Influence of pre-harvest chemical treatments on physio-chemical characteristics and shelf life of Sapota [Manilkara achras (Mill.) Forsberg] var. PKM 1

P Anusuya, I Muthuvel, J Rajangam and K Venkatesan

Abstract
The present investigation “Influence of pre-harvest chemical treatments on physio-chemical characteristics and shelf life of Sapota [Manilkara achras (Mill.) Forsberg] Var. PKM1” was conducted at Department of Fruit Crops, Horticultural college and Research Institute, Periyakulam during 2019. Pre harvest spraying of Calcium chloride (1.0% & 2.0%), Gibberellic acid (50ppm &100ppm) along with control (water) sprayed on 20 years old sapota tree at one month before harvesting stage. The fruits were stored at cold storage (14±1 °C, 90-95% RH) after harvest. Among these treatments, results proved that pre-harvest spraying of CaCl₂ 2.0% found to be most effective for maintaining titrable acidity (0.21%), ascorbic acid content (21.09 kg/100mg), minimum physiological loss in weight (7.72%), gradual increase in total soluble solids (20.45%), total sugars (11.32%), reducing sugars (6.50%), and increase in shelf life (28 days) of sapota as compared to untreated fruits (21.75days).

Keywords: Sapota, pre-harvest spray, calcium chloride, Gibberellic acid, shelf life

Introduction
Sapota [Manilkara achras (Mill.) Fosberg] belongs to the family Sapotaceae and commonly known as chiku is an evergreen fruit tree native of Tropical America. The total area, production and productivity of sapota in India is about 107.2 Thousand Hectare with 1284.60 Thousand MT production and 12 mt/ha productivity respectively (NHB, 2017). Sapota fruit is highly perishable and impossible to store for longer period at ambient temperature and must be stored at cold conditions. Being a climatic fruit, sapota ripens within 4 to 7days after harvest at full ripened stage due to fast biochemical changes which reduced the shelf life of sapota. Sapota fruit is usually consumed in the fresh form. However, the export of fresh Sapota has been restricted because of its perishability, difficult to handle and transport in fresh form due to quick ripening and fruit softening. Calcium supports to increase the shelf life of fruits by influencing the structural integrity of both the cell wall and plasma membrane. It involves in delaying ripening and senescence, increase in firmness, vitamin C and reduction in respiration and there by extending storage life which is due to reducing the incidence of physiological disorders and storage rots (Sharma et al., 1996) [11].

Gibberellins are used for increasing fruit size and firmness. These plant growth regulators have also been found to decrease fungal infections, either by delaying ripening or senescence, or by altering the structure of the fruit. Hence, it becomes necessary to find out some suitable pre-harvest spray to improve the physico-chemical properties and to extend the shelf life of sapota.

Materials and Methods
The present investigation was carried out at the central block, Department of Fruit crops, Horticultural College and Research Institute, Periyakulam, Theni district during the year 2019. The experiment was laid out in Factorial Randomized Block design (FRBD) with four replication comprising three plants per treatment. 20 years old uniform trees of sapota var. PKM1 were marked and one month before harvest the selected trees were sprayed with different level of plant growth regulators (GA3 @ 50ppm, GA3 @ 100@ppm) and chemicals (Calcium chloride 1.0%, 2.0%) along with control (Water spray). The pre- harvest fruits were collected in plastic crates. Three kg fruits from each replication sof each treatment were stored under cold storage condition (14±1 °C, 90-95% Relative Humidity).
The observations like physiological loss in weight, TSS, titrable acidity, total sugars, reducing sugar, ascorbic acid content and shelf life fruits were assessed at 1<sup>st</sup>, 10<sup>th</sup>, 19<sup>th</sup>, 28<sup>th</sup> days interval. The total soluble solids (TSS) were determined by using Erma Hand refractometer of 0-32<sup>o</sup> Brix range following the procedure described in A.O.A.C. (1990) [1]. The physiological loss in weight (PLW), ascorbic acid content (kg/100mg), titrable acidity (%), Total sugars (%) and reducing sugars (%) were determined by adopting the A.O.A.C. (1990) [1] method and expressed in percentage. The shelf life was determined by recording the number of days the fruits remained in marketable condition without spoilage in each replication during storage.

