Original article

Mangaba (*Hancornia speciosa* Gomes) from the Brazilian Cerrado: nutritional value, carotenoids and antioxidant vitamins

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Mangaba (*Hancornia speciosa* Gomes) from the Brazilian Cerrado: nutritional value, carotenoids and antioxidant vitamins.

Abstract – Introduction. The mangaba is an exotic fruit from the Brazilian Cerrado that presents high antioxidant activity and may benefit human health. Its antioxidant activity may be associated with the presence of bioactive compounds such as carotenoids and antioxidant vitamins. The physical and chemical characteristics, nutritional value, carotenoids and antioxidant vitamins were evaluated in mangaba from the Cerrado of Minas Gerais, Brazil. **Materials and methods**. Titratable acidity was determined by volumetric neutralization, pH by potentiometry, soluble solids by refractometry, moisture by gravimetry after oven drying, ash by calcination in a muffle furnace, proteins by the micro-Kjeldhal method, dietary fibers by the gravimetric non-enzymatic method and lipids by gravimetry after extraction in ethyl ether. Vitamin C (ascorbic and dehydroascorbic acids) and carotenoids (α-carotene, β-carotene, β-cryptoxanthin and lycopene) were analyzed by HPLC-DAD. Vitamin E (α-, β-, γ- and δ-tocopherols and tocotrienols) and folates (tetrahydrofolate, 5-methyltetrahydrofolate and 5-formyltetrahydrofolate) were analyzed by HPLC with fluorescence detection. **Results and discussion**. Mangaba showed a high pulp yield (80.08%), moisture (83.0 mg·100 g^{-1}) and dietary fiber content (2.3 g·100 g^{-1}). Mangaba presented β-carotene, β-cryptoxanthin, ascorbic acid, α-tocopherol; α-, β- and γ-tocotrienols; tetrahydrofolate, 5-methyltetrahydrofolate and 5-formyltetrahydrofolate, and it can be considered an excellent source of vitamin C (165.8 mg·100 g^{-1}) and folates (98.3 µg·100 g^{-1}). Carotenoid and vitamin E contents were 0.12 mg·100 g^{-1} and 2,732.5 µg·100 g^{-1}, respectively. **Conclusion.** Mangaba presented a high pulp yield, and several carotenoids and antioxidant vitamins, and can be considered an excellent source of vitamin C and folates.

Brazil / Minas Gerais / *Hancornia speciosa* / fruits / physicochemical properties / antioxidants / ascorbic acid / vitamin E / folates

Le mangaba (*Hancornia speciosa* Gomes) du Cerrado brésilien : valeur nutritive, caroténoïdes et vitamines antioxydantes.

Résumé – Introduction. Le mangaba est un fruit exotique du Cerrado brésilien qui a une forte activité antioxydante et peut offrir de nombreux avantages pour la santé humaine. L'activité antioxydante peut être associée à la présence de composés bioactifs tels que des caroténoïdes et des vitamines antioxydantes. Les caractéristiques physiques et chimiques, la valeur nutritive, les caroténoïdes et les vitamines antioxydantes ont été évalués dans les fruits du mangaba du Cerrado du Minas Gerais, au Brésil. **Matériel et méthodes**. L'acidité titrable a été déterminée par neutralisation volumétrique, le pH par potentiométrie, la teneur en solides solubles par réfractométrie, l'humidité par gravimétrie après séchage au four, la teneur en cendres par calcination dans un four à moufle, les protéines par la méthode micro-Kjeldhal, les fibres alimentaires par la méthode gravimétrique non-enzymatique et les lipides par gravimétrie après extraction à l'éther éthylique. La vitamine C (acides ascorbique et déhydroascorbique) et les caroténoïdes (α-carotène, β-carotène, β-cryptoxanthine et lycopène) ont été analysés par HPLC-DAD. La vitamine E (α, β, γ et δ-tocophérols et tocotriénols) et les folates (tétrahydrofolate, 5-méthyltétrahydrofolate et 5-formyltétrahydrofolate) ont été analysés par HPLC avec détection de fluorescence. **Résultats et discussion**. Les fruits du mangaba ont montré un rendement élevé en pulpe (80,08 %), en humidité (83,0 mg·100 g^{-1}) et une forte teneur en fibres alimentaires (2,3 g·100 g^{-1}). Ils contiennent du β-carotène, β-cryptoxanthine, de l'acide ascorbique, de l'α-tocophérol, des α-, β- et γ-tocotriénols, du tétrahydrofolate, du 5-méthyltétrahydrofolate et du 5-formyltétrahydrofolate. Ils peuvent être considérés comme une excellente source de vitamine C (165,8 mg·100 g^{-1}) et de folates (98,3 ug·100 g^{-1}). Les teneurs en caroténoïdes et vitamine E ont été de 0,12 mg·100 g^{-1} et 2732,5 µg·100 g^{-1}, respectivement. **Conclusion**. Les fruits du mangaba présentent un rendement élevé en pulpe, plusieurs caroténoïdes et vitamines antioxydantes ; ils peuvent être considérés comme une excellente source de vitamine C et de folates.

