EFFECT OF EDIBLE SURFACE COATINGS ON POSTHARVEST QUALITY AND SHELF LIFE OF GUAVA (PSIDIUM GUAJAVA L. CV. PANT PRABHAT) FRUITS

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KEYWORDS
Edible coating
Guava
Post harvest quality
Shelf life

INTRODUCTION

Guava (Psidium guajava L.) ‘The apple of the tropics’ is one of the most delicious and nutritious fruit crops grown in India. Guava is considered to be superior to several other fruits by virtue of its commercial and nutritional value (Menzel, 1985). It is rich in vitamin C (260 mg/100g) and a fair source of calcium, phosphorus, iron and vitamin A. Calcium chloride dipping treatment slow down and delayed the changes in ascorbic acid in fig fruit (Irfan et al., 2013). Guava fruits treated with calcium chloride @1% and wrapped in newspaper recorded minimum reduction in fruit weight during storage period (Kumar et al., 2014). Chitosan @2.5% increased the shelf-life of (Mutia) guava fruits (Widodo et al., 2015). Kumari et al. (2015) observed that chitosan alone or in combination were found highly effective in minimizing weight loss of litchi fruit during storage at 4°C. An increase of three days shelf life of mexican guava was observed when fruits were coated with sodium alginate @10% (Gallo et al., 2003). Valero et al. (2013) reported that alginate treatments significantly decreased weight loss for all plum cultivars. Azaraksh et al. (2014) observed a decrease in softening for fresh-cut pineapple coated with alginate, while firmness of 0.5% was found in control. Dip treatment of sapota fruit in Aloe vera gel coating 1:2 for 7 minutes had best retained the physico-chemical characteristics (Padmaja et al., 2015). Vieira et al. (2016) reported that application of an edible coating containing Aloe vera on the blueberry surface after harvesting provides an additional barrier to reduce postharvest contamination by fungi and also by reducing the rate of water loss. Due to highly perishable nature, guava fruits undergo rapid postharvest ripening in few days under ambient conditions (Hashem and Alamri, 2009). The fruit ripening in guava is characterized by loss of green colour, softening, shrinkage, loss of brightness and rot development (Ali and Lazan, 1997). The post harvest losses can be minimized by extension of shelf life through checking the rate of transpiration and respiration, microbial infection. The perishability of fruits requires the development of technologies that reduce their postharvest deterioration and extend their shelf life (Gonzalez Aguilar et al., 2009). In a country like India where sufficient refrigeration facilities are not available, the alternative means for increasing shelf life of fruits for a short period are likely to prove more beneficial. Edible coatings can provide an alternative means for extending keeping life of fresh fruits. Several types of edible coatings such as carbohydrate, protein, lipid and combination of these are in practice nowadays to extend the shelf life and quality of fruits. Among these, chitosan, calcium chloride, sodium alginate and Aloe vera gel has been known to protect perishable fruits from deterioration by reducing transpiration, respiration and maintaining textural quality. Edible coatings play an important role in the quality, safety, transportation, storage and display of a wide range of fresh and processed foods (Daniel et al., 2007; Elizabeth et al., 1995). They act as barriers to moisture and oxygen during handling (Olivas et al., 2005) and storage. They do not solely retard food deterioration but also enhance its safety due to their natural biocide activity or by incorporating antimicrobial compounds (Maria et al., 2008). For maintaining the quality and shelf life of guava fruits,
postharvest application of coatings like Aloe vera gel, calcium chloride, chitosan and sodium alginate was done. So, keeping all these in view, an experiment was conducted to assess the suitability of various edible coatings on quality, shelf life and physico-chemical characteristics of guava cv. Pant Prabhat fruits at different storage periods.

MATERIALS AND METHODS

Plant material
Physiologically mature green fresh fruits of guava cv. Pant Prabhat were procured from an orchard of the Horticulture Research Centre, Patharchatta of G. B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) in November, 2015. Fruits were transported to the laboratory in plastic crates where sorting was done to remove immature, misshaped, blemished, diseased and infected fruitts per method of Hong et al. (2012). Selected uniform size fruits were washed and blanched in hot water at 100ºC for 4 minutes. The blanched flesh was then blended and the base and tips of the leaves were washed with water and the base and tips of the leaves were carefully separated from parenchyma to obtain Aloe vera flesh.