**Results and Discussion**

**Physiological loss in weight (%)**

The result presented in Table 1 showed that Minimum physiological loss in weight(631, 4.581, 9.777 and 15.922%) was observed in T<sub>5</sub> (CaCl<sub>2</sub> @ 2%) followed by treatment T<sub>4</sub> (CaCl<sub>2</sub> @ 1%). i.e. 9.964, 6.062, 10.862 and 17.704%), while maximum physiological loss in weight (2.795, 13.776, 25.131 and 44.500%) was observed in treatment T<sub>1</sub> (control). The reduction in weight loss might be due to the maintenance of firmness of fruit by calcium which decreased the enzyme activity responsible for disintegration of cellular structure and decreases the gaseous exchange. Similar findings have been reported by Aradhya et al. (2006) [5] in sapota and Bhusan et al., (2015) [5] in mango.

**Total soluble solids (TSS) (%Brix)**

Data presented in Table 2 showed that gradual increase in total soluble solids (20.12, 20.21, 20.69, 20.76 %Brix) was recorded in T<sub>5</sub> (CaCl<sub>2</sub> @2%) followed by treatment T<sub>4</sub> (CaCl<sub>2</sub> @1%) i.e. 20.45, 20.53, 20.78, 20.86 %Brix), while rapid increase in total soluble solids (20.98, 21.34, 22.12, 22.67 %Brix) was observed in treatment T<sub>1</sub> (control). This may be due to the increase in soluble solids content and total sugars caused by hydrolysis of polysaccharides like starch, cellulose and pectin sub-stances into simpler substances. Similar findings have been reported by Sudha et al., (2007) [12] in sapota.

**Ascorbic acid content (mg/100 g pulp)**

The result presented in Table 3 showed that gradual decrease of Ascorbic acid content (28.92, 24.9, 19.28 and 11.24 mg/100g pulp) was recorded in treatment T<sub>5</sub> (CaCl<sub>2</sub> @2%) followed by treatment T<sub>4</sub> (CaCl<sub>2</sub> @1%) i.e. (27.31, 20.88, 17.67 and 10.44 mg/100g pulp), while rapid decrease in Ascorbic acid content (24.9, 18.47, 10.44 and 2.41 mg/100g pulp) was observed in treatment T<sub>1</sub> (control). Calcium probably retarded oxidation process and hence the rate of conversion of L-ascorbic acid in to de-hydro ascorbic acid slow down. Similar findings have been reported by Desai (2016) [7] in sapota.

**Titrable acidity (%)**

The result presented in Table 4 showed that gradual decrease of titrable acidity (0.29, 0.27, 0.17, 0.13%) was recorded with T<sub>3</sub> (CaCl<sub>2</sub> @ 2%) followed by treatment T<sub>4</sub> (CaCl<sub>2</sub> @ 1%) i.e. 0.28, 0.23, 0.16, 0.12%), while rapid decrease in titrable Acidity (0.24, 0.18, 0.13 and 0.08 %) was observed in treatment T<sub>1</sub> (control). The treatment with CaCl<sub>2</sub> recorded the maximum titrable acidity might be due to delayed respiration rate and conversion of organic acids into sugars. The similar result on acidity was also reported by Patel et al., (2017) [10] in sapota, Habimana (2014) in mango.

**Total sugars (%)**

The result presented in Table 5 showed that gradual increase total sugars (%) was observed (10.12, 10.44, 11.36 and 13.34%) in treatment T<sub>5</sub> (CaCl<sub>2</sub> @2%) was followed by treatment T<sub>4</sub> (CaCl<sub>2</sub> @1%) i.e. 10.31, 10.76, 12.13, 13.79%), while rapid increase in total sugar content (11.18, 11.78, 13.12, 14.87% ) was observed in treatment T<sub>1</sub> (control). The gradual increase in total sugar during initial storage period might be due to the hydrolysis of starch into sugar as on complete hydrolysis of starch, no further increase occurs and subsequently a decline in total sugar is predictable. Similar findings have been reported by Tsomu and Patel (2014) [13] in sapota, Bisen et al. (2014) [6] in guava.

