

Physico-Chemical Quality Changes in Mangaba (*Hancornia speciosa* gomes) Fruit Stored at Different Temperatures

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ABSTRACT

The physical-chemical quality changes in mangaba fruit were studied. The fruit which attained full development at half-ripe stage were harvested and initially stored at 6, 8, 10 and 12±1°C for four days. After this period, the fruit were transferred to an acclimatized room (24±2°C) and maintained for five days. For control purposes, recently harvested fruit were stored directly in an acclimatized room (24±2°C) for six days. After the transfer and storage at 24°C, fruit were analyzed daily for their vitamin-C, soluble solids (°Brix), titratable acidity, pH and firmness contents. In fruit directly stored at 24°C, there was a sharp fall in vitamin C and acid contents. The fruit firmness decrease, after four days of storage, and they turned totally ripe. The fruit which were initially maintained at 6 or 8°C did not show any significative difference in physical-chemical quality during the storage.

Key words: Cold storage, postharvest, tropical fruits, vitamin C

INTRODUCTION

The plant mangabeira (term referred for trees of mangaba fruit) is a tropical plant, native of Brazil, which possesses a great potential for economic exploration. Mangaba fruits are utilized by processing industries for the production of juices, refreshing drinks, wine, liquor, ice-cream and syrups (Narain, 1990). In the state of Sergipe situated in the northeast region of Brazil, mangaba is one of the major fruit and very much sought in open markets, attaining even a price higher than that of grape and other noble fruits. The fruit also presents good digestibility, high nutrition value and the contents of protein and vitamin C higher than majority of the fruits. The native plants are

still their main source of exploration as there is no systematic plantation for its commercial use (Vieira Neto, 1994). In being an exotic fruit very little known, studies on its post-harvest conservation and storage of this fruit attain great importance for the rational utilization of mangaba. The harvest time for mangaba is based on the changes involved with the tonality in its skin color varying from green to light yellow with some black spots. In this stage, known as half-ripe, the fruit are still physiologically ripe as verified with the pressing of fruit with fingers which presents a little fragility and the fruits ripen between 2 to 4 days after harvest (Narain, 1990; Vieira Neto, 1994; Vieira Neto, 2002). Fruit when totally ripe get detached and fall from the plant, resulting

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sometimes in bruising of the fruits and loss in its appearance. These fruit are denominated "as of natural fall" and although being highly perishable, these are much more valorized in commercial terms (Carnelossi et al., 2004).

The refrigerated storage is one of the most important methods used in the maintenance of the quality of the fruits, which consequently results in a decrease in the metabolic processes involved with maturation and thus maintains the fruit quality for a longer period (Chitarra & Chitarra, 2005). Due to its intense metabolic activity after the harvest which results in ripening of the fruits very rapid and hence a short shelf-life of 3 or 4 days even when harvested in the state of half-ripe stage (Alves et al., 2005). It is, therefore, important to study the temperature and storage effects on the conservation of these fruits by adjusting its refrigerated conservation.

The objective of the present work was to study the physico-chemical quality changes and storage life of half-ripe mangaba fruit when stored under refrigerated conditions.

MATERIALS AND METHODS

Mangaba fruit were harvested in the morning periods from the trees in the municipality of Itaporanga D'Ajuda in the state of Sergipe in Brazil. The fruit were selected and classified according to its skin color and development stage. The fruit, totally developed on the plant, which possessed externally yellowish-green color with red spots were classified as half-ripe (Vieira Neto, 2002). After selection, the fruit were transported in small cardboard boxes to avoid any mechanical damage, the fruit were washed and again selected in order to obtain whole unbruised fruit.

Fruit Storage

Mangaba fruit were stored at 6, 8, 10 and 12°C ($\pm 1^\circ\text{C}$) in the chilled rooms for an initial period of four days. After this period, the fruits were removed from the chilled room and transferred to an acclimatized room ($24 \pm 2^\circ\text{C}$), where the fruits were maintained for further five days, the total storage time of fruit thus being of nine days.

Recently harvested fruit were also maintained directly in an acclimatized room ($24 \pm 2^\circ\text{C}$) for six days for evaluation of their ripening and these fruit were considered as of control.