Calcium chloride coating
Calcium chloride 1%, 1.5% and 2% (w/v) solution was prepared according to Khaliq et al. (2016) by dissolving 1, 1.5 and 2 g of CaCl₂ in 100 mL of distilled water. The solution was agitated constantly using a magnetic stirrer (model SP 18420-26 Barnstead Thermolyne 2555 Kerper Boulevard Dubuque, USA) for 30 minutes and 0.2 mL of Tween 20 (Polyoxyethylene sorbitan monoleate) was added to the solution to improve wettability.

Chitosan coating
Chitosan coating was prepared according to Vargas et al. (2006). 5, 10 and 15 grams of chitosan were dispersed separately to make 0.5%, 1% and 1.5% solution in an aqueous solution of glacial acetic acid (1% v/v) at 40°C. Tween 80 at 0.1% was added to improve wettability.

Alginate coating
Alginate coating was prepared according to Rojas-Grau et al. (2007). 5, 10 and 15 grams of sodium alginate (NaC₆H₇O₆) was dissolved separately to make 0.5%, 1% and 1.5% in sterilized distilled water and heated at 70°C, until the solution became clear. After cooling, glycerol (C₃H₅(OH)₃, 85% purity) was added as plasticiser to a final concentration of 1.5 g/100 ml solution. The final volume of solution was made to 1 litre.

Aloe vera gel coating
Aloe vera gel preparation was undertaken according to Ramachandra and Rao (2008) who advised that Aloe vera leaves must be processed within 2 hours of harvesting to prevent oxidation of the gel due to their exposure to air. Whole leaves were washed with water and the base and tips of the leaves along with its spikes were removed. Next, the skin was carefully separated from parenchyma to obtain Aloe vera flesh. The flesh was then washed and blanched in hot water at 100°C for 4 minutes. The blanched flesh was then blended and the Aloe vera gel obtained was filtered through activated carbon to remove anthraquinones that have a laxative effect. Before pasteurization, the pH of the gel was adjusted to 3.0 by the addition of citric acid to stabilize and prevent browning. The process was then continued with pasteurization at 85°C for 1 minute. After pasteurization, the gel was quickly cooled to 5°C or below. Finally, the Aloe vera gel was filled into pre-sterilized, opaque glass bottles for storage in a chiller at 5°C and 75-80% relative humidity. Accordingly, coatings of Aloe vera gel were made in 1:1, 1:2 and 1:3 ratio with water.

The treated and non-treated fruits were divided into different lots and were placed in ambient conditions of the postharvest laboratory having 25-28°C and 75% RH. Fruits were dipped in these solutions for 1-2 minutes, drained and surface dried by using procedure according to Hong et al. (2012). The observations on various physico-chemical attributes were studied on same day of harvest and after 3, 6, 9 and 12 days of storage at ambient conditions (27-29°C and 70-75% RH).

RESULTS AND DISCUSSION

Shrinkage in size
Treatments exerted a significant influence on fruit length and breadth of fruits. Minimum shrinkage in fruit length (7.37%) was recorded in chitosan 1.5% (T₆) followed by (8.05%) in chitosan 1.0% (T₅) while maximum shrinkage in fruit length (17.79%) was recorded in control (T₁₃) followed by (17.59%) in calcium chloride 1.5% (T₂) (Table 1). Shrinkage percentage in chitosan 1.5% (T₆) treatment was 7.37% (from 6.32 cm to 5.86 cm) for fruit length and 6.70% (from 6.93 cm to 6.86 cm) for fruit breadth. Minimum shrinkage in fruit breadth (6.70%) was also recorded in chitosan 1.5% (T₆) treatment.
Table 1: Effect of different edible coatings and their concentrations on length and breadth of fruits

