

NOTAS CIENTÍFICAS

Physical and chemical characteristics of sapota fruit at different stages of maturation⁽¹⁾

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Abstract – In the present work, the physical and chemical characteristics in three stages of maturation of sapota (*Manilkara zapota* L.P. Royen) fruit were studied as well as its post-harvest behavior during storage at ambient and refrigerated conditions. With the advance of maturation, the concentration of the reducing sugars increased while the total acidity and tannin contents decreased. The fruits which did not have their pedicel removed during the post-harvest presented the storage time superior when compared with the fruits having their pedicels removed. The fruits stored under refrigeration had higher weight retention as compared to the fruits stored under ambient conditions.

Index terms: analysis, post-harvest, quality, storage.

Características físicas e químicas do fruto da sapota em diferentes estádios de maturação

Resumo – No presente trabalho foram estudadas, em três estádios de maturação, as características físicas e químicas da sapota (*Manilkara zapota* L.P. Royen), bem como o seu comportamento pós-colheita durante o armazenamento, no seu ambiente natural e sob refrigeração. Com o avanço do amadurecimento, foi verificado um aumento no teor de açúcares redutores, acompanhado pela redução dos teores da acidez total e de taninos. Os frutos que não tiveram o pedúnculo removido durante a pós-colheita apresentaram um tempo de armazenamento superior aos frutos que tiveram o pedúnculo removido. Os frutos armazenados sob refrigeração tiveram uma maior retenção do peso em relação aos frutos armazenados em condições ambientais.

Termos para indexação: análise, pós-colheita, qualidade, armazenamento.

Sapota fruit (*Manilkara zapota* L. P. Royen) is a native of tropical America and it probably originated from Southern Mexico or Central America. The sweet tasting fruit possesses a delicate characteristic aroma, sometimes slightly astringent (Balerdi & Shaw, 1998). There is apparently no varietal classification of sapota fruit. Shape, size, weight, pulp colour, seed number, taste and flavour determine the cultivars characteristics. In Brazil, the cultivars are not well defined, however, in the State of Pernambuco, a study undertaken over a

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period of seven years recommended the cultivar Itapirema-31 for large scale plantations in the Northeast region of Brazil, since it produces better organoleptic characteristics, agronomic suitability for the region, with an average production of 208 kg of fruit/tree/year and the fruit weighs on an average about 187 g (Moura et al., 1983). Based on this study a large scale propagation of this cultivar was supported and now it is widespread in the Northeast of Brazil.

The sapota fruit is very much appreciated, but the production and commercialization of the fruit is limited. Furthermore, there is lack of information on the physical and chemical characteristics of the fruit during post-harvest storage.

The objective of the present study was to investigate changes in the physical and chemical characteristics of the sapota fruit at different stages of maturity and to evaluate the effect of the removal of the pedicel and of storage conditions on the shelf life of the fruit.

Sapota fruits, cultivar Itapirema-31, were harvested at the Experimental Station of the Instituto de Pesquisas Agropecuárias of the State of Pernambuco, situated in Goiana, Brazil. The fruits were harvested manually and transported to the Laboratório de Bioquímica de Alimentos of Universidade Federal da Paraíba, João Pessoa, Brazil. At the laboratory, the fruits were washed, selected and classified into three stages of maturation (green mature, half-ripe and ripe) (Table 1).

Fruit diameter and length were measured with a vernier calliper. The measurement of the length was made in the polar axis of the fruit, i.e. between apex and stem. The maximum width of the fruit, measured in the direction perpendicular to the axis was defined as diameter. The weight retention was verified daily for fruits in the mature green and the half-ripe stage with or without the pedicel, stored at ambient conditions ($27\pm 2^\circ\text{C}$ and relative humidity between 65 and 75%). The half-ripe fruits with the pedicel were also stored under refrigerated conditions ($9\pm 2^\circ\text{C}$ and relative humidity between 40 and 60%).

To conduct chemical analysis, the edible portion of the fruit was separated manually from the skin using a stainless steel knife, and triturated in a mortar until complete homogenization. The analysis except that of the alcohol insoluble solids was performed according to the standard methods presented in Ranganna

Table 1. Criteria for classification of maturation stage of sapota fruits.

Characteristics	Stage of maturity		
	Mature green	Half-ripe	Ripe
Facility to remove skin dust during washing	Difficult	Difficult	Easy
Skin color	Light green	Light brown	Brown
Texture	Hard	Semi-hard	Soft
Facility to remove pedicel	Difficult	Normal	Easy

(1986). The alcohol insoluble solids were analysed according to the method of Roe & Bruemmer (1981).

