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Cagaita (*Eugenia dysenterica* DC.) of the Cerrado of Minas Gerais, Brazil: Physical and chemical characterization, carotenoids and vitamins

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ABSTRACT

The physical characteristics (diameters, height and mass), chemical composition (tritratable acidity, soluble solids, pH, moisture, ash, protein, lipids and total dietary fiber), occurrence and content of vitamin C (ascorbic acid and dehydroascorbic acid), carotenoids (α-carotene, β-carotene, β-cryptoxanthin and lycopene), vitamin E (α-, β-, γ- and δ-tocopherol and tocotrienol) and folates (tetrahydrofolate, 5-methyltetrahydrofolate and 5-formyltetrahydrofolate) were evaluated in the cagaita obtained from the Cerrado of Minas Gerais, Brazil. The analyses of vitamin C and carotenoids were performed by HPLC-DAD and vitamin E and folates by HPLC with fluorescence detection. The cagaita pulp presented high content of moisture (91.56 g 100 g^{-1}), vitamin C (34.11 mg 100 g^{-1}) and folates (25.74 µg 100 g^{-1}). The presence of protein (0.63 g 100 g^{-1}), ash (0.18 g 100 g^{-1}), lipids (0.57 g 100 g^{-1}), carbohydrates (5.54 g 100 g^{-1}), dietary fiber (1.54 g 100 g^{-1}) and carotenoids (0.77 mg 100 g^{-1}) was observed in its composition. Vitamin E isomers were not detected. Consumption of cagaita (100 g) contributed significantly to supply the daily requirements of vitamin C (on average 71.0%), vitamin A (on average 7.5%) and folates (on average 7.9%). The cagaita showed high pulp yield, reduced total energy value and was considered a source of vitamin C, which play important role in human health.

1. Introduction

The Cerrado covers approximately two million square kilometers and stretches across thirteen states in Brazil's interior, representing 25% of the country. However, the current form of agricultural expansion in Brazil has overlooked the potential use of native species of the Cerrado (Fonseca & Sano, 2003), reducing the original cover of this biome and compromising the conservation of its rich flora.

Many native species of the Cerrado provide fruits that have unique sensory characteristics and high nutrient concentrations. These fruits play important roles, both economic, via commercialization of its products, and nutritional, by its consumption. One of the fruits belonging to the Cerrado is the *Eugenia dysenterica* DC., an exotic fruit belonging the family *Myrtaceae*, which is popularly known as cagaiteira or cagaita.

The cagaita is considered a species of economic interest, mainly due to use of its fruit in culinary. Besides fresh consumption, there are countless typical preparations that utilize the taste of its pulp. This use is widespread among the residents of the Cerrado where various regional preparations are made from the pulp of this fruit, especially sweets, jams, liqueurs, soft drinks, juices and ice creams (Martinotto, Paiva, Soares, Santos, & Nogueira, 2008).

The cagaita pulp has high moisture and also observed in its composition the presence of nutrients such as proteins, lipids, carbohydrates and dietary fiber (Roesler et al., 2007). However, little data is available in literature related to the content of carotenoids and vitamin C in cagaita pulp, especially when using reliable analytical methods such as high performance liquid chromatography (HPLC). Information on the presence and content of vitamin E and folates in fruits in general also is scarce in literature and information about the presence of these vitamins in exotic fruits such as cagaita is not encountered.

Given the scarcity of information regarding the nutritional value of cagaita, in particular carotenoids and vitamins, this study aimed to evaluate the physical characteristics, chemical composition, and occurrence and content of carotenoids, vitamin C, vitamin E and folates of the cagaita pulp from the Cerrado of Minas Gerais, Brazil.

2. Material and methods

2.1. Raw material

Fruits of cagaita (*E. dysenterica* DC.) were collected in areas of native vegetation typical of the Cerrado, in the rural area of Felixlândia (south latitude 18° 15′ and west longitude 44° 55′), Minas Gerais, Brazil.

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2.2. Standards

Standards of vitamin E (α-, β-, γ- and δ-tocopherol and tocotrienol) were purchased from Calbiochem®, EMD Biosciences, Inc. (USA). L-ascorbic acid was purchased from Sigma-Aldrich® (Germany). The folate standards used were (6S)-5,6,7,8-tetrahydrofolate (THF), (6S)-5-methyl-5,6,7,8-tetrahydrofolate (5-MTHF) and (6S)-5-formyl-5,6,7,8-tetrahydrofolate (5-FTHF), kindly provided by Merck-Eprova® (Switzerland). Standards of α-carotene and β-carotene were isolated from concentrated carrot extract, and β-cryptoxanthin and lycopene were isolated from papaya and tomato extracts, respectively, by open column chromatography (Rodriguez-Amaya, 1989).

2.3. Collection and sample preparation

The fruits were collected during the harvest season (from October to November 2009) from mature trees. To obtain five repetitions, the collection area was divided into sub-areas, where in each sub-area approximately 1.0 kg of fruit was collected. The samples were transported from the collection area to the laboratory in polystyrene boxes, in less than 24 h after collection.

The morphologically perfect fruits with complete maturation were washed with tap water to remove dirt and dried at room temperature. Then, the cagaita pulp and peel were separated manually from the seeds and homogenized in a food processor (Faet Multipratic, model MC5). This procedure was performed for each of the five repetitions.