Brésil / Minas Gerais / *Hancornia speciosa* / fruits / propriété physicochimique / antioxydant / acide ascorbique / vitamine E / folates

1. Introduction

Brazil has the largest biodiversity in the world and due to this it has a large number of unknown fruit species [1] which are not yet commercially available. The Cerrado is the second largest biome in South America (the largest biome is the Amazon rainforest). It covers 22% of the Brazilian territory and is present in nine Brazilian states, including Minas Gerais [2]. This biome has a large number of underexploited exotic fruits, which have the potential to be used by the agro-industry and generate income for the local population [3].

The mangaba tree (*Hancornia speciosa* Gomes), whose fruit is popularly known as mangaba, is an exotic species from the Brazilian Cerrado [2]. Mangaba is a rounded or ellipsoidal fruit with a yellowish exocarp and red stripes or spots [2]. Its pulp is whitish, fleshy, viscous, sweet and slightly acid. It is greatly appreciated by consumers and it can be eaten fresh or in ice creams, juices, jellies, jams, liqueurs, yogurts and nectars as their major component [1].

Mangaba has potential for the development of products and therefore it may be used in human feeding and generate income, especially for socially vulnerable families. Studies demonstrated that mangaba presented high antioxidant activity [4, 5] and therefore it may reduce the incidence of cancer, and cardiovascular and cerebrovascular diseases. The antioxidant activity may be mainly associated with the presence of numerous bioactive compounds, including carotenoids, vitamin C, vitamin E and folates [6].

Few data regarding the nutritional value, and contents of carotenoids and antioxidant vitamins of mangaba are available in the scientific literature. These data relate to the chemical composition, carotenoids and vitamin C contents of fruits collected in the northeastern region of Brazil (Ceará and Paraíba states). Since chemical characteristics and bioactive compounds of fruits may be affected by edaphoclimatic differences among the cultivation regions, so far, the present study is the first to evaluate the content of macronutrients, carotenoids and vitamins, including vitamin E and folates, in mangaba from the Minas Gerais state.

Knowledge of the nutritional composition of foods consumed in Brazil, including this fruit, is essential to assess the availability of nutrients and consumption by populations and individuals, verify the nutritional adequacy of diets, evaluate nutritional status, conduct future research about the relationship between diet and disease, and develop new products for the food industry [7].

Therefore, our study aimed to evaluate the physical characteristics, nutritional value and antioxidant compounds (carotenoids, folates, vitamin C and vitamin E) in mangaba pulp from the Cerrado of Minas Gerais, Brazil.

2. Materials and methods

2.1. Raw material, collection and sampling

Mangaba fruits (*Hancornia speciosa* Gomes) were collected during the harvest season (October and November, 2012) in the Cerrado of the municipality of Curvelo (lat. 18°45' S and long. 44°25' W), Minas Gerais, Brazil.

Since mangaba is fragile and highly susceptible to injuries, the collection of the fruits was performed directly from the trees. The fruits were collected in order to obtain five repetitions. So, the collection area was divided into five sub-areas, which represented the repetitions. In each repetition, a sample of 1.0 kg of fruits (about 20 fruits) from different trees was collected.

The samples were transported overland, in polystyrene boxes, from the collection site to the laboratory, within 36 h after collection. In each repetition, only the perfect morphologically and completely mature fruits (fruit with soft texture and yellow peel with red pigmentation in 75% of the fruit) were selected, washed in tap water and dried at room temperature. Later, the pulp and peel of the mangaba were manually separated from the seeds and homogenized in a domestic food processor (Faet Multipratic, MC5, Brazil).

