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Physical and physicochemical composition of mangaba fruits (*Hancornia speciosa* Gomes) at three maturity stages

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The mangaba (*Hancornia speciosa* Gomes) is a typical fruit of the Brazilian cerrado and caatinga. It has excellent nutritional composition but there are no studies reporting the fruit characteristics and its industrial use. The aim of this study was to analyze the physical and physicochemical characteristics of mangaba fruit in three different maturity stages. Fruit weight, volume, length, titratable acidity, vitamin C, soluble solids and color at 1/3 ripe, 2/3 ripe and ripe maturity stages were analyzed. Physical characteristics showed great potential for industrialization due to the size and weight of fruits. High vitamin C levels and low acidity indexes were obtained, which are of interest for use of fruits in jams, jellies and liquors. However, soluble solids content was lower for ripe fruits, which indicates low sugar contents. Thus, the fruit has potential for consumption in the natural form and for processing and can be incorporated into many food products.

Key words: Maturation, composition, economic potential.

INTRODUCTION

Mangaba tree (*Hancornia speciosa Gomes*) is a native species of the *Apocynaceae* family. The fruit species occurs spontaneously in the Mid-western, Northern, Northeastern and Southeastern Brazil, being especially appreciated by consumers and cottage industries for the production of sweets, liquor, wine, soft drinks and jellies (Ganga et al ., 2010; Silva et al., 2007). The fruit exploitation is extractive and accounts for almost the entire demand of the domestic production (Freitas et al., 2010). Technical mangaba cultivation occurs in few Brazilian areas, mostly in Northeastern Brazil (Silva, 2004).

Mangaba has excellent physical features, aroma, flavor and nutritional qualities (Santos et al., 2009). The

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Table 1. Physical and physicochemical characteristics of mangaba fruits at three maturity stages.

Parameter	Fruits 1/3 ripe	Fruits 2/3 ripe	Ripe fruits
Volume (cm^3)	18.20^b	24.68^b	41.74^a
Length (mm)	31.37^b	33.76^b	40.76^a
Mass (g)	18.70^c	27.01^b	41.91^a
Vitamin C (mg de ascorbic acid /100g)	188.33^a	184.57^a	174.12^a
Titratable Acidity (% total acid)	6.50^a	4.50^a	6.41^a
Soluble solids (°Brix)	8.95^a	8.78^{ab}	7.94^b
L	39.81^a	48.42^b	44.26^{ab}
a*	-21.48^a	-21.10^a	-21.84^a
b*	40.60^a	44.95^a	40.25^a

fruit is fleshy with ellipsoid or rounded shape with creamy and juicy pulp and sweet and slightly acidic flavor. The color of the fruit is predominantly greenish or yellowish and may have red pigments (Santos et al., 2012).

There are few studies on the physical and physicochemical characteristics of mangaba fruits at different maturity stages. Therefore, this study aimed to study mangaba fruits and its physical and physicochemical characteristics at three maturity stages.

MATERIALS AND METHODS

Mangaba fruits from an area under homogeneous cultivation in the region of Caçu-GO. (18°33'S and 51°08'W) were manually harvested in October 2013 and brought to the Fruits and Vegetables Laboratory, Instituto Federal Goiano, Rio Verde Campus-GO. Fruits were selected by size, color and absence of mechanical injuries, sanitized in chlorinated water for three minutes (100 mg / L).

For physical, vitamin C, titratable acidity and soluble solids analyses, fruits were divided into three maturity stages. The average volume of the fruit was calculated using a 1000mL Vidrolab test tube by water displacement. Fruit diameter was analyzed with Digital Caliper Model Digimess. The average weight of fruits was carried out by weighing 50 fruits on an analytical scale.

Soluble solids content was determined using the Abbe Refractometer and expressed in °Brix (AOAC, 1992). Titratable acidity levels were determined by AOAC methodology (1992). Ascorbic acid content was determined by titration with potassium iodate (AOAC, 1992). External appearance of fruits was evaluated with respect to color instrumental parameters according to the CIELab L *, a *, b * system, and the results were expressed in L *, a * and b *, where L * (brightness) ranged from black (0) to white (100), a * values ranged from green (-60) to red (60), and b * values from blue (-60) to yellow (+60). The results were presented according to the Tukey test ($p < 0.05$).