**Reducing sugars (%)**

The result presented in Table 6 showed that significantly gradual increase of reducing sugar (6.04, 6.27, 6.62, 7.05%) was observed with T<sub>5</sub> (CaCl<sub>2</sub> @ 2%) followed by treatment T<sub>4</sub> (CaCl<sub>2</sub> @1%) i.e. 6.12, 6.48, 6.94, 7.45%), while (control) fruits presented the rapid increase total sugar content (6.32, 6.84, 7.47, 8.43%) in sapota fruits. The gradual increase of reducing sugar content by calcium application might be due to the less utilization of sugar in respiration and conversion of starch into sugar, while the subsequent decline was perhaps due to consumption of sugar for respiration during storage. Similar findings have been reported by Bhalerao et al. (2010) in sapota.

**Shelf life (days)**

The result presented in Table 7 showed that maximum shelf life (28 days) was observed in T<sub>1</sub> (CaCl<sub>2</sub> @ 2%) followed by treatment T<sub>4</sub> (CaCl<sub>2</sub> @ 1%).While minimum shelf life (21.75 days) was observed in treatment T<sub>1</sub> (control). Effect of calcium chloride was found to be most effective to prolong shelf life by decreasing the respiration rate and improving the shelf life. The similar result on shelf life was also reported by Amarjeet et al., (2016) [2] in sapota.

**Tables**

Table 1: Effect of pre harvest treatments of Physiological loss in weight (%) of sapota var. PKM 1 under cold storage

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Physiological loss in weight (%)</th>
<th>Days after Storage</th>
<th>MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 DOS</td>
<td>11 DOS</td>
<td>20 DOS</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt; Control</td>
<td>2.80</td>
<td>13.78</td>
<td>25.13</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;-GA@50ppm</td>
<td>1.86</td>
<td>16.31</td>
<td>30.32</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;-GA@100ppm</td>
<td>1.55</td>
<td>6.45</td>
<td>12.67</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@1%</td>
<td>0.96</td>
<td>6.06</td>
<td>10.86</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@2%</td>
<td>0.63</td>
<td>4.58</td>
<td>9.78</td>
</tr>
<tr>
<td>Mean</td>
<td>1.56</td>
<td>9.43</td>
<td>17.75</td>
</tr>
<tr>
<td>Source</td>
<td>Treatments(T)</td>
<td>Days of storage(D)</td>
<td>Interaction(TXD)</td>
</tr>
<tr>
<td>SE(d)</td>
<td>0.130</td>
<td>0.118</td>
<td>0.264</td>
</tr>
<tr>
<td>CD(p=0.05)</td>
<td>0.264</td>
<td>0.236</td>
<td>0.529</td>
</tr>
</tbody>
</table>
Table 2: Effect of pre harvest treatments on Total soluble solids (TSS) (ºBrix) of sapota var. PKM 1 under cold storage

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total soluble solids (TSS) (ºBrix)</th>
<th>Days after Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;-Control</td>
<td>20.98</td>
<td>21.34</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;-GA@50ppm</td>
<td>20.67</td>
<td>20.75</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;-GA@100ppm</td>
<td>20.56</td>
<td>20.76</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@1%</td>
<td>20.45</td>
<td>20.51</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@2%</td>
<td>20.12</td>
<td>20.21</td>
</tr>
<tr>
<td>Mean</td>
<td>20.56</td>
<td>20.72</td>
</tr>
<tr>
<td>Source</td>
<td>Treatments(T)</td>
<td>Days of storage(D)</td>
</tr>
<tr>
<td>SE(d)</td>
<td>0.132</td>
<td>0.147</td>
</tr>
<tr>
<td>CD(p=0.05)</td>
<td>0.264</td>
<td>0.295</td>
</tr>
</tbody>
</table>

Table 3: Effect of pre harvest treatments on Ascorbic acid content (mg/100g pulp) of sapota var. PKM 1 under cold storage

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Ascorbic acid (mg/100g)</th>
<th>Days after Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;-Control</td>
<td>24.9</td>
<td>18.47</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;-GA@50ppm</td>
<td>24.9</td>
<td>19.28</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;-GA@100ppm</td>
<td>25.7</td>
<td>20.08</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@1%</td>
<td>27.31</td>
<td>20.88</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@2%</td>
<td>28.92</td>
<td>24.9</td>
</tr>
<tr>
<td>Mean</td>
<td>26.346</td>
<td>20.722</td>
</tr>
<tr>
<td>Source</td>
<td>Treatments(T)</td>
<td>Days of storage(D)</td>
</tr>
<tr>
<td>SE(d)</td>
<td>0.116</td>
<td>0.130</td>
</tr>
<tr>
<td>CD(p=0.05)</td>
<td>0.232</td>
<td>0.260</td>
</tr>
</tbody>
</table>