2.2. Physical characterization

Individual measurements of height and diameter were carried out in 50 fruits (10 fruits of each repetition) using a digital caliper rule (Mitutoyo, M5, Brazil). The mass of whole fruits (MF), pulp (pulp + peel, MP) and seeds (MS) were obtained by individual direct weighing in a semi-analytical balance (Gehaka, BG 2000, Brazil). The pulp yield was calculated by the equation [(MP / MF) × 100].

2.3. Physicochemical analysis

Titratable acidity, soluble solids and pH [8] were determined in the mangaba pulp with three repetitions. The titratable acidity was determined by volumetric neutralization using a standard solution of sodium hydroxide 0.1 $mol \cdot L^{-1}$. The pH was determined by direct potentiometry and the soluble solids were determined by refractometry, using a portable refractometer (Multibras, M45, Brazil).

2.4. Proximate composition

Moisture, ash, proteins, lipids and total dietary fiber [9] were determined in the pulp of mangaba with three repetitions. Moisture was determined by gravimetry after oven drying (Nova Etica, 4000, Brazil) at 105 °C; and the ash was determined by calcination in a muffle furnace (Quimis, Q2342, Brazil) at 550 °C. Protein content was determined by the micro-Kjeldhal method; and total dietary fiber was determined by the gravimetric non-enzymatic method. The lipids were determined by gravimetry after extraction in ethyl ether using a Soxhlet extractor (Eletrothermo, 500WX, Brazil), while available carbohydrates were calculated as the difference, by the equation: [100 – (% moisture + % lipids + % proteins + % total dietary fiber + % ash)]. The total energy value of the mangaba pulp was estimated considering the conversion factors of 4 $kcal \cdot g^{-1}$ of protein or available carbohydrate and 9 $kcal \cdot g^{-1}$ of lipid [10].

2.5. Extraction and analysis of carotenoids and antioxidant vitamins

The preparation and analysis of carotenoids and vitamins of mangaba were performed with five repetitions, using methods recently validated (limits of detection and quantification, repeatability test and recovery test) in our laboratory for analysis of the Cerrado fruits [11, 12]. The samples and extracts were protected from both sunlight and artificial light with the use of amber glass bottles, aluminum foil and blackout curtains, and were also protected from oxygen by using lids and environments with nitrogen gas in glass bottles.

2.5.1. Carotenoids

The carotenoids (α-carotene, β-carotene, β-cryptoxanthin and lycopene) of the mangaba were extracted in acetone and transferred to petroleum ether [13]. Carotenoids were analyzed using a high-performance liquid chromatography system (HPLC) (Shimadzu, SCL 10AT VP, Japan) comprising a high-pressure pump (Shimadzu, LC-10AT VP, Japan), an autosampler with a loop of 50 μL (Shimadzu, SIL-10AF, Japan) and a diode array detector (DAD) (Shimadzu, SPD-M10A, Japan). The chromatographic conditions used were developed by Pinheiro-Sant'Ana *et al.* [14]. The vitamin A value was calculated according to the recommendations of the Institute of Medicine [15], in which 1 Retinol Activity Equivalent (RAE) is equivalent to 1 μg of retinol, 12 μg of β-carotene, or 24 μg of other provitamim A carotenoids.

2.5.2. Vitamin C

The ascorbic acid (AA) and dehydroascorbic acid (DHA) were extracted using a buffer solution (3% metaphosphoric acid, 8% acetic acid, 0.3 $mol \cdot L^{-1}$ sulfuric acid and 1 $mmol \cdot L^{-1}$ EDTA), and the conversion of ascorbic acid to dehydroascorbic acid was performed using dithiothreitol [16]. The vitamin C analyses were performed on the same HPLC system used for analysis of carotenoids. DHA content in the pulp was calculated using the equation: [DHA content = AA content after conversion – AA content before conversion].

2.5.3. Vitamin E

The vitamin E components (α-, β-, γ- and δ-tocopherols and tocotrienols) of the mangaba pulp were extracted by an extractor mixture (hexane:ethyl acetate; 85:15 v/v), isopropyl alcohol, ultrapure water, hexane with 0.05% of butylated hydroxytoluene (BHT) and anhydrous sodium sulfate [17], with some modifications. After extraction, aliquots of 5.0 mL of the extract were dried in nitrogen gas, dissolved in 2.0 mL of HPLC-grade hexane (Tedia, Brazil) and filtered through filter units with porosity of 0.45 µm. Mangaba presents a high latex content, which makes its pulp highly viscous. To avoid possible damage to the HPLC system by latex impregnation, the vials containing the filtered extracts were stored in a freezer at –24 °C ± 1 °C for 30 min. It was observed that a viscous and whitish phase (containing latex) was formed, as well as a yellowish liquid phase, which was collected with the use of a Pasteur pipette, transferred to a new vial and injected into the chromatographic column for analysis.