Five samples obtained from fruits of each maturity were analysed in triplicate. Results were compared by the analysis of variance. Significant differences amongst means were confirmed using the Tukey test for multiple comparisons at $P < 0.05$.

The average diameter and length of the half-ripe sapota fruit were 7.5 and 6.4 cm, respectively, and there was a significant difference in these parameters between the mature green and the half-ripe stages (Table 2). There was a greater increase in diameter than in the length during the change from mature green to half-ripe. The fact that the diameter was greater than the length classifies the fruit more towards round in shape. In a total of twenty-three cultivars studied, only six had round fruits, and all these six fruits had a higher standard deviation than the fruits of cultivar Itapirema-31 (Lakshminarayana & Rivera, 1979; Moura et al., 1983; Abdul-Karim & Bakar, 1989). From the mature green to the half-ripe stage there was a great increase in the weight of the fruit, from an average of 91.9 to 198.4 g. Fruits of Itapirema-31 were smaller than the three Mexican cultivars (Lakshminarayana & Rivera, 1979), but the standard deviation of the Brazilian fruit was lower which leads to a more uniform fruit weight.

Table 2. Physical, physico-chemical and chemical characteristics (mean±standard deviation) value of the sapota fruit at different stages of maturity⁽¹⁾.

Parameter	Stage of maturity		
	Mature green	Half-ripe	Ripe
Physical characteristics			
Weight (g)	91.9±10.9a	198.4±28.5b	197.5±26.9b
Diameter (cm)	5.7±0.3a	7.5±0.4b	7.6±0.5b
Length (cm)	5.1±0.7a	6.4±0.3b	6.4±0.5b
Length/diameter ratio	0.9±2.3a	0.9±0.8a	0.8±1.0a
Physico-chemical characteristics			
pH	5.89±0.08a	5.81±0.07a	4.95±0.14b
°Brix	21.40±0.74a	23.20±0.57b	15.80±1.30c
Titrateable acidity (mEq NaOH/100 g)	3.5±0.6a	3.3±0.6a	1.5±0.2b
°Brix/titrateable acidity	6.1±1.2a	7.0±1.0a	10.5±6.5b
Chemical characteristics			
Moisture (%)	76.8±1.3a	76.6±1.7a	75.1±0.9a
Reducing sugars (%)	9.6±0.4a	9.3±0.2a	12.5±0.9b
Non-reducing sugars (%)	2.2±0.2a	5.6±0.9b	1.0±0.8a,c
Total sugars (%)	11.4±0.4a	14.8±0.7b	13.5±1.7a,b
Fiber (%)	2.5±0.2a	2.2±0.1b	0.6±0.1c
Alcohol insoluble solids (%)	9.9±1.3a	7.3±0.4b	2.4±0.4c
Lipids (%)	1.3±0.2a	1.0±0.1a	0.5±0.1b
Ash (%)	0.4±0.1a	0.5±0.1a	0.4±0.1a
Ascorbic acid (mg/100 g of pulp)	21.7±2.7a	18.0±2.5a	Trace ⁽²⁾
Tannin (% tannic acid)	4.5±0.6a	0.3±0.1b	0.2±0.1b

⁽¹⁾Means in each row followed with different letters were significantly different at 5% probability level, by Tukey test. ⁽²⁾Less than 1 mg/100g pulp.

The sweet and pleasant taste of the sapota fruit is related to the reduced values of the titratable acidity (1.5 mEq NaOH/100 g) and pH (4.95) which was a little lower than the average value (5.2) reported by Balerdi & Shaw (1998) (Table 2). These parameters had no significant difference between the fruits of mature green and half-ripe stages, but were reduced significantly at the ripe stage. The low acidity associated with the high brix value (15.8°) resulted in an elevated °Brix/acidity ratio, characteristic of the sapota fruit. The brix changed in all the three stages of maturity with a reduction from the half-ripe to the ripe stage. The lower brix value for the ripe fruit in relation to the mature green and half-ripe fruits could be related to the latex interference in the refratometric measurement, since in the ripe fruits there was a lower amount of alcohol insoluble solids (2.4%) as compared with the mature green (9.9%) and half-green (7.3%) fruits.

The total sugars increased from the mature green (11.4%) to the half-green (14.9%) stage mainly due to the increase in the non-reducing sugars which increased from 2.2 to 5.6% (Table 2). Subsequently, during the maturation, the total sugars content did not differ significantly, however, the non-reducing sugars decreased from 5.6 to 1.0% and the reducing sugars increased from 9.3 to 12.5%, which is attributed to the sucrose inversion.