RESULTS

Volume, longitudinal diameter and mass of mangaba fruits analyzed showed significant differences from each other. According to Table 1, the physical characteristics of mangaba fruits showed higher values for ripe fruits. Freitas et al. (2012) studied ripe mangaba fruits and determined average mass of 20.97 g, which is lower than value determined for ripe fruits of this work, 41.91g. Mangaba clones analyzed by Souza et al. (2007) showed mass values between 42.07 and 21.74 g. The length of these clones ranged from 35.01 to 45.62 mm (Souza et al., 2007), whose values are close to those found for the three maturity stages of mangabas fruits studied here.

The physical characteristics of fruits showed acceptable values according to factors specific to species such as genetic characteristics, maturity stage, place of cultivation and harvest times (Soares et al., 2008).

The highest vitamin C levels were found for fruits 1/3 ripe. In mangaba clones, values ranged from 139.83 to 188.75 mg of ascorbic acid / 100 g pulp (Souza et al., 2007), which are close to those found in this work. Mangaba fruits kept under refrigeration showed lower values (132.60 to 166.49 mg $100g^{-1}$) (Campos et al., 2011). Carnelossi et al. (2004) observed higher values for ripe and fallen mangaba fruits, ranging from 252.7 to 274.7 mg 100 g^{-1}.

Differences in vitamin C levels may be related to the role of this vitamin as antioxidant due to oxidative reactions that occur during fruit ripening. Research with "citrus" revealed that there is a drop in the vitamin C content of fruits during fruit ripening (Malgarin et al., 2008).

Titratable acidity values ranged from 0.045 to 0.065% citric acid for mangaba fruits. The titratable acidity of newly harvested ripe mangaba fruits analyzed by Campos et al. (2011) was 0.554 g / 100 g of pulp, Carnelossi et al. (2004) determined 0.8%, and Soares et al. (2008) found values ranging from 0.38 to 0.78% citric acid, which are higher than values found in this study.

Differences in acidity levels may be associated with fruit breathing and hydrolysis rates of pectin present in the cell wall of fruits (Borges et al., 2000), which may vary according to the region where fruit is grown.

Soluble solids values ranged from 7.94 to 8.95 ° Brix, which are lower than those found by Cohen and Sano (2010) from 17.7 to 20.3 ° Brix. For mangaba fruits kept

Table 2. Pearson correlation among physical and chemical variables for mangaba fruits 1/3 ripe.

Variables	Volume	Length	Mass	Vitamin C	Titratable acidity	Soluble solids	L	a	b
Volume	-	0.65 ns	0.47 ns	0.45 ns	0.08 ns	0.41 ns	0.42 ns	-0.65 ns	0.59 ns
Length	-	-	0.40 ns	0.03 ns	-0.01 ns	0.35 ns	0.87 *	-0.54 ns	0.66 ns
Mass	-	-	-	0.84 *	0.76 ns	0.544 ns	0.02 ns	-0.96 *	0.90 *
Vitamin C	-	-	-	-	0.95 *	0.18 ns	-0.42 ns	-0.83 *	0.54 ns
Titratable acidity	-	-	-	-	-	-0.10 ns	-0.48 ns	-0.70 ns	0.32 ns
Soluble solids	-	-	-	-	-	-	0.34 ns	-0.51 ns	0.74 ns
L	-	-	-	-	-	-	-	-0.12 ns	0.40 ns
a	-	-	-	-	-	-	-	-	-0.89 *
B	-	-	-	-	-	-	-	-	-

Table 3. Pearson correlation among physical and chemical variables for mangaba fruits 2/3 ripe.

Variables	Volume	Length	Mass	Vitamin C	Titratable acidity	Soluble solids	L	a	b
Volume	-	0.66 ns	0.63 ns	-0.61 ns	0.33 ns	-0.34 ns	0.50 ns	0.68 ns	-0.02 ns
Length	-	-	0.41 ns	-0.36 ns	0.42 ns	0.19 ns	0.28 ns	0.05 ns	0.06 ns
Mass	-	-	-	-0.63 ns	0.28 ns	-0.12 ns	0.79 ns	0.65 ns	0.15 ns
Vitamin C	-	-	-	-	0.43 ns	-0.32 ns	-0.74 ns	-0.27 ns	-0.34 ns
Titratable acidity	-	-	-	-	-	-0.59 ns	-0.07 ns	0.42 ns	-0.29 ns
Soluble solids	-	-	-	-	-	-	0.04 ns	-0.73 ns	0.25 ns
L	-	-	-	-	-	-	-	0.30 ns	0.70 ns
a	-	-	-	-	-	-	-	-	-0.35 ns
b	-	-	-	-	-	-	-	-	-

at room temperature with yellow aspect and red pigments, values ranging from 11 to 15 ° Brix were found (Santos et al., 2009). However, Parente et al. (1985) found values between 7.5 and 13 ° Brix for mangaba fruits harvested in the Federal District.

Mangaba is a climacteric fruit, therefore, the SS content increases with maturation. This fact is related to the biosynthesis of soluble sugars or degradation of polysaccharides (Kays, 1997). The decrease in SS contents can be related to fruit selection and low values are related to the region that mangaba is grown, since this rate is related to the presence of sugars in chemical reactions.

Regarding the color of fruits at different maturity stages, only brightness showed statistical differences, parameters a * and b * remained statistically equal and brightness tends to increase during ripening. Jha et al. (2006) reported that the brightness value of fruit shell decreases during growth and increases during ripening when yellowing occurs.

Comparing variables analyzed in Table 2, positive correlation between mangaba mass and vitamin C, vitamin C and total acidity, length and brightness was found. In addition, negative correlation between vitamin C and color parameter a *, mangaba mass and color parameters a * and b * and between color variables a * and b * was also found. The vitamin C or ascorbic acid content was positively associated with total acidity, indicating that ascorbic acid may influence the acid flavor of fruits. The negative correlation between color parameters a * and b * is compatible, since there are changes in fruit pigments, i.e., there is a decrease in chlorophyll and increase in carotenoids.

Table 3 showed no significant correlations among variables analyzed. In Table 4, fruit volume is positively related to vitamin C content; fruit mass is negatively related with color parameter b * and parameter L is negatively related with parameter b *.

Conclusion

Mangaba fruits showed physical qualities similar to those found in literature and are consumed by industries and in the fresh form by consumers. It was observed that fruits showed relevant physicochemical characteristics, with high vitamin C contents and low acidity. The correlation between physical and chemical variables can estimate production parameters during the processes of mangaba selection. However, further studies are needed to analyze the SS content, which values were not in agreement with literature.

Table 3. Pearson correlation among physical and chemical variables for mangaba fruits 2/3 ripe.

Variables	Volume	Length	Mass	Vitamin C	Titratable acidity	Soluble solids	L	a	b
Volume	-	0.66 ns	0.63 ns	-0.61 ns	0.33 ns	-0.34 ns	0.50 ns	0.68 ns	-0.02 ns
Length	-	-	0.41 ns	-0.36 ns	0.42 ns	0.19 ns	0.28 ns	0.05 ns	0.06 ns
Mass	-	-	-	-0.63 ns	0.28 ns	-0.12 ns	0.79 ns	0.65 ns	0.15 ns
Vitamin C	-	-	-	-	0.43 ns	-0.32 ns	-0.74 ns	-0.27 ns	-0.34 ns
Titratable acidity	-	-	-	-	-	-0.59 ns	-0.07 ns	0.42 ns	-0.29 ns
Soluble solids	-	-	-	-	-	-	0.04 ns	-0.73 ns	0.25 ns
L	-	-	-	-	-	-	-	0.30 ns	0.70 ns
a	-	-	-	-	-	-	-	-	-0.35 ns
b	-	-	-	-	-	-	-	-	-

Table 4. Pearson correlation among physical and chemical variables for ripe mangaba fruits.

Variables	Volume	Length	Mass	Vitamin C	Titratable acidity	Soluble solids	L	a	b
Volume	-	0.65 ns	0.63 ns	0.96 *	-0.71 ns	0.31 ns	-0.20 ns	-0.44 ns	-0.48 ns
Length	-	-	0.40 ns	0.69 ns	-0.45 ns	0.44 ns	-0.43 ns	-0.64 ns	-0.32 ns
Mass	-	-	-	0.74 ns	-0.29 ns	-0.03 ns	-0.67 ns	0.20 ns	-0.88 *
Vitamin C	-	-	-	-	-0.68 ns	0.33 ns	-0.37 ns	-0.40 ns	-0.63 ns
Titratable acidity	-	-	-	-	-	0.17 ns	-0.31 ns	0.74 ns	0.01 ns
Soluble solids	-	-	-	-	-	-	-0.45 ns	-0.2 ns	-0.31 ns
L	-	-	-	-	-	-	-	-0.34 ns	0.86 *
a	-	-	-	-	-	-	-	-	-0.34 ns
b	-	-	-	-	-	-	-	-	-

Conflict of Interests

The authors have not declared any conflict of interests.

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