Analyses of the vitamin E components were performed by injections of 5 µL and 50 µL of extract into a HPLC system (Shimadzu, SCL-10AD VP, Japan), comprising a high-pressure pump (Shimadzu, LC-10AD VP, Japan), autosampler with a 50 µL loop (Shimadzu, SIL-10AF, Japan), helium degassing system of the mobile phase (Shimadzu, DGU-2A, Japan) and fluorescence detector (Shimadzu, RF-10AXL, Japan). For analysis, the chromatographic conditions proposed by Pinheiro-Sant'Ana *et al.* [17] were used with a mobile phase composed of hexane:isopropanol:glacial acetic acid, in the proportion 98.9:0.6:0.5, respectively.

2.5.4. Folates

The folates of the mangaba pulp were extracted using phosphate buffer solution 0.1 mol·L^{-1}, pH 6.0, with ascorbic acid 1% and 2-mercaptoetanol 0.1%, and then submitted to the deconjugation of polyglutamates into monoglutamates and purification through an ionic exchange column, with a stationary phase of Q Sepharose Fast Flow [18]. The analyses were carried out in the same system used for analysis of vitamin E and the chromatographic conditions were developed by Della Lucia *et al.* [18].

2.5.5. Identification and quantification

The identification and quantification of compounds were performed using the following standards: vitamin E standards (α-, β-, γ- and δ-tocopherols and tocotrienols) purchased from Calbiochem®, EMD Biosciences, Inc. (USA); L-ascorbic acid purchased from Sigma-Aldrich® (Germany); folate standards [(6S)-5,6,7,8-sodium tetrahydrofolate (THF), (6S)-5-methyl-5,6,7,8-tetrahydrofolate (5-MTHF) and (6S)-5-formyl-5,6,7,8-tetrahydrofolate (5-FTHF)] provided by Merck-Eprova® (Switzerland); α-carotene and β-carotene isolated from concentrated carrot extract and β-cryptoxanthin and lycopene isolated from extracts of papaya and tomato, respectively, by open column chromatography [19].

Identification of the compounds was performed by comparing the retention times obtained for standards and samples analyzed under the same conditions. Moreover, the folates and vitamin E components were identified by co-chromatography, while ascorbic acid and the carotenoids were identified by comparing the standard absorption spectra for the peaks of interest in the samples, using a (DAD).

The compounds found in mangaba pulp (β-carotene, β- cryptoxanthin, ascorbic acid, α-tocopherol; α-, β- and γ-tocotrienol; THF, 5-MeTHF and 5-FoTHF) were quantified by external standard curves constructed from injection, in duplicate, of six increasing concentrations of standard solutions (*table I*). A linear correlation was calculated between the peak areas and the concentrations of each compound injected.

2.6. Data statistical analysis

Chemical analyses were performed in three repetitions and analyses of carotenoids and

Table I.
Minimum and maximum concentrations of the standards for the construction of analytical curves and regression equations used for quantification of the compounds.

Compounds	Minimum and maximum concentrations of the standards (μg)	Regression equations	R^2
β-carotene	0.0330 – 2.0600	1,389,460.4 *x* + 24,320.87	0.996
β- cryptoxanthin	0.0045 – 1.4333	1,730,130.16 *x* – 8,057.58	0.999
Ascorbic acid	0.0589 – 5.8800	3,277,607.19 *x* – 66,204.16	0.998
α-tocopherol	0.0010 – 0.1042	76,030,901.90 *x* – 66,102.66	0.999
α-tocotrienol	0.0020 – 0.2041	28,452,328.82 *x* – 105,303	0.997
β-tocotrienol	0.0020 – 0.9845	93,182,765.60 *x* – 17,033.14	0.999
(6S)-5,6,7,8-sodium tetrahydrofolate	0.00004 – 0.04622	942,240,050.58 *x* – 162,371.44	0.996
(6S)-5-methyl-5,6,7,8-tetrahydrofolate	0.00001 – 0.01077	1,237,294,689.67 *x* – 259,476.97	0.994
(6S)-5-formyl-5,6,7,8-tetrahydrofolate	0.00003 – 0.03312	710,036,264.81 *x* – 1,088,694.36	0.996

vitamins were performed in five repetitions. Descriptive statistics (means, standard deviations and range of parameters) were performed for each parameter. To assess the linearity range of the analytical standards, the peak areas and the concentrations of each compound injected were used for linear regression analysis and to calculate the coefficient of determination (R^2). Statistical analysis was performed using the SAS package (Statistical Analysis System), version 9.2 (2008), licensed for the UFV.