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Length Breadth Shrinkage (%)</th>
<th>Days after treatments</th>
<th>At harvest</th>
<th>12</th>
<th>12</th>
<th>Mean</th>
<th>12</th>
<th>12</th>
<th>Mean</th>
<th>12</th>
<th>12</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: Calcium chloride 1.0%</td>
<td>6.49</td>
<td>5.36</td>
<td>6.95</td>
<td>5.68</td>
<td>17.41</td>
<td>18.35</td>
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<tr>
<td>T2: Calcium chloride 1.5%</td>
<td>6.40</td>
<td>5.28</td>
<td>6.92</td>
<td>5.67</td>
<td>17.59</td>
<td>18.10</td>
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<tr>
<td>T3: Calcium chloride 2.0%</td>
<td>6.30</td>
<td>5.66</td>
<td>7.18</td>
<td>6.24</td>
<td>10.11</td>
<td>13.06</td>
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<tr>
<td>T4: Chitosan 0.5%</td>
<td>6.40</td>
<td>5.72</td>
<td>6.92</td>
<td>6.12</td>
<td>10.63</td>
<td>11.52</td>
<td></td>
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<tr>
<td>T5: Chitosan 1.0%</td>
<td>6.21</td>
<td>5.71</td>
<td>6.93</td>
<td>6.03</td>
<td>8.05</td>
<td>13.02</td>
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<tr>
<td>T6: Chitosan 1.5%</td>
<td>6.32</td>
<td>5.86</td>
<td>6.93</td>
<td>6.46</td>
<td>7.37</td>
<td>6.70</td>
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<tr>
<td>T7: Sodium alginate 0.5%</td>
<td>6.30</td>
<td>5.71</td>
<td>7.12</td>
<td>6.35</td>
<td>9.37</td>
<td>10.85</td>
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<tr>
<td>T8: Sodium alginate 1.0%</td>
<td>6.41</td>
<td>5.66</td>
<td>7.18</td>
<td>6.12</td>
<td>11.70</td>
<td>14.73</td>
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<tr>
<td>T9: Sodium alginate 1.5%</td>
<td>6.55</td>
<td>5.84</td>
<td>7.12</td>
<td>6.37</td>
<td>10.89</td>
<td>10.49</td>
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<td>T10: Aloe vera 1:1</td>
<td>6.41</td>
<td>5.83</td>
<td>6.94</td>
<td>6.44</td>
<td>9.00</td>
<td>7.12</td>
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<td>T11: Aloe vera 1:2</td>
<td>6.46</td>
<td>5.71</td>
<td>6.92</td>
<td>6.28</td>
<td>11.61</td>
<td>9.25</td>
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<tr>
<td>T12: Aloe vera 1:3</td>
<td>6.61</td>
<td>5.64</td>
<td>6.94</td>
<td>5.85</td>
<td>14.67</td>
<td>15.66</td>
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<tr>
<td>T13: Control</td>
<td>6.41</td>
<td>5.27</td>
<td>6.88</td>
<td>5.57</td>
<td>17.79</td>
<td>19.08</td>
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</tbody>
</table>

Factors CD at 5% SE(m) CD at 5% SE(m)
Storage Intervals (S) 0.018 0.006 0.012 0.004
Treatments (T) 0.029 0.010 0.019 0.007
Interaction (S × T) 0.066 0.023 0.042 0.015

Table 2: Effect of different edible coatings and their concentrations on physiological weight loss and decay percentage