2.4. Experimental design and statistical analysis

A completely randomized experimental design was employed, with five repetitions. The data were stored in worksheets using the Microsoft Office Excel software system, version 2007. To calculate the means, standard deviations and the amplitude of the parameters, the SAS (Statistical Analysis System) software, version 9.2 (2008), licensed to the UFV, was used.

2.5. Physical characterization

Individual measurements of mass, transverse and longitudinal diameters were carried out in 30 fruits using a digital caliper rule (Mitutoyo). The mass of the fruits (MF), pulp (pulp + peel, MP) and seed (MS) were obtained by direct individual weighing on a semi-analytical balance (Gehaka, model BG 2000). The pulp yield was calculated using the formula (MP/MF) × 100.

2.6. Chemical analyses

The chemical analyses were performed at the Laboratory of Food Analysis, Department of Nutrition and Health, Federal University of Viçosa (UFV), using 3 repetitions. Values of titratable acidity, soluble solids and pH (IAL—Instituto Adolfo Lutz, 2005); moisture, ash, protein, lipids and total dietary fiber (AOAC—Association of Official Analytical Chemists, 1998) were determined. The carbohydrates were calculated by subtraction using the formula: (100 − % moisture − % lipids − % protein − % of total dietary fiber − % ash). The total energy value was estimated considering the conversion factors of 4 kcal g^{-1} of protein or carbohydrate and 9 kcal g^{-1} of lipid (Merril & Watt, 1973).

2.7. Determination of carotenoids and vitamins

2.7.1. Extraction and analysis of carotenoids and vitamins

The preparation and analysis of the samples were performed at the Laboratory of Vitamins Analysis of Department of Nutrition and Health, UFV, with 5 repetitions. During the steps of extraction and analysis of carotenoids and vitamins, the cagaita pulp and extracts were protection against sunlight and artificial light with the use of amber glass, aluminum foil and blackout drapes, while the recipients were seals and oxygen was removed using nitrogen gas.

For analysis of carotenoids and vitamins the following HPLC grade reagents were used: hexane, isopropanol, ethyl acetate, methanol and acetonitrile (Tedia, Brazil), and glacial acetic acid (Vetec, Brazil).

The carotenoid extraction (α-carotene, β-carotene, β-cryptoxanthin and lycopene) was performed according to Rodriguez-Amaya, Raymundo, Lee, Simpson, and Chichester (1976). The chromatographic conditions used were developed by Pinheiro-Sant'Ana, Stringheta, Brandão, and Azeredo (1998), and included: HPLC system (Shimadzu, model SCL 10AT VP), diode array detector (DAD); chromatographic column Phenomenex Gemini RP-18, 250 × 4.6 mm, 5 μm, fitted with guard column Phenomenex ODS (C18), 4 mm × 3 mm; mobile phase composed of methanol: ethyl acetate: acetonitrile (70:20:10, v/v/v); and flow rate of 1.7 mL min^{-1}. The chromatograms were obtained at 450 nm. Calculation of vitamin A was performed according to the recommendations of the Institute of Medicine (2001).

The extraction of ascorbic acid (AA), conversion of AA to dehydroascorbic acid (DHA) and analyses of AA were performed according to Campos, Ribeiro, Della Lucia, Pinheiro-Sant'Ana, and Stringheta (2009). The DHA content in the pulp was calculated using the formula: DHA content = content of AA after conversion − content of AA before conversion.

The vitamin E isomers (α-, β-, γ- and δ-tocopherol and tocotrienol) in pulp cagaita were extracted according to Guinazi, Milagres, Pinheiro-Sant'Ana, and Chaves (2009). For analysis we used the chromatographic conditions proposed by Guinazi et al. (2009) and mobile phase composed of hexane: isopropanol: glacial acetic acid (98.9:0.6:0.5, v/v/v).

The extraction, purification, deconjugation and analysis of folates (THF, 5-MTHF and 5-FTHF) were performed according to methods proposed by Della Lucia et al. (2011).

2.7.2. Identification and quantification of carotenoids and vitamins

Qualitative identification of the compounds was performed comparing the retention times obtained for standards and samples analyzed under the same conditions. Moreover, the folates and vitamin E isomers

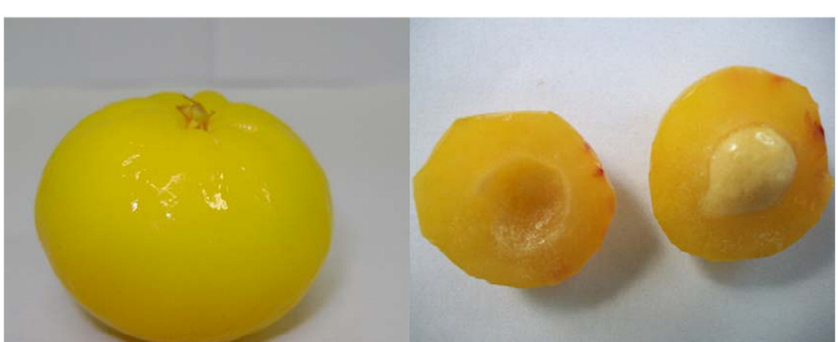

Fig. 1. Photographic representation of fruits of the cagaita (*Eugenia dysenterica* DC.).