Sapodilla (*Manilkara zapota* L.) Maturation and Conservation of Submitted to Postharvest Treatment with 1-Methylcyclopropene

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Abstract

The sapodilla is an exotic fruit adapted to edafo-climatic conditions from the Brazilian Northeast region in Brazil and show high potential for exportation; although, it is perishable and need technologies to increase its shelf-life. Considering what it has been said above, the aim of this work is to evaluate the use of ethylene action blocker (1-MCP) on sapodilla ripening control. The fruits were harvested at physiological maturation stage and treated with 100, 200 and 400 nL.L\(^{-1}\) of 1-MCP by 12 hours into sealed chambers at 25±2ºC and 70±5% relative humidity. After opening the chamber, the fruits were stored on the same conditions by 23 days. The analyzed parameters were: mass loss, external appearance, firmness, pulp colour, total titratable acidity, pH, total soluble solids (TSS), total soluble sugar (SS) and phenolic compounds. The experimental design was fully randomized with three replicates of four fruits each. There was a significant difference between the control fruits and those fruits treated with 1-MCP for the analyzed variables, excepting TSS, SS, pH and pulp chromaticity. Fruits which were treated with 1-MCP showed an increase of six days in shelf-life. The 200 and 400 nL.L\(^{-1}\) dosages were more efficient than the 100 nL.L\(^{-1}\) dose to delay the sapodilla firmness and pulp colour during ripening.

INTRODUCTION

Sapodilla is an exotic fruit adapted to edafo-climatic conditions from the Brazilian Northeast region, and it shows a high export potential. Its fruits are rich in sugar and phenolics compounds with excellent flavour and taste for consumption in natura. In spite of the sapodilla great potential as a fruit full alternative for the Northeast region agroindustry in Brazil, it needs technologies for being handled and post-harvest keeping (Bandeira et al., 2003).

Sapodilla is a climacteric fruit (Sastry, 1970). Hence, ethylene is in charge of initial ripening procedure and coordination process. There have been utilized inhibitors of ethylene action to delay the fruits ripening. Currently, the 1-Methylcyclopropene (1-MCP), which is a gaseous compound that inhibits the ethylene perception, has stood out because it is linked in an irreversible way to the receiver protein (Bower et al., 2003). As it has been exposed above and based on these facts, this work aims to evaluate the ethylene action blocker use (1-MCP) in ripening control of sapodilla.

MATERIALS AND METHODS

Sapodilla fruits were harvested from a commercial orchar localized in JAISA (Jaguaruana P.L.C.) Agroindustry in Ceara state-Brazil. The fruits were harvested in their physiological maturation stage, being treated with 0, 100, 200 and 400 nL.L\(^{-1}\) of 1-MCP by 12 hours into sealed chambers at 25±2ºC temperature and 70±5% relative humidity

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(RH), releasing gas from a commercial powered formulation. Concentrations were achieved following the manufactures instructions (Floralife product specification sheet). After that, chambers were opened and sapodilla placed on polyestirene trays, each of them containing four fruits being wrapped with PVC film (polyvinyle chloride) with 12 μ thickness, PVC film to reduce the ripening inequality among them that is very high, as well as to reduce the weight loss that is high too. Then, they were stored in the same conditions of the treatment (25±2°C and 70±5% RH) for 23 days being the assesses made by periods of 0, 4, 8, 11, 14, 17, 20 and 23 storing days.

The analyzed variables were: mass loss, using a semi-analytical weighing machine; external appearance adapting a subjective scale with grades ranging from 0 to 4, when grade 0 corresponded to none of fruits decay exhibiting signals of fungal decay and wrinkling, 1≤25% 2 = 25 to 50%; 3 = 50 to 75% and 4 = 75 to 100% (Miranda et al., 2000); firmness using an electronic texturometer; pulp colour obtained by using a Minolta Chroma Meters, CR-300 model, which showed the colour through three parameters - Lightness (L) indicating brightness, chromaticity (C) that showed pureness and Hue angle (H) reporting colour variability with a value of 90º representing a total yellow colour and 180º a total green colour; total titratable acidity with NaOH 0,1 N (IAL, 1985); pH with a potentiometer; total soluble solids by a refractometer (AOAC, 1992); total soluble sugars indicated by antrona method (Yemm and Willis, 1954); and phenolic compounds in accordance with Reicher et al. (1981) method according to their soluble in water, 50% methanol and pure methanol.

The experimental design was that entirely randomized in a 4 x 8 factorial design (4 concentrations and 8 storing time) with three replications and four fruits per set. The obtained data were submitted to a variance analysis and when a significant variance was found, the polynomial regression analysis was accomplished to time factor. To dose factor the averages were tested by the Tukey test at a 5% percent probability level.

RESULTS AND DISCUSSION

There was not a significant interaction between storing time factors and 1-MCP dose, however, the isolated factors were significant. Table 1 shows that fruits that had been treated with 1-MCP were statistically different from those of the control fruits and that the 1-MCP tested dosages showed no significant difference. Mean while the fruits treated with 1-MCP upheld optimal appearance for consumption until 20 days, the control fruits maintained theirs until the 14th day. The main limit factor of the fruits appearance was the high incidence of Pestalotiopsis fungus, either on the fruits treated with 1-MCP as on the control fruits, probably due to the high humidity provoked within the trays because of the use of PVC film.

The fruits treated with 1-MCP have had a lesser mass loss than those of the control, regardless the utilized 1-MCP dose (Fig. 1). The mass loss highest value was about 10% for fruits control at the end of the storage period, value considered still low for sapodilla, indicating that the use of PVC film has quite reduced the mass loss avoiding that so common wrinkled appearance in stored sapodilla without a modified atmosphere. The mass loss reduction by the 1-MCP influence has been registered in other fruits such as apples and pears (Baritelle et al., 2001).