3. Results and discussion

3.1. Physical characterization

Mangaba fruits are round-shaped with fragile yellow-greenish peel and reddish spots (*figure 1*). Inside, a greenish viscous pulp with many beige seeds is found.

The diameter of the mangaba ranged from 2.4 cm to 6.2 cm, and its length ranged from 2.3 cm to 6.7 cm. The mangaba mass from the Minas Gerais (on average, 53.9 g, from 12.3 g to 142.3 g) was 50% higher than those grown in the state of Paraíba, Brazil [20]. However, the pulp yield (on average, 85.1%, from 74.6% to 86.9%) was similar to fruits from the other Brazilian states (84.9% and 87.0%) [20, 21]. The fruit mass and pulp yield are the most important physical characteristics of the mangaba, since the pulp is used in human feeding and it has high economic potential, mainly for technological processing for the development of products.

Figure 1.
Mangaba fruits (*Hancornia speciosa* Gomes).

The differences between the physical characteristics of the fruits analyzed in our study and the fruits evaluated by other authors [20, 21] may be attributed to edaphoclimatic differences among the collection regions of the fruits. The mangaba fruits analyzed in our study were collected in southeastern Brazil (state of Minas Gerais), which is located approximately 1,150 miles from the area where the fruits analyzed by the

Table II.
Chemical characteristics and total energy value of mangaba (*Hancornia speciosa* Gomes) pulp of the Cerrado (Curvelo, Minas Gerais, Brazil). Values are expressed in fresh matter. Mean of three repetitions ± standard deviation.

Soluble solids (°Brix)	Titratable acidity (g citric acid·100 g^{-1})	pH	Moisture	Proteins	Lipids	Ash	Total dietary fiber	Available carbohydrates	Total energy value (kcal·100 g^{-1})
			(g·100 g^{-1})						
15.1 ± 1.1	0.8 ± 1.2	3.6 ± 0.1	83.0 ± 1.4	0.8 ± 0.1	1.7 ± 0.1	0.6 ± 0.1	11.6 ± 0.8	2.3 ± 0.2	64.8 ± 5.1

other authors were collected (northeastern region of Brazil, in Ceará and Paraïiba states).

3.2. Chemical characterization

Mangaba presented a slightly acid pulp with reduced titratable acidity and pH (*table II*). The content of soluble solids was lower than those observed in fruits from the northeastern region of Brazil (17.2 °Brix and 16.7 °Brix) [20, 21]. The pulp presented high moisture, which makes this fruit highly susceptible to deterioration and requires fast consumption or technological processing after maturation.

The proximate composition and total energy value of mangaba from the Cerrado of Minas Gerais were similar to those of the fruits of the Cerrado of Goiás, Brazil [22], except for lipids and total dietary fiber. In 100 g of fruits from the Goiás, 1.20 g of proteins, 2.37 g of lipids, 10.02 g of carbohydrates, 3.40 g of dietary fiber, 0.58 g of ash and energy value of 66.21 kcal were observed.

Mangaba presented dietary fiber content (2.3 g·100 g^{-1}) similar to the fruits considered sources of dietary fiber, including tangerine (2.7 g·100 g^{-1}) and pear (2.7 g·100 g^{-1}) [7]. The high fiber content of mangaba is important for human health since it may help reduce the glycemic index of the diet, improve glycemic control, and benefit weight control [23].

3.3. Carotenoids and antioxidant vitamins

3.3.1. Qualitative composition

Mangaba pulp presented 10 compounds with antioxidant and vitamin activity. β-carotene (retention time - RT: 12.4 min), β-cryptoxanthin (RT: 5.3 min) and ascorbic acid (RT: 3.5 min) were identified in the mangaba pulp (*figure 2*). Among the eight vitamin E components investigated, the following were identified: α-tocopherol (RT: 5.2 min) and α-, β- and γ-tocotrienol (RT: 5.5 min, 10.4 min and 11.2 min, respectively). The following folates were identified: THF (RT: 8.2 min), 5-MTHF (RT: 10.2 min) and 5-FTHF (RT: 18.2 min). The compounds α-carotene, lycopene; β-, γ- and δ-tocopherols; and δ-tocotrienol were not detected in the samples.