The moisture and the ash contents were the only parameters that did not significantly change in the fruits of different stages of maturity (Table 2). Lipids decreased from the half-ripe (1.1%) to the ripe stage (0.5%). Tannins had a greater decrease between the mature green (4.6%) and the half-ripe stage (0.3%), which was attributed by Lakshminarayana & Rivera (1979) primarily to the increase in the fruit size. Mature fruit is not a good source of vitamin C because of its great reduction from the half-ripe to the ripe stage. The sapota fruits are considered a good source of fiber (Balerdi & Shaw, 1998) but the fruits of the cultivar Itapirema-31 had a lower fiber content in the mature fruit (0.6%), the value being almost four times lower than that in the green and half-ripe stages.

Mature green fruit retained less water than the half-ripe fruits which have a lower surface area/volume relation (Figure 1). The half-ripe fruits with and without the pedicel had a similar behaviour in relation to the weight retention, but the fruits without the pedicel got rotten on the eighth day while the fruits with the pedicel remained adequate for consumption until the fourteenth day. The manual removal of the pedicel causes a mechanical injury that makes the fruits susceptible to infestation, accelerating the ethylene production and consequently resulting in an early senescence. It was also observed that the use of scissors to cut the pedicel resulted in an improvement in the quality of sapota fruit. The storage of the half-ripe fruits under refrigeration led to a greater weight retention as compared with the fruits stored under ambient conditions (Figure 2). This behaviour was also noted for sapota fruit stored in dry ambient conditions (Broughton & Wong, 1979). Furthermore, refrigerated storage extended the shelf life of the fruits by approximately ten days.

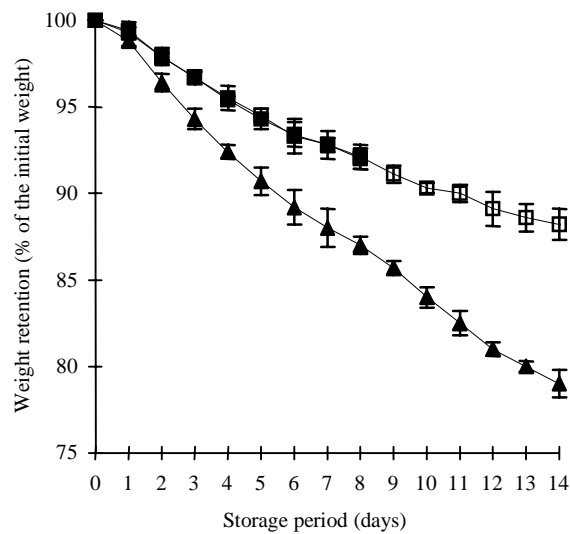


Figure 1. Weight retention of sapota fruit stored at ambient conditions ($27\pm 2^{\circ}\text{C}$ and 65-75% relative humidity) (\square : half-ripe fruit with pedicel; \blacksquare : half-ripe fruit without pedicel; \blacktriangle : mature green fruit with pedicel).

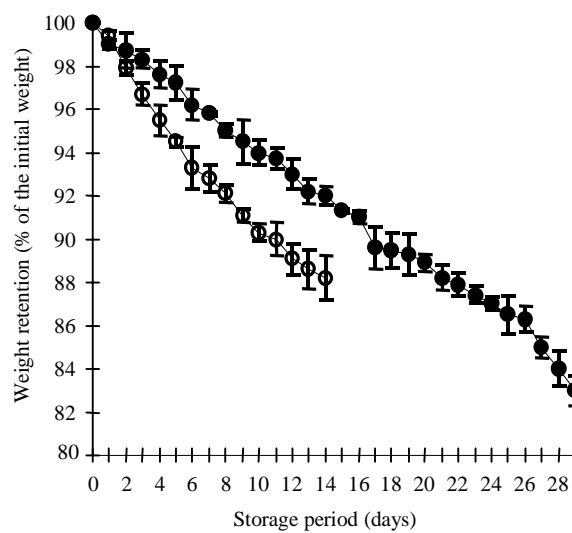


Figure 2. Weight retention of half-ripe sapota fruit with pedicel stored at ambient ($27\pm 2^{\circ}\text{C}$ and 65-75% relative humidity) and at refrigerated ($9\pm 2^{\circ}\text{C}$ and 40-60% relative humidity) conditions (\circ : ambient storage; \bullet : refrigerated storage).

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