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Physiological loss in weight (%)</th>
<th>Days after treatments</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>Mean</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>Mean</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: Calcium chloride 1.0%</td>
<td>8.21</td>
<td>12.10</td>
<td>15.75</td>
<td>18.26</td>
<td>10.86</td>
<td>6.50</td>
<td>15.22</td>
<td>20.05</td>
<td>25.03</td>
<td>13.36</td>
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<tr>
<td>T2: Calcium chloride 1.5%</td>
<td>6.03</td>
<td>12.61</td>
<td>15.86</td>
<td>18.62</td>
<td>10.63</td>
<td>6.20</td>
<td>12.21</td>
<td>18.17</td>
<td>22.23</td>
<td>11.76</td>
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<tr>
<td>T3: Calcium chloride 2.0%</td>
<td>4.05</td>
<td>7.68</td>
<td>8.30</td>
<td>12.72</td>
<td>6.55</td>
<td>7.21</td>
<td>15.90</td>
<td>19.07</td>
<td>23.22</td>
<td>13.08</td>
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<tr>
<td>T4: Chitosan 0.5%</td>
<td>2.67</td>
<td>11.65</td>
<td>12.08</td>
<td>15.22</td>
<td>8.32</td>
<td>5.11</td>
<td>11.19</td>
<td>19.48</td>
<td>25.57</td>
<td>12.27</td>
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<tr>
<td>T5: Chitosan 1.0%</td>
<td>1.18</td>
<td>8.91</td>
<td>14.01</td>
<td>17.84</td>
<td>8.39</td>
<td>4.49</td>
<td>11.10</td>
<td>17.50</td>
<td>21.55</td>
<td>10.93</td>
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<tr>
<td>T6: Chitosan 1.5%</td>
<td>2.14</td>
<td>2.24</td>
<td>8.88</td>
<td>10.91</td>
<td>4.83</td>
<td>0.00</td>
<td>10.29</td>
<td>16.54</td>
<td>20.06</td>
<td>9.38</td>
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<tr>
<td>T7: Sodium alginate 0.5%</td>
<td>5.19</td>
<td>11.04</td>
<td>17.48</td>
<td>17.42</td>
<td>10.23</td>
<td>6.22</td>
<td>12.03</td>
<td>18.11</td>
<td>25.30</td>
<td>12.33</td>
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<tr>
<td>T8: Sodium alginate 1.0%</td>
<td>2.58</td>
<td>3.01</td>
<td>11.75</td>
<td>23.41</td>
<td>8.15</td>
<td>5.52</td>
<td>12.56</td>
<td>19.14</td>
<td>26.26</td>
<td>12.70</td>
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<tr>
<td>T9: Sodium alginate 1.5%</td>
<td>2.28</td>
<td>7.94</td>
<td>12.96</td>
<td>15.12</td>
<td>7.66</td>
<td>4.81</td>
<td>11.50</td>
<td>19.08</td>
<td>25.50</td>
<td>12.18</td>
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<tr>
<td>T10: Aloe vera 1:1</td>
<td>6.28</td>
<td>5.65</td>
<td>8.24</td>
<td>10.19</td>
<td>5.27</td>
<td>0.00</td>
<td>10.70</td>
<td>15.91</td>
<td>22.59</td>
<td>9.84</td>
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<tr>
<td>T12: Aloe vera 1:3</td>
<td>1.64</td>
<td>11.44</td>
<td>16.05</td>
<td>22.67</td>
<td>10.36</td>
<td>5.49</td>
<td>13.47</td>
<td>19.06</td>
<td>27.18</td>
<td>13.04</td>
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<tr>
<td>T13: Control</td>
<td>6.16</td>
<td>12.56</td>
<td>17.81</td>
<td>20.77</td>
<td>11.46</td>
<td>9.48</td>
<td>17.23</td>
<td>26.29</td>
<td>35.11</td>
<td>18.02</td>
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</tr>
</tbody>
</table>

Factors CD at 5% SE(m) CD at 5% SE(m)
Storage Intervals (S) 0.627 0.224 0.064 0.023
Treatments (T) 1.010 0.361 0.104 0.037
Interaction (S × T) 2.259 0.807 0.232 0.083

by (7.12 cm) in Aloe vera 1:1 (T10) while the maximum shrinkage in fruit breadth (19.08%) was recorded in control (T13) followed by (18.35%) in calcium chloride 1.0% (T1). Storage period affected the fruit length and breadth significantly which decreased gradually as the storage period progressed. The decrease in fruit length and breadth with the increase in storage time might be due to increased moisture loss resulting in shrinkage of fruits. The above findings are in agreement with the findings of Tiwary (2011) and Singh et al. (2010).