3.3.2. Carotenoid and vitamin content

Scientific data about the content of carotenoids and vitamins in mangaba are rare [4, 21], mainly obtained using reliable analysis methods, such as HPLC. The lack of nutritional information about mangaba demonstrates the significance of our study, as well as the need for further studies about the presence and content of bioactive compounds in fruits of the Brazilian Cerrado, as well as other Brazilian biomes.

Among the carotenoids found in mangaba pulp, β-carotene was the major component and corresponded to 52.6% of the total content (β-cryptoxanthin: 47.4%) (*table III*). Mangaba from the Minas Gerais presented a carotenoid content 60.0% lower than that observed in fruits from the Brazilian state of Piauí (0.30 mg·100 g^{-1}) [4].This content was lower than that observed in fruits considered sources of these compounds (mango: 1.63 mg·100 g^{-1}; papaya: 7.48 mg·100 g^{-1}) [24]. Furthermore,the vitamin A value of mangaba was lower than that observed in fruits sold in Minas Gerais state such as Formosa papaya (31.8 RAE·100 g^{-1}) and Haden mango (123.2 RAE·100 g^{-1}) [25].

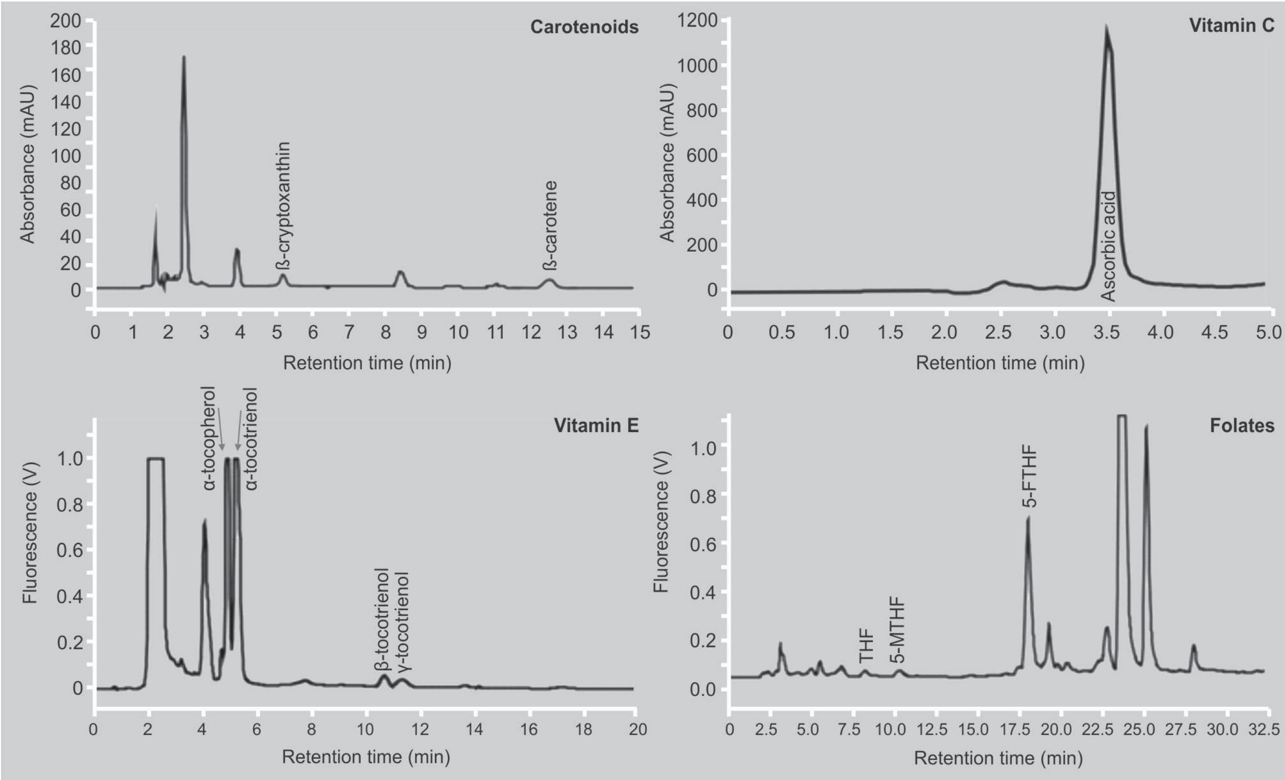

Figure 2.
HPLC analysis of carotenoids, vitamin C, vitamin E and folates in mangaba (*Hancornia speciosa* Gomes) pulp of the Cerrado (Curvelo, Minas Gerais, Brazil). THF: tetrahydrofolate; 5-MTHF: 5-methyltetrahydrofolate; 5-FTHF: 5-formyltetrahydrofolate.

