Application of biodegradable coatings to improve quality and shelf life of minimally processed melon dices

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ABSTRACT

In this study, alginate and chitosan based coatings were prepared and their effect on minimizing the postharvest losses and allied nutritional attributes in minimally processed melon dices. Meanwhile, a comparison with the commercial wax coating was also estimated. Results showed that moisture loss was reduced to 4.26 (Chitosan 3%) as compared to 15.01% in T0 (Control) in melon. Likewise, pH and titratable acidity was appreciably maintained by the coating application. The ascorbic acid contents were retained considerably in the coated treatments with 16.12mg/100g in T1 (Chitosan 3%) as compared to 14.54mg/100gm in T0 (Control) in coated dices. It is concluded that edible coatings served to resist weight loss, maintain pH and ascorbic acid levels in treated fruits. Resultantly, overall quality and shelf life was enhanced by the application of coatings. Based on the findings, edible coatings are suggested as an innovative, cost effective and environmental friendly preservation technique that holds potential to be used on fresh perishable commodities.

Keywords: Edible coatings, shelflife, quality, ascorbic acid, moisture loss

INTRODUCTION:

Over the years, edible coatings have coined as promising tool to address alarming rate of post-harvest losses in fresh horticultural commodities while conserving their nutritional and sensory attributes. Traditionally, these novel coatings have widely been used to enhance the appearance of different fruits and vegetables. It has been proved that these biofilms usually forms an intact transparent edible layer that acts as a barrier to moisture migration, solute retention and oxygen permeability during handling, processing and storage (Huang et al., 2012).

Historically, wax coating is among the old preservation approaches introduced by the Chinese in 12th century. Although lipid based complex coatings are effective in inducing desired barrier properties yet followed by poor consumer acceptability, faded skin tonality and off flavors production (Tharanathan, 2003). With the ingress in technology, there arose concept of biodegradable coatings that would not only serve to control moisture loss and improve shelf life but also exhibit certain desirable attributes (Cutter, 2006).

As far as their application is concerned, coatings are usually applied by dipping, spraying, foaming, brushing and dripping to induce a modified atmosphere. These are helpful to enhance retention of flavor, texture and color that ultimately improve appearance and desire quality traits with less incidence of spoilage. The property of edible coatings to maintain the quality of minimally processed produce may vary depending upon composition and thickness of coating, variety and maturity of product, food surface coverage and storage conditions (Aujila et al., 2011).

Edible coatings are of versatile nature in accommodating suitable additives for carrying certain nutritional and textural effects in the coated commodity (Baldwin et al., 2012). Resultantly, quality, shelf life stability and safety of fresh fruits are improved significantly with the incorporation of antioxidants, antimicrobials or functional ingredients. Furthermore, addition of nutraceuticals in coating formulations has also been devised to improve the functionality of coating mixture and enhance the nutritional worth of commodities (Dhall, 2013).

Melon (Cucumis melo) has also some medicinal value and is used as a tonic, laxative and diuretic. Musk melon is good source of vitamins A, B and C and improves the urinary discharge. Minimally processed foods have opened a new horizon in ready to serve food market owing to escalating demand for time, energy and labor conservation. Alongside, minimally processed fruits have proven as effective approach in ensuring quality and retain desirable sensoric attributes. The respiration rate and enzymatic browning in minimally processed fruits can be controlled by the application of edible coatings with functional additives (Ohlsson, 1994).

The present research project is an attempt to extend the shelf life of minimally processed melon dices using edible coatings. Purposely, chitosan and alginate based coatings were developed and applied on the fruit. The coated fruits were kept at controlled climate chamber maintained at 4°C and 85% relative humidity.
MATERIALS AND METHODS

Procurement and preparation of minimally processed melon

Fresh melon were procured from the local market and chosen on the basis of uniformity in size, shape, optimum color and absence of physical damage, abrasion or any evidence of fungal infection. For minimal processing, melon was cut to uniform dices and kept at refrigerated temperature before coating in order to avoid enzymatic browning and allied metabolic changes.

Development of chitosan based coatings

Chitosan based coatings (2, 2.5 & 3%) were prepared following the methods prescribed by Chien et al. (2007) and Simões et al. (2009). Chitosan coating formulations were prepared by dissolving chitosan (crabshell chitosan, Sigma Chemicals) in distilled water (100mL) followed by the addition of acetic acid (1g) to dissolve chitosan. To ensure uniform suspension, heating was done at 25°C with rigorous stirring for one hour. To prevent enzymatic browning, ascorbic (2g/100mL) and citric acids (1g/100mL) were also added in the developed solution followed by stirring using magnetic stirrer for 30 minutes. Afterwards, glycerol was added as plasticizer @ 1.5g/100mL to impart shine and reduce brittleness in the coated fruits. At the end, sunflower oil (0.025g/100mL) was added to improve the water vapor barrier properties.

Alginate based coatings

Alginate coatings (2, 2.5 & 3%) were formulated following the method of Rojas-Grau et al. (2008). For the purpose, alginate powder was dissolved in distilled water and heated at 70°C with continuous stirring until clear film formation. Coating solution was then emulsified with sunflower oil (0.025g/100mL) followed by the addition of glycerol (1.5g/100mL) as plasticizer. Afterwards, N-acetyl L-cysteine (1g/100mL) was added along with the calcium chloride (2g/100mL water) required for cross linking of carbohydrate polymers.