Physiological loss in weight
Data depicted in Table 2 showed that all the treatments exerted a significant influence on physiological loss in weight. Minimum physiological loss in weight (4.83%) was recorded in chitosan 1.5% (T4) followed by (5.27%) in Aloe vera 1:1 (T10) and maximum (11.46%) was recorded in control (T13) followed by (10.86%) in calcium chloride 1.0% in (T1). Loss of weight in fresh fruit is mainly due to the loss of water caused by transpiration and respiration processes (Zhu et al., 2008).
Chitosan coating also forms a layer of semi-transparent to smooth pericarp surface (Dong et al., 2004) and can be used as a protective barrier to reduce respiration and transpiration rates through fruit surfaces (Kester and Fennema, 1986). Coating the guava fruit with chitosan was clearly effective in conferring a physical barrier to moisture loss; therefore, a decreased weight loss in the chitosan coated fruit was observed during evaluation in this study. The results are supported by Ali et al. (2011) where water loss of papaya fruits can be reduced by coating with chitosan. Brishiti et al. (2013) also reported similar results that weight loss of uncoated fruit (sample) was significantly greater than that of Aloe vera gel coated papaya fruit. At the end of the storage, uncoated papaya showed 22.5% loss in weight, whereas the weight losses of samples coated with Aloe vera gel was 7.93%. Reduction of moisture loss may be due to the hygroscopic properties of Aloe vera gel that allow the formation of water barrier between the fruit and the surrounding environment, thus preventing its external transfers (Morrilon et al., 2002).

Decay
The data on effect of various treatments and storage periods on decay percentage of guava under ambient condition are presented in Table 2. It indicated that all the treatments exerted a significant influence on fruit decay percentage. There was very less sign of decay until 3 days of storage period. Control uncoated fruit had shown maximum decay percentage during the storage period. No symptoms of decay were observed on the fruits coated with chitosan 1.5% (T6) and Aloe vera 1:1 (T10) until 3 days of storage period. Minimum fruit decay percentage (9.38%) was recorded in chitosan 1.5% (T6) followed by (9.84%) in Aloe vera 1:1 (T10) and maximum fruit decay percentage (22.5%) was recorded in control uncoated fruit (T1). The factors CD at 5% SE(m) for storage intervals (S) was 0.023, treatments (T) was 0.008 and interaction (S × T) was 0.029.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Ascorbic acid (mg/100g) Days after treatments</th>
<th>Mean</th>
<th>Total sugars (%) Days after treatments</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 Calcium chloride 1.0%</td>
<td>279.00 273.33 176.67 90.00 125.00 216.00 200.80</td>
<td>9.44</td>
<td>6.62 6.63 6.92 7.23 7.47 6.97</td>
<td></td>
</tr>
<tr>
<td>T2 Calcium chloride 1.5%</td>
<td>275.00 261.00 222.33 173.67 162.00 218.80</td>
<td>9.47</td>
<td>6.62 6.63 6.92 7.23 7.47 6.97</td>
<td></td>
</tr>
<tr>
<td>T3 Calcium chloride 2.0%</td>
<td>283.00 255.00 232.00 190.00 155.00</td>
<td>9.45</td>
<td>6.62 6.77 7.01 7.19 7.28 6.97</td>
<td></td>
</tr>
<tr>
<td>T4 Chitosan 0.5%</td>
<td>284.00 262.00 176.67 175.00</td>
<td>9.54</td>
<td>6.62 6.81 6.90 7.12 7.25 6.94</td>
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</tr>
<tr>
<td>T5 Chitosan 1.0%</td>
<td>282.33 261.47 241.00 198.00</td>
<td>9.59</td>
<td>6.62 6.76 6.92 7.15 7.22 6.93</td>
<td></td>
</tr>
<tr>
<td>T6 Chitosan 1.5%</td>
<td>282.33 261.33 241.00 217.33</td>
<td>9.55</td>
<td>6.62 6.66 6.73 6.81 6.94 6.75</td>
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</tr>
<tr>
<td>T7 Sodium alginate 0.5%</td>
<td>282.67 252.00 241.00</td>
<td>150.00</td>
<td>9.53</td>
<td>6.62 6.67 6.73 6.81 6.94 6.75</td>
</tr>
<tr>
<td>T8 Sodium alginate 1.0%</td>
<td>283.33 254.00 232.00 190.00</td>
<td>155.00</td>
<td>9.54</td>
<td>6.62 6.77 7.01 7.19 7.28 6.97</td>
</tr>
<tr>
<td>T9 Sodium alginate 1.5%</td>
<td>285.00 210.00 201.67</td>
<td>163.00</td>
<td>9.52</td>
<td>6.62 6.67 6.73 6.81 6.94 6.75</td>
</tr>
<tr>
<td>T10 Aloe vera 1:1</td>
<td>282.67 226.67 182.00</td>
<td>155.00</td>
<td>9.51</td>
<td>6.62 6.67 6.73 6.81 6.94 6.75</td>
</tr>
<tr>
<td>T11 Aloe vera 1:2</td>
<td>282.67 226.67 182.00</td>
<td>155.00</td>
<td>9.50</td>
<td>6.62 6.67 6.73 6.81 6.94 6.75</td>
</tr>
<tr>
<td>T12 Aloe vera 1:3</td>
<td>282.67 226.67 182.00</td>
<td>155.00</td>
<td>9.50</td>
<td>6.62 6.67 6.73 6.81 6.94 6.75</td>
</tr>
<tr>
<td>T13 Control</td>
<td>275.00 232.00</td>
<td>205.00</td>
<td>150.00</td>
<td>9.49</td>
</tr>
</tbody>
</table>