Analytical Conditions

During the storage period, vitamin C, total soluble solids ($^\circ\text{Brix}$), total titratable acidity, pH and firmness contents of the fruits were determined.

The vitamin C content was determined according to the methodology of AOAC (2002) and expressed in $\text{mg } 100 \text{ g}^{-1}$ of whole fruit.

The pH was determined in the filtrate obtained after homogenization of 10 g of fruit pulp dissolved in 10 ml of water and filtered through two layers of cotton. The filtrate was transferred to a beaker, the volume of which was completed to 100 ml with distilled water and the pH values were determined using a potentiometer.

The total titratable acidity (TTA) was determined in the filtrate under agitation, with NaOH (0.1 N), using phenolphthalein (1%) as an indicator. The results were expressed as % citric acid contents.

The total soluble solids content ($^\circ\text{Brix}$) was determined by taking 2 mL of extract, obtained after applying a manual press from approximately 5g of fruit pulp. The determinations were made using an Abbe refractometer (Type WYA model 2WA-J, Biobrix).

The fruit firmness was determined by utilizing a penetrometer (make TR, model FT 327) with a 8 mm needle and the values were expressed in Newton (N).

Statistical analysis

The statistical experimental design was completely randomized, in factorial arrangement of storage of fruits at five different temperatures (6, 8, 10, 12 and 24°C) for different storage periods (0, 1, 2, 3, 4, 5 days after an initial storage of four days of fruit at lower temperatures; fruit considered as Control did not have initial storage of four days at lower temperatures). The data were expressed as mean values of five samples analysis and were subjected to ANOVA (Analysis of variance). Differences among the treatments were analysed for significative effects ($P < 0.05$) using general linear model program of SAS (1996).

RESULTS AND DISCUSSION

Table 1 presented the data on fruit firmness on all the fruit which were initially maintained at lower temperatures for four days and the control which did not have this initial storage. The fruit (Control) stored directly at 24°C presented a sharp decrease

from 49 to 1 N after five days of storage. The loss in firmness is one of the general characteristics of ripening of mangaba. When the fruits were stored initially at 6 or 8°C, the fruits maintained their firmness during all the period of refrigerated storage. After their removal from refrigeration atmosphere, the firmness of the fruits maintained

at 6 or 8°C decreased attaining the values similar to the fruits maintained initially at 24°C (Table 1), showing that the fruits ripened normally. For the fruits stored at 10 or 12°C, a fall of about 50% in its firmness was observed during the refrigeration, showing that these temperatures was not suitable for maintaining the fruit characteristics.

Table 1 - Firmness (N; mean±standard deviation) of mangaba fruit stored initially for 4 days at different temperatures (6, 8, 10 and 12°C) and later transferred to storage at 24±1°C.

Storage Temperature	Storage time (Days)					
	4+0	4+1	4+2	4+3	4+4	4+5
Control*	49±0.1 aA	39±3.3 aB	28±1.4 aC	2±1.0 aD	1±1.0 aD	1±0.0 aD
6°C	49±0.1 aA	32±4.0 bB	8±2.8 bC	3±0.6 aD	1±1.2 aD	1±0.0 aD
8°C	49±0.1 aA	27±0.7 cB	5±0.1 bcC	5±2.3 aC	1±1.1 aC	2±0.0 aC
10°C	27±1.7 bA	27± 0.1cA	5.±0.3bcB	4±2.3 aB	4±2.7 aB	3±0.3 aB
12°C	25± 0.1bA	24± 2.9cA	3±1.4 cB	3±0.3 aB	2±1.4 aB	2±0.7 aB

Means followed by different subscript letters - small for the columns and capitals for the rows were significantly different ($P<0.05$).

* These fruits did not have 4 days of initial storage at lower temperatures; instead these were directly stored at 24±1°C.

These results indicated that fruit stored at 10 or 12°C did not retard the fruit ripening as was observed in fruits initially stored at 6 or 8°C. However, the fruit maintained at 6°C, after two days of removal from refrigeration atmosphere showed chilling injury as observed by the formation of some soft pulpy areas, similar to other fruits stored at low temperatures (Wills et al., 1989). For the fruit maintained at 8°C this effect was not observed, thus suggesting that the temperature of 8°C, would be an optimum storage temperature for mangaba fruit. It was further observed that independent of temperature, mangaba fruits would ripen normally after removal from low-temperature storage.