Ascorbic acid and dehydroascorbic acid corresponded to 61.9% and 39.1% of the total vitamin C. The vitamin C content in mangaba was higher than that in fruits of the same species (139.64 mg·100 g^{-1}) [21]. This content was approximately two times higher than that found in fruits considered as an excellent source of vitamin C (papaya: 80.2 mg·100 g^{-1}; guava: 85.9 mg·100 g^{-1}) and in Cerrado fruits (cagaita: 34.11 mg·100 g^{-1}; araticum: 5.23 mg·100 g^{-1}) [11, 24, 26]. Vitamin C participates in the body's basic functions such as collagen biosynthesis and energy metabolism. Moreover, it may provide an alternative pathway for controlling tumor progression, infections and inflammation, and provides protection against oxidative stress [27].

α-Tocotrienol was the major vitamin E component identified in mangaba, accounting for 77.9% of the total vitamin E (α-tocopherol: 19.7%; β-tocotrienol: 1.8% and γ-tocotrienol: 0.5%) (*table IV*). This component is one of the best antioxidant agents in membranes, reducing the risk of development of several chronic-degenerative diseases, especially breast cancer [28]. Mangaba presented high vitamin E content when compared with other fruits. This content was similar to that found in the avocado (2,750.00 µg·100 g^{-1}) and higher than that observed in kiwi (1,450.00 µg·100 g^{-1}) [29], fruits that are among those with the highest content of this vitamin. These results demonstrate that, compared with most fruits consumed by the population, mangaba had higher vitamin E content.

5-FTHF was the prevalent folate in mangaba pulp, making up 93.50% of the total folates (5-MTHF: 3.5% and THF: 3%) (*table IV*). This content was similar to or higher than those observed in fruits that have the highest folate content such as orange (30 µg·100 g^{-1}) and guava (49 µg·100 g^{-1}) [30], and cagaita (25.74 µg·100 g^{-1}) from the Brazilian Cerrado. Folates are important vitamins for human health, because their consumption can reduce the risk of neural tube defects. Moreover, there is epidemiological and clinical evidence that

Table III.
Content of carotenoids and vitamin C in mangaba (*Hancornia speciosa* Gomes) pulp of the Cerrado (Curvelo, Minas Gerais, Brazil). Values are expressed in fresh matter. Mean of five repetitions ± standard deviation.

Total carotenoids	β-carotene	β-cryptoxanthin	Vitamin A value	Total vitamin C	Ascorbic acid	Dehydroascorbic acid
	(mg·100 g^{-1})		(retinol activity Eq·100 g^{-1})		(mg·100 g^{-1})	
0.11 ± 0.01	0.06 ± 0.01	0.05 ± 0.01	7.47 ± 0.40	165.82 ± 24.46	102.77 ± 12.82	63.04 ± 17.62

Table IV.
Content of vitamin E and folates in mangaba (*Hancornia speciosa* Gomes) pulp of the Cerrado (Curvelo, Minas Gerais, Brazil). Values are expressed in fresh matter. Mean of five repetitions ± standard deviation.

Total vitamin E	α-tocopherol	α-tocotrienol	β-tocotrienol	γ-tocotrienol	Total folates	THF	5-MTHF	5-FTHF
		(µg·100 g^{-1})				(µg·100 g^{-1})		
2,732.5 ± 77.8	538.4 ± 39.4	2,129.2 ± 724.7	50.5 ± 19.1	14.4 ± 4.0	98.3 ± 19.6	2.9 ± 0.6	3.5 ± 0.5	91.9 ± 18.6

THF: tetrahydrofolate, 5-MTHF: 5-methyltetrahydrofolate, 5-FTHF: 5-formyltetrahydrofolate.

suggests an inverse relationship between folate and risk for a variety of chronic diseases such as cancer and cardiovascular diseases [31].