Table 4: Effect of pre harvest treatments on Titrable Acidity (%) of sapota var. PKM 1 under cold storage

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Titrable Acidity (%)</th>
<th>Days after Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;-Control</td>
<td>0.24</td>
<td>0.18</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;-GA@50ppm</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;-GA@100ppm</td>
<td>0.27</td>
<td>0.21</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@1%</td>
<td>0.28</td>
<td>0.23</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@2%</td>
<td>0.29</td>
<td>0.27</td>
</tr>
<tr>
<td>Mean</td>
<td>0.27</td>
<td>0.22</td>
</tr>
<tr>
<td>Source</td>
<td>Treatments(T)</td>
<td>Days of storage(D)</td>
</tr>
<tr>
<td>SE(d)</td>
<td>0.0010</td>
<td>0.0012</td>
</tr>
<tr>
<td>CD(p=0.05)</td>
<td>0.0021</td>
<td>0.0024</td>
</tr>
</tbody>
</table>

Table 5: Effect of preharvest treatments on Total sugar (%) of sapota var. PKM 1 under cold storage

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total sugar (%)</th>
<th>Days after Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;-Control</td>
<td>11.18</td>
<td>11.78</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;-GA@50ppm</td>
<td>10.78</td>
<td>11.43</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;-GA@100ppm</td>
<td>10.54</td>
<td>11.12</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@1%</td>
<td>10.31</td>
<td>10.76</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@2%</td>
<td>10.12</td>
<td>10.44</td>
</tr>
<tr>
<td>Mean</td>
<td>10.59</td>
<td>11.11</td>
</tr>
<tr>
<td>Source</td>
<td>Treatments(T)</td>
<td>Days of storage(D)</td>
</tr>
<tr>
<td>SE(d)</td>
<td>0.070</td>
<td>0.079</td>
</tr>
<tr>
<td>CD(p=0.05)</td>
<td>0.141</td>
<td>0.158</td>
</tr>
</tbody>
</table>

Table 6: Effect of preharvest treatments of Reducing sugars (%) of sapota var. PKM 1 under cold storage

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Reducing sugar (%)</th>
<th>Days after Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;-Control</td>
<td>6.32</td>
<td>6.84</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;-GA@50ppm</td>
<td>6.24</td>
<td>6.99</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;-GA@100ppm</td>
<td>6.2</td>
<td>6.57</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@1%</td>
<td>6.12</td>
<td>6.48</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt;-CaCl&lt;sub&gt;2&lt;/sub&gt;@2%</td>
<td>6.04</td>
<td>6.27</td>
</tr>
<tr>
<td>Mean</td>
<td>6.18</td>
<td>6.57</td>
</tr>
<tr>
<td>Source</td>
<td>Treatments(T)</td>
<td>Days of storage(D)</td>
</tr>
<tr>
<td>SE(d)</td>
<td>0.044</td>
<td>0.049</td>
</tr>
<tr>
<td>CD(p=0.05)</td>
<td>0.088</td>
<td>0.098</td>
</tr>
</tbody>
</table>
Table 7: Effect of pre harvest treatments on Shelf life of sapota var. PKM 1 under cold storage

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Shelf life</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-Control</td>
<td>21.75</td>
</tr>
<tr>
<td>T2-GA3@50ppm</td>
<td>22.3</td>
</tr>
<tr>
<td>T3-GA3@100ppm</td>
<td>22.5</td>
</tr>
<tr>
<td>T4-CaCl2@1%</td>
<td>26.3</td>
</tr>
<tr>
<td>T5- CaCl2@2%</td>
<td>28.0</td>
</tr>
<tr>
<td>Mean</td>
<td>24.15</td>
</tr>
<tr>
<td>SE(d)</td>
<td>0.58</td>
</tr>
<tr>
<td>CD(p=0.05)</td>
<td>1.28</td>
</tr>
</tbody>
</table>

Conclusion
On the basis of findings, it can be concluded that preharvest (30 days before harvest) spraying of CaCl2@2% found effective for gradual increase in shelf life gradual increase in total soluble solids, total sugars, reducing sugars, with maximum acidity, ascorbic acid content and minimum physiological loss in weight and in sapota fruits.

References