Figure 1 presents the changes in vitamin C content during storage of mangaba fruits. After two days of storage, an increase in vitamin C content was observed in the fruit stored at 24 ±2°C. After this period, the vitamin C contents fell by about 50%. Various authors (Klein, 1987; Favell, 1998; Melo et al., 2000) report that in fruits and vegetables, vitamin C content generally decrease during their storage. However, some citric fruits and vegetables may characterize for higher retention or even an increase in their vitamin C contents when stored. In the case of asparagus, vitamin C content increased during two days of storage after the harvest when fruits were stored at 4°C (Lee & Kader, 2000). Vitamin C also acts as an important

antioxidant (Smirnoff, 1995). Thus, it could be suggested that an increase in vitamin C content observed in fruit stored at 24°C in the initial days of its storage (Fig.1) could be related to its effect as an antioxidant in response to the advances in oxidative reactions which occur during the ripening.

Fruit maintained at 6, 8, 10 and 12°C showed a slight increase in vitamin C contents during the refrigeration period. After removal of fruits from refrigerated storage, it was observed that the vitamin C content presented similar behavior as that of the fruits maintained directly at 24°C. These results indicated that the fruit maintained under refrigeration ripen normally after their removal from the cold atmosphere. However, there was no significative difference observed in the vitamin C contents between the fruit stored at 6 and 8°C.

According to the results obtained in this study, mangaba fruit contained an elevated vitamin C content being approximately, 420 mg of vitamin C in 100g⁻¹ whole fruit, when compared with other fruits, such as citric fruits, guava, mango and umbu-cajá (Alves et al., 2006). These results showed that mangaba could be considered as a fruit rich in vitamin C. It was also observed that mangaba fruit stored at 6 or at 8°C retained the vitamin C contents during the refrigerated storage.

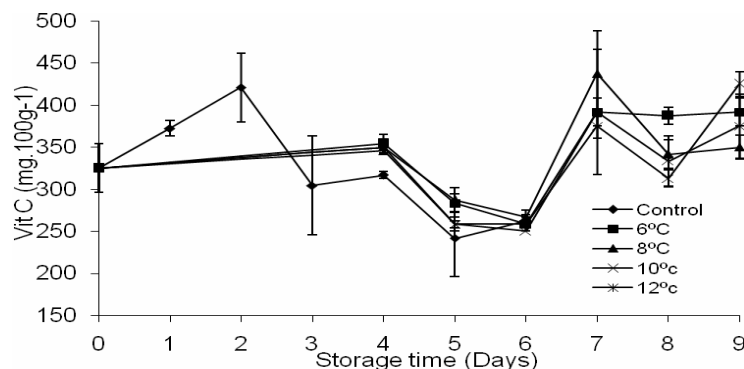


Figure 1- Vitamin C contents of mangaba fruit stored at 6, 8, 10, 12±1°C for an initial period of 4 days and later transferred to 24°C and stored 24±1°C(control). The bars represent the standard error values of the means (n=5).

For all the temperatures studied, an increase in the total soluble solids (Fig. 2A) and total titratable acidity (Fig. 2B) contents in mangaba fruit was observed during their storage. Several researchers have demonstrated that increase in total soluble solids contents during the storage was related to the conversion of starch to sugars during the ripening process of fruits (Chitarra & Chitarra, 2005; Narain et al., 2005).

According to Chitarra & Chitarra (2005), the advance ripening could cause a decrease in the total titratable acidity. However, for mangaba, this type of behavior was not observed. Similar results were also reported by Carnelossi et al. (2004) and Narain et al. (2005) indicating that this behavior could be an inherent characteristic of mangaba.

For the fruit initially maintained at 24°C, an increase in the total soluble solids contents was observed until four days of storage where after it decreased (Fig. 2A). The reduction in the total soluble solids contents was related to the degradation of the fruit with the prolonged storage. There was no significant difference observed in the total soluble solids and total titratable acidity contents among the fruit initially maintained either at 6 or at 8°C (Fig. 2A and 2B), indicating again that these temperatures were efficient in maintaining the quality of the fruit, which presented better conservation when compared with the fruits stored at either 10 or at 12°C. After the removal of the fruit from refrigeration, an increase in the total soluble solids and total titratable

acidity contents was observed which indicated that the fruit ripened normally. After nine days of storage, the fruit which were maintained initially at 6 and 8°C presented soluble solids contents lower than the fruit which were maintained either at 10 or at 12°C (Fig. 2A). However, no significant difference was observed in their total titratable acidity.