The treatment with 1-MCP kept the fruits firmness (Fig. 2). A 100 nL.L⁻¹ dosage showed lower mean values than those ones of 200 and 400 nL.L⁻¹ dose which were very similar. Fruits control has showed a sharp decrease on firmness from 81,06 N to 10,01 N after 8 days storing while the fruits treated with 100 nL.L⁻¹ of 1-MCP got a similar softening at the end of the 14th day storing time and those with 200 and 400 nL.L⁻¹ dosage only after 20 days storing. The treatment with 1-MCP and 450 nL.L⁻¹ dosages by 24 hours at 20°C decreased significantly the softening rate and mass loss in avocados (Jeong et al., 2002). Nevertheless, it has also been observed the existence of some fruits such as orange, that the treatment with 1-MCP does not show any effect over firmness and mass loss (Porat et al., 1999).

We have observed significant interaction among factors for lightness, hue angle
and chromacity. The luminousness and hue angle values indicated that the treatment with 1-MCP was efficient to delay the pulp colour. It was also possible to observe that the 200 and 400 nL L$^{-1}$ doses have been more efficient than the 100 nL L$^{-1}$ dose (Figs. 3A, B, C). These results agree with others found in specific literature, which reports that the 1-MCP has influence in the enzymatic activity such as phenilalmine ammonia liase and chlorofilase, which an important on the fruits development and colour (Jiang et al., 2001; Porat et al., 1999).

Interaction among the factors was significant to the titratable acidity (Fig. 4); however, for pH just the isolated time factor was significantly different from the control fruits to total titratable acidity. An increasing tendency was also observed on total titratable acidity, and consequently, a diminishment on the pH when the storage period is over, probably due to the sugar fermentation that occurs during the senescence.

The isolated factors were significant for total soluble solids, but for total soluble sugars, only the storing time factor was significant. Nevertheless, it can be observed in Table 1, that the fruits treated with 1-MCP did not show significant difference of the control fruits for total soluble solids. Hofman et al. (2001) also observed in apples treated with 1-MCP little or no alteration on solid soluble content when it was compared with the control fruits. For total soluble sugars, there was a small increasing tendency during the storage period (Fig. 5). Pathak and Bhat (1952) have reported that during the sapodilla ripening, its latex is metabolized and then transformed in sucrose. As alteration in sugars contains is very little during the storing period, probably, the substrate for respiration is coming out either from the latex, or from the cellular wall compounds solubilization.

The isolated factor as well as interaction among them, have presented significant effects to the three phenolic fractions. The treatment with 1-MCP delayed the decrease on phenolic fraction contents, regardless of the utilized dose (Figs. 6A, B, C). This sharp decrease of phenolic compounds during sapodilla storage it has already been observed (Miranda, 2002), and at the same time it has been observed that the 1-MCP delays several volatile compounds production in fruits such as bananas, apples, melon and citrus (Flores et al., 2002, Porat et al., 1999; Golding et al., 1999; Rupasinghe et al., 2000). The results of these works agree with Watkins (2002) who claims to exist consistent results proving that the volatiles way production is regulated by ethylene.

CONCLUSIONS

Fruits which were treated with 1-MCP showed a six days increase in its post-harvest useful shelf-life.

The 200 and 400 nL L$^{-1}$ doses were more efficient than the 100 nL L$^{-1}$ dose to delay the sapodilla firmness and pulp colour during ripening.

Literature Cited


### Tables

Table 1. Sapodilla external appearance (note: 0-4) and total soluble solids (TSS) submitted to treatment with different 1-MCP dosages. Fortaleza - Brazil, 2004.

<table>
<thead>
<tr>
<th>1-MCP (nL⁻¹)</th>
<th>External appearance (note: 0–4)</th>
<th>TSS (°Brix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1,65a</td>
<td>25,43ab</td>
</tr>
<tr>
<td>100</td>
<td>1,17b</td>
<td>24,87b</td>
</tr>
<tr>
<td>200</td>
<td>1,10b</td>
<td>24,88b</td>
</tr>
<tr>
<td>400</td>
<td>1,10b</td>
<td>26,16a</td>
</tr>
</tbody>
</table>

Averages followed by the same letter do not differ by the Tukey test to 5% level.
Figures

Fig. 1. Sapodilla mass loss which were treated with different 1-MCP dosages and stored to 25±2°C temperature and 70±5% relative humidity. Fortaleza-Brazil, 2004.

Fig. 2. Sapodilla firmness were treated with different 1-MCP dosages and stored to 25±2°C temperature and 70±5% relative humidity. Fortaleza - Brazil, 2004.
Fig. 3. Sapodilla Lightness (A), Hue angle (B) and Chrom (C) treated with different 1-MCP dosages and stored to 25±2°C temperature and 70±5% relative humidity. Fortaleza-Brazil, 2004.
Fig. 4. Sapodilla titratable total acidity treated with different 1-MCP dosages and stored to 25±2°C temperature and 70±5% relative humidity. Fortaleza-Brazil, 2004.

Fig. 5. Sapodilla total soluble sugars that were treated with different 1-MCP dosages and stored to 25±2°C temperature and 70±5% relative humidity. Fortaleza-Brazil, 2004.
Fig. 6. Sapodilla phenolic compounds soluble in water (A), methanol 50% (B) and pure methanol (C) treated with different 1-MCP dosages and stored to 25±2°C temperature and 70±5% relative humidity. Fortaleza-Brazil, 2004.