Factors CD at 5% SE(m) for storage intervals (S) was 0.034, treatments (T) was 0.054 and interaction (S × T) was 0.121.
The data presented in Table 3 depicted that 12th days storage TSS et al. fruits was due to the antimicrobial potentiality of the gel (Brishti et al., 2013). Lower decay incidence in Aloe vera coating that inhibited the respiratory rates and retarded the overall metabolic activities of guava fruits during storage. Retention of titratable acidity because of the lowest gas permeability of Aloe vera coating that inhibited the respiratory rates and retarded the overall metabolic activities of guava fruits during storage. Retention of titratable acidity has been reported previously for various fruits treated with edible coatings and films (e.g. Ali et al., 2010; Yaman and Bayoindirli, 2002). A lower acidity loss in chitosan coated fruits during storage was also reported in guava by Hong et al. (2012) suggesting that chitosan treatment may play a role in delaying fruit senescence. Aloe vera coating was more effective in the retention of titratable acidity because of the lowest gas permeability of Aloe vera coating that inhibited the respiratory rates and retarded the overall metabolic activities of guava fruits during storage. Treatment of titratable acidity has been reported for various fruits treated with edible coatings and films (e.g. Ali et al., 2010; Yaman and Bayoindirli, 2002).

The solubilisation of the cell wall polyuronides and hemicelluloses in mature strawberry might also contribute to the increase in TSS (Tanada-Palmu and Grosso, 2005). Similar findings has been reported by (Hassanpour, 2015) where Aloe vera treated raspberry fruits has higher TSS. Depletion of TSS in the fruit could be explained by a high metabolism of the fruits and senescence processes.

**Titratable Acidity**

A gradual decrease in titratable acidity was found in both coated and uncoated guava fruits throughout the storage period (Table 3). Maximum fruit titratable acidity (0.24%) was recorded in Aloe vera 1:1 (T1) followed by (0.23%) in chitosan 1.0% (T2) and minimum (0.20%) was recorded in control (T13) followed by (0.21%) in sodium alginate 1.5% (T4). Slower decline in acidity in treated fruits compared to control might be due to delayed senescence and lower respiration rate in those fruits. Similar observations were also reported by Sayyari et al. (2009) in pomegranate and Hernandez-Munoz et al. (2007) in strawberry.

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**Ascorbic Acid**

Treatments exerted a significant influence on ascorbic acid (Table 4). Maximum fruit ascorbic acid (231.60) was recorded in chitosan 1.5% (T2) which was statistically at par with T1 (218.80), T5 (223.00), T7 (227.07), T9 (218.27) and T12 (217.20) while minimum (197.80) was recorded in control (T13). Storage
days affected the ascorbic acid content significantly which decreased gradually irrespective of the treatment as the storage period progressed. The results are similar with the findings of Kumar et al. (2000), they found that ascorbic acid decreased with increasing period of storage in fruits of kinnon. But the decreased in ascorbic was less in coated fruits as compare to control. Maximum ascorbic acid in control treatment might be due to increased respiration causing loss of ascorbic acid. Ascorbic acid is susceptible to oxidative deterioration as well as mild oxidation of ascorbic acid results in formation of dehydroascorbic acid (Wills et al., 1981). Vitamin C in guava fruits gradually decreased during storage and this reduction was effectively inhibited by 1.5% chitosan coating (T6). The chitosan treatment in fruits might have reduced the oxygen permeability by providing a physical barrier thereby delayed the deteriorative oxidation reaction of ascorbic acid. A similar finding has been reported in litchi by Ayranci and Tunc (2004). It suggests that the modified atmosphere created by chitosan coating suppresses the loss of vitamin C.

Sugars

It is revealed from Table 4 & 5 that there was a significant increase in the total sugar, reducing sugar and non-reducing sugar content of coated as well as uncoated guava fruits during the storage period. However, the rate of increase in total sugar, reducing sugar and non-reducing sugar contents was significantly lower in coated samples as compared with control sample. Maximum total sugars (7.16%) was recorded in control (T1) followed by (7.03%) in sodium alginate 1.5% (T3) and minimum (6.75%) was recorded in chitosan 1.5% (T6) followed by (6.79%) in Aloe vera 1:1 (T10). Maximum reducing sugars (3.59%) was recorded in control (T1) which was followed by (3.54%) in chitosan 0.5% (T7) and minimum (3.37%) was recorded in chitosan 1.5% (T6) followed by (3.40%) in Aloe vera 1:1 (T10). Maximum non-reducing sugar (3.57%) was recorded in control (T1) followed by (3.56%) in Aloe vera 1:2 (T1) and minimum (3.38%) was recorded in chitosan 1.5% (T6) followed by (3.40%) in Aloe vera 1:1 (T10).

The total sugar, reducing sugar and non-reducing sugar contents was found to be higher in uncoated guava fruit which might be due to a decrease in the acidity as a result of physiological changes and rapid conversion of starch to sugars as a result of moisture loss as previously reported by Wills and Rigney (1980). In case of coated samples a significantly slower increase in total sugar, reducing sugar and non-reducing sugar contents were noted with respect to that of control that might be due to their slower ripening rate. This view concurs with the results of Abbas et al. (2009) who studied the effect of chitosan coatings on postharvest quality of mango fruit and observed that the total sugar, reducing sugar and non-reducing sugar contents were less in the coated samples. These results are in agreement with those of Li and Yu (2000) who concluded that reducing sugar and non reducing sugar content was significantly affected by gelatin coatings in mango. Maqbool et al. (2011) cited that during ripening the fruit texture is changed due to alteration in the cell wall structure and the degradation of starch and resultantly bound carbohydrate fractions especially pectic substances and hemicelluloses, rapidly depolymerize by hydrolysis. The present results were similar to the results of Hoa and Ducamp (2008) on ‘cat Hoa loc’ mangoes where they studied the effect of different coatings and observed that the contents of total sugar, reducing sugar and non-reducing sugar were lower in the coated fruit with respect to those of control fruits.

REFERENCES


disease (Botryodiplodia theobromae) of guava (Psidium guajava L.) by the application of yeast strains. Postharvest Biology and Technology. 53: 123-130.

Hassanpour. 2015. Effect of Aloe vera gel coating on antioxidant capacity, antioxidant enzyme activities and decay in raspberry fruit. Food Science and Technology. 60: 495-501.


Wills, R. B. G. and Rigney, C. J. 1980. Effect of calcium on activity of


