researchers such as Elcinto (2000), highlighted the high potassium values found in fruits and vegetables, also having a great agronomic importance, since it is involved in the acidity of the pulp, root development and tissue turgor, and, as well as, potassium is involved in the transportation of metabolites inside the cell (Soares et al., 2005). The daily recommendations for this element are 1600-2000 mg day⁻¹ (Mahan and Stump, 2005). The second element found in major concentrations in this fruit was calcium, being an element involved in the inorganic fraction of the bones and responsible for its hardness, and is important in blood coagulation process, with a daily recommendation of 1000 mg day⁻¹ (De França and Martini, 2014). The third most abundant mineral was sodium (0.71 ± 0.03 g 100 g⁻¹). This element is associated with the form of sodium chloride in food, and is related to hypertension having recommended doses according to the WHO of 5 g of sodium chloride or 200 mg of sodium per day in the adult (IOM, 2001). The one found in the lowest concentration among the minerals was magnesium with a concentration of 0.17 ± 0.03 g 100 g⁻¹. According to the Recommended Dietary Allowances (RDA), the daily intake of magnesium for men is 420 mg day⁻¹ and for women is 320 mg day⁻¹.

Among the minor minerals in the pulps, iron (0.14 ± 0.03 g 100 g⁻¹) and copper (0.04 ± 0.01 g 100 g⁻¹) were reported. Iron is one of the microelements whose level in the human body is found in 40 mg kg⁻¹ for men and 50 mg kg⁻¹ for women, being an element linked to metabolic and enzymatic functions; also, it is linked to hemoglobin, myoglobin, cytochrome, ferricine and transferrin among others (Teixeira, 2003). For copper, the daily consumption in adults according to Bairele et al. (2010) varies between 0.9 to 2.2 mg, being a micronutrient incorporated into the body mainly through food. The

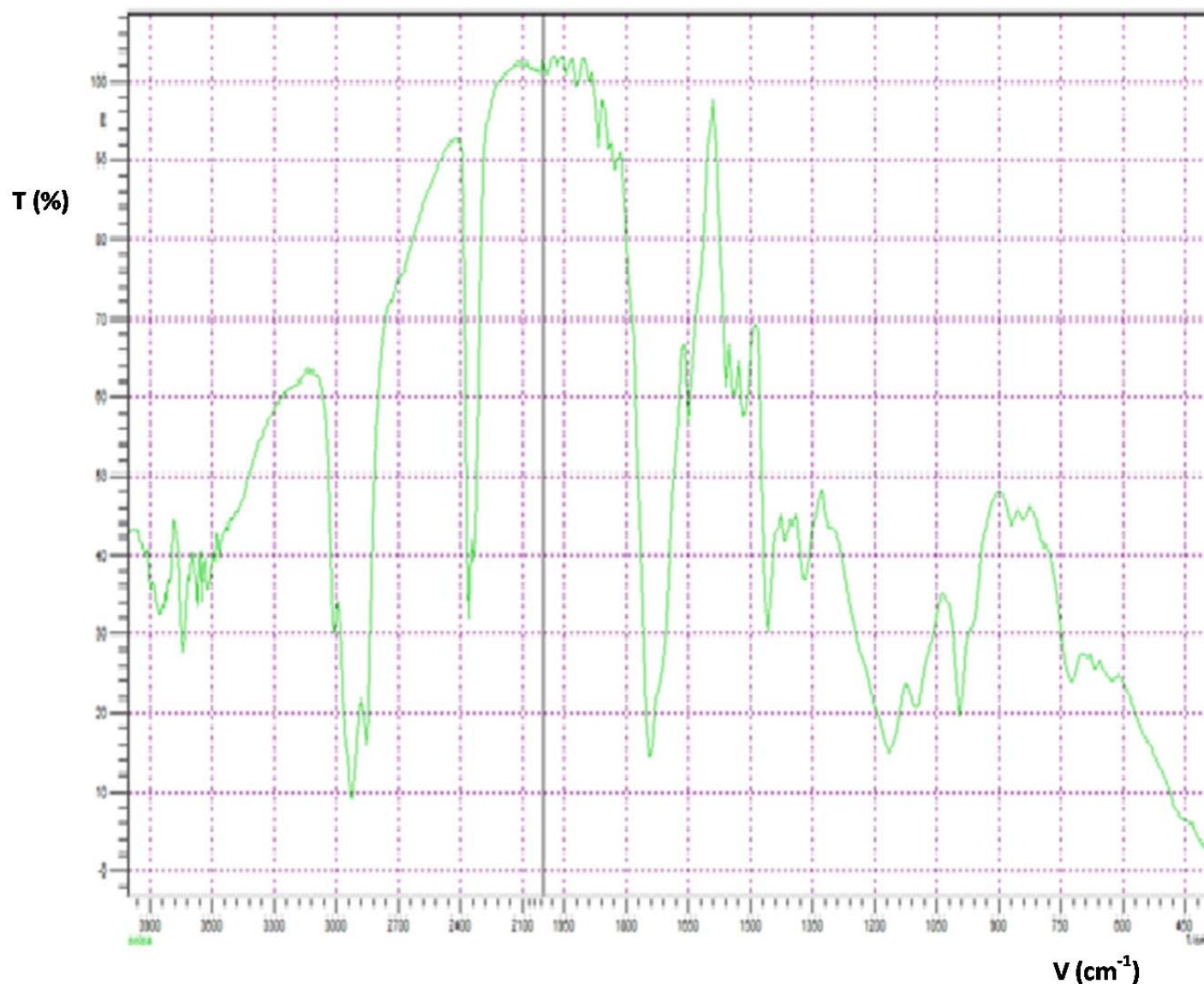


Figure 2. IR spectrum of the hexane fraction *C. icaco* L.

doses found in this study are below the levels consumed.

Identification of functional groups

The infrared spectrum was performed in absorbance mode from 400–4000 cm^{-1} with the two regions being distinguished. One of them was the region of the functional groups and another was the region of the fingerprint. Analyzing the spectrum of Figure 2, it was possible to attribute absorptions of characteristic bands of the triacylglycerides, such as the band that appears, at approximately 1,600 cm^{-1} , referring to the carbonyl group ($\text{C}=\text{O}$) of carboxylic acids. The absorptions between 2,910 to 2,850 cm^{-1} refer to the axial deformation of the $\text{C}-\text{H}$ bond (sp^3 -s), in which the strong absorption at 2,910

cm^{-1} refers to the methyl group (CH_3), followed by an absorption with an average intensity of 2,850 cm^{-1} , attributed to the CH_2 methylenic groups. There was also a band at 1,470 cm^{-1} attributed to an axial deformation of the methylene group and, finally, at 1,180 cm^{-1} , a band of medium intensity characteristic of axial deformation of the functional group ($\text{C}-\text{O}-$) was observed.

Conclusions

The use of Amazonian fruit species was reflected in the offer of new alternatives of fresh fruit for consumption and raw material for the agribusiness, constituting a precious source of food. Therefore, *C. icaco* L. is a specie with high nutritional and mineralogical potential to be

incorporated into the diet.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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