3.3.3. Nutritional value of mangaba as source of vitamins

The content of vitamin C present in one serving of mangaba pulp (100 g) can supply 663.3%, 184.2% and 221.1% of recommendations of this vitamin for children (4 to 8 years old), adult men (19 to 30 years old) and pregnant women, respectively [32]. Furthermore, one serving of pulp significantly contributed to providing the folate recommendations for children, adult men and pregnant women (49.2%, 24.6% and 16.4%, respectively) [33]. The consumption of one serving of mangaba pulp (100 g) can supply 7.7% of the recommendations for children and 3.6% for adult men and pregnant women [33]. It was verified that the consumption of this fruit (100 g) offers a small contribution to the supply of vitamin A recommendations to these three groups (less than 2.0%) [15].

Philippi classifies foods as “sources” of a nutrient if they supply from 5.0% to 10.0% of the Dietary Reference Intake (DRI), as “good sources” if they supply from 10.0% to 20.0% of the DRI, and as “excellent sources” if they supply more than 20.0% of the DRI [32]. Therefore, the mangaba can be considered an excellent source of vitamin C and folates for the three human groups and a source of vitamin E for children.

4. Conclusion

The mangaba from the Cerrado of the Minas Gerais presented a high pulp yield. The pulp presented high moisture and a low energy value.

The mangaba pulp showed numerous bioactive compounds which present antioxidant and vitamin activity (β-carotene, β-cryptoxanthin, ascorbic acid, α-tocopherol; α-, β- and γ-tocotrienol; THF, 5-MTHF and 5-FTHF). It presented high contents of vitamin C, vitamin E and folates, being a source of these nutrients.

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El mangaba (*Hancornia speciosa* Gomes) del Cerrado brasileño: valor nutritivo, carotenoides y vitaminas antioxidantes.

Resumen – Introducción. El mangaba es un fruto exótico del Cerrado brasileño que posee una fuerte actividad antioxidante y puede ofrecer numerosas ventajas para la salud humana. La actividad antioxidante puede asociarse a la presencia de componentes bioactivos, tales como los carotenoides y las vitaminas antioxidantes. Las características físicas y químicas, el valor nutritivo, los carotenoides y las vitaminas antioxidantes se evaluaron en los frutos del mangaba del Cerrado de Minas Gerais, en Brasil. **Material y métodos**. Se determinó la acidez valorable por neutralización volumétrica, el pH por potenciometría, el contenido de sólidos solubles por refractometría, la humedad por gravimetría tras secado en horno, el contenido de cenizas por calcinación en un horno de mufla, las proteínas por el método micro Kjeldhal, las fibras alimentarias por el método gravimétrico no-enzimático y los lípidos por gravimetría tras extracción con el éter dietílico. La vitamina C (ácidos ascórbico y ácido dehidroascórbico) y los carotenoides (α-caroteno, β-caroteno, β-criptoxantina y licopeno) se analizaron por HPLC-DAD. La vitamina E (α, β, γ y δ-tocoferoles y tocotrienoles) y los folatos (tetrahidrofolato, 5-metiltetrahidrofolato y 5-formil tetrahidrofolato) se analizaron por HPLC con detección de fluorescencia. **Resultados y discusión**. Los frutos del mangaba mostraron un alto rendimiento en pulpa (80,08 %), en humedad (83,0 mg·100 g^{-1}), así como un fuerte contenido de fibras alimentarias (2,3 g·100 g^{-1}). Contienen β-caroteno, β-criptoxantina, ácido ascórbico, α-tocoferol, α-, β- y γ -tocotrienoles, tetrahidrofolato, 5-metiltetrahidrofolato y 5-formil tetrahidrofolato. Pueden considerarse como una excelente fuente de vitamina C (165,8 mg·100 g^{-1}) y de folatos (98,3 ug·100 g^{-1}). Los contenidos de carotenoides y vitamina E fueron de 0,12 mg·100 g^{-1} y 2732,5 μg·100 g^{-1}, respectivamente. **Conclusión**. Los frutos del mangaba presentan un alto rendimiento en pulpa, varios carotenoides y vitaminas antioxidantes. Pueden considerarse como una excelente fuente de vitamina C y de folatos.

Brasil / Minas Gerais / *Hancornia speciosa* / frutas / propiedades fisicoquímicas / antioxidantes / ácido ascórbico / vitamina E / folatos