Storage of whole and minimally processed fruits

After coating, minimally processed melon dices were stored in controlled climate chamber at 4±1°C temperature and 85% relative humidity. Furthermore, both coated and uncoated whole fruits were also placed at room temperature to evaluate the storage behavior. Likewise, the efficiency of commercial wax coating was also assessed for comparison purpose. During storage, different physicochemical analyses were performed at designated intervals.

Physicochemical analysis

Following physicochemical parameters were assessed at selected intervals to examine the shelf life stability of coated fruits.

Moisture loss

pH

Total soluble solids

Ascorbic acid

Moisture loss

Moisture loss was measured by following the protocols mentioned in AOAC (2006). The moisture loss percentage relative to initial weight was calculated by weighing the samples at regular intervals during storage. Moisture loss percentage was calculated by using the following formula.

\[
\text{Moisture Loss} \% = \left( \frac{\text{Initial weight} - \text{final weight}}{\text{initial weight}} \right) \times 100
\]

Extraction of juice

For juice extraction, 500g of fruit was blended followed by filtration to remove solid contents. The obtained juice was subjected to various assays like pH, titratable acidity, total soluble solids and vitamin C.

pH

The pH of each sample was determined with the help of digital pH meter following the procedures of AOAC (2006). Purposely, 50mL of fruit juice was taken in 100mL beaker and pH was recorded by the pH meter (Inolab pH 720, Germany).

Total soluble solids

Total soluble solids of the coated samples were directly recorded by using Digital Refractometer (RA-600 refractometer, Kyoto Electronics Manufacturing Co., Ltd., Japan) following the standard procedure of AOAC (2006). A drop of fruit juice was placed on the prism of refractometer and reading was noted. The results were expressed as °Brix.

Ascorbic acid

The ascorbic acid content was estimated using 2, 6-dichlorophenolindophenol dye, according to the method of AOAC (2006). Ascorbic acid reduces 2, 6- dichlorophenol indophenol to a colorless solution. Initially, different solutions like ascorbic acid standard, metaphosphoric acid and indophenol were made. Afterwards, prepared standard ascorbic acid solution was titrated against the dye (2, 6-dichlorophenolindophenol). The obtained reading was served as standard. Afterwards, extracted juice sample along with meta-phosphoric acid solution was titrated against indophenol dye and noted the volume used.

Vitamin C contents were determined using the formula as
Ascorbic acid = \((X - B) \times \left(\frac{F}{E}\right) \times \frac{V}{Y}\)

Where,

\(X = \text{mL for sample titration}\)
\(B = \text{mL for sample blank titration}\)
\(F = \text{mg ascorbic acid equiv. to 1.0 mL indophenol standard solution}\)
\(E = \text{mL of juice sample}\)
\(V = \text{volume initial assay solution}\)
\(Y = \text{volume sample aliquot titrated}\)

Statistical analysis

The data obtained for each parameter was subjected to statistical analysis to determine the level of significance and comparison of means was also carried out according to the methods as described by Steel et al. (1997).

RESULTS & DISCUSSION

Moisture loss

Mean squares regarding moisture loss in edible coated minimally processed melon dices stored at controlled climate chamber revealed significant differences due to treatments, storage and their interaction. It is deduced from means (Table 1) that the maximum moisture loss was observed in T\(_0\) (Control) as 15.01±0.52% whilst the lowest reported values were exhibited in T\(_3\) (Chitosan 3%) as 4.26±0.15%. However, for T\(_4\) (Alginate 2%) and T\(_5\) (Alginate 2.5%), moisture loss was recorded as 7.44±0.26 and 7.02±0.24%, respectively. The lowest value for the parameter was noted in T\(_2\) (Chitosan 2.5%) as 4.87±0.17%, respectively.

Over the storage, a steady increase in moisture loss was witnessed ranging from 5.87±0.21% at 3\(^{rd}\) day progressed to 9.60±0.34 and 11.54±0.43% at 6\(^{th}\) and 9\(^{th}\) days, respectively. However, at the termination moisture loss was noted as 12.94±0.45%. Among treatments, a similar trend regarding increment in moisture loss was reported with maximum loss recorded in T\(_0\) ranging from 10.82±0.27 to 24.88±0.63% at 3\(^{rd}\) to 9\(^{th}\) days, respectively. Likewise, for T\(_7\) (Commercial wax), moisture loss differed from 10.44±0.26 to 22.96±0.58% at initiation to termination, respectively. Moreover, for T\(_4\), T\(_3\) and T\(_6\), moisture loss varied from 5.91±0.15 to 11.88±0.31%, 5.67±0.14 to 10.58±0.27% and 3.48±0.09 to 8.30±0.21% at mentioned intervals, respectively. The lowest moisture loss was estimated in T\(_3\) from 2.94±0.07 to 7.11±0.18% at the end of entire storage interval.

Edible coatings have proved to be effective in retarding moisture loss of fresh cut melon. These results are in line with the earlier work of Sangsuwan et al. (2008) who reported similar findings to lessen the moisture loss of fresh cut cantaloupe and pineapple. Later, Supapvanich et al. (2011) were of the view that softening of melon dices is associated with the loss of moisture that increases with the progression in storage time. In another attempt, Raybaudi-Massilia et al. (2008) studied effect of alginate based antimicrobial coatings on extension of shelf life of minimally processed melon dices. They observed that coatings were effective in maintaining weight loss appreciably.

pH

Mean squares regarding pH of treated melon dices kept at controlled climate chamber revealed differences were observed for effect of both treatments and storage. However, their interaction did not differ appreciably. It is explicated from means (Table 2) that the maximum value for pH of melon dices was recorded in T\(_0\) (Control) as 6.24±0.25 followed by T\(_7\) (Commercial wax) as 6