Among all the treatments tried in this study, a significant increase in pH values during storage was observed (Fig. 3). Similar results were reported by Carnelossi et al. (2004), Alves et al. (2006) and Narain et al. (2005) for mangaba fruit stored at ambient temperature(28±1°C).

CONCLUSIONS

The mangaba fruit contained high ascorbic acid content and thus it could be considered a fruit rich in vitamin C when compared with citric fruits. The fruit stored initially at 6 or 8±1°C extended the fruit's shelf-life by about four days as compared to the fruit maintained at 10 or 12±1°C for the same period. The results indicated also that fruit stored at 10 or 12°C did not retard the fruit ripening as was observed in the fruits initially stored at 6 or 8°C, being the optimum temperature of 8°C for the conservation of mangaba. It was further observed that independent of temperature, mangaba fruits would ripen normally after the removal from low-temperature storage.

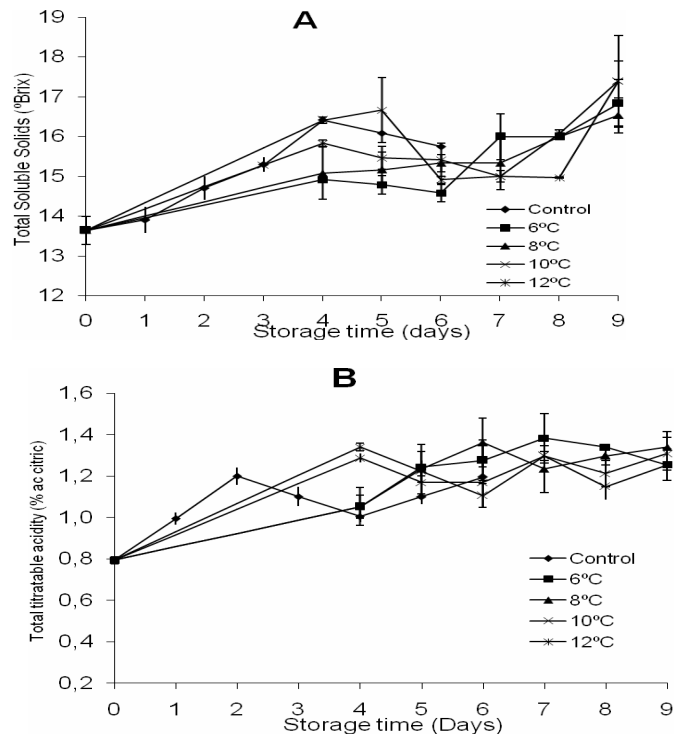


Figure 2 - Total soluble solids (A) and total titratable acidity (B) of mangaba fruit stored at 6, 8, 10, 12±1°C for an initial period of 4 day, and later transferred to 24°C and stored 24±1°C(control). The bars represent the standard error values of the means (n=5).

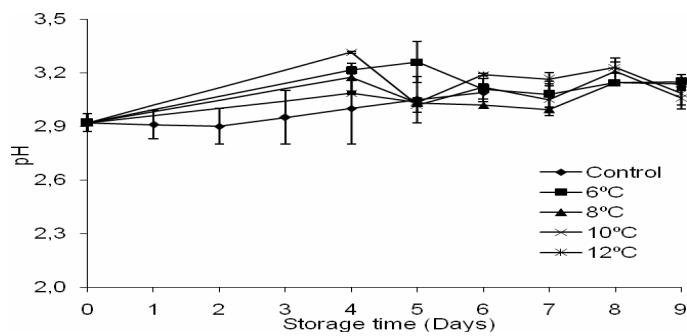


Figure 3 - pH of mangaba fruit stored at 6, 8, 10, 12±1°C for an initial period of 4 day and later transferred to 24°C and stored 24±1°C (control). The bars represent the standard error values of the means (n=5).

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RESUMO

O presente trabalho teve como objetivo estudar as mudanças físico-químicas e qualidade da mangaba. Frutos totalmente desenvolvidos, no estágio verde-maduro, foram colhidos e armazenados inicialmente em 6, 8, 10 e 2±1°C em câmaras frias por 4 dias. Após este período, os frutos foram transferidos a câmaras climatizadas (24±2°C) e mantidos por 5 dias. Para o controle, os frutos recém-colhidos foram armazenados diretamente em sala climatizada (24±2°C) por 6 dias. Após o período de refrigeração, os mesmos foram transferidos para armazenamento a 24°C, diariamente foram analisados os teores de vitamina-C, sólidos solúveis (°Brix), acidez titulável, pH e firmeza. Frutos armazenados diretamente a 24°C, houve uma queda significativa nos teores de vitamina C e ácidos. A firmeza dos frutos diminuiu, após 4 dias de armazenamento, após esse período apresentaram totalmente maduros. Frutos que foram mantidos inicialmente em 6 ou 8°C não mostraram nenhuma diferença significativa na qualidade física química durante o armazenamento.

REFERENCES

- Alves, R. E., Carnelossi, M. A. G., Silva, S. M., Figueiredo, R. W., (2006), Colheita e pós-colheita. In-A Cultura da Mangaba. Eds. Silva Junior, J.F., Ledo, A.S. Aracaju Embrapa Tabuleiros Costeiros, pp. 207-219.
- AOAC, (2002), Official Methods of Analysis. 17th edition, Association of Official Analytical Chemists. Washington, DC.

- Carnelossi, M. A. G., Toledo, W. F. F., Souza, D. C. L., Lira, M. L., Silva, G. F., Jalali, V. R. R., Viégas, P. R. A., (2004), Conservação pós-colheita de mangaba (*Hancornia speciosa* Gomes). *Ciência e Agrotecnologia*. **28**, 1119-1125.
- Chitarra, M. I. F., Chitarra, B., (2005), *Pós-colheita de Frutos e Hortaliças – Fisiologia e Manuseio*. 2. Editora UFLA, Lavras-MG, Brazil.
- Favell, D. J., (1998), A comparison of the vitamin C content of fresh and frozen vegetables. *Food Chem.*, **62**, 59-64.
- Klein, B. P., (1987), Nutritional consequences of minimal processing of fruits and vegetables. *J. Food Qual.* **10**, 179-93.
- Lee S.K., Kader, A.A., (2000), Preharvest and postharvest factors influencing vitamin C content of horticultural crops. *Postharvest Biol. Technol.* **20**, 207-20.
- Mélo, E. A., Lima, V. L. A. G., Nascimento, P., (2000), Temperatura e armazenamento de pitanga. *Scientia Agricola*. **57**, 629-34.
- Narain, N., (1990), Mangaba. In-*Fruits of Tropical and Subtropical Origin: Composition, Properties and Uses*, eds. Nagy, S., Shaw, P.E., Wardowski, W. F. FSS, Lake Alfred, pp. 159-165.
- Narain, N., Ferreira, D. S., Aragão, G.C., Aragão, W. M., (2005), *Tecnologia do processamento do fruto*. In-A *Cultura da Mangaba*. eds. Silva Junior, J. F., Ledo, A. S. Aracaju, Embrapa Tabuleiros Costeiros, pp. 220-232.
- SAS., (1996), SAS User's Guide. SAS Institute, Cary, NC.
- Smirnoff, N., (1995), *Environment and Plant Metabolism*. BIOS Scientific publishers, Oxford, UK.
- Vieira Neto, R.D., (1994), *Cultura da Mangabeira*. Aracaju: Embrapa-CPATC. 16pp. (Technical Note-02).
- Vieira Neto, R. D., (2002), Mangaba. In: *Frutíferas potenciais para tabuleiros costeiros e baixadas litorâneas*. ed. Vieira Neto. Embrapa Tabuleiros Costeiros, Aracaju.
- Wills, R. H. H., McGlasson, W. B., Graham, D., Lee, T.H., Hall, E.G., (1989), *Postharvest: An Introduction to the Physiology and Handling of Fruit and Vegetables*. AVI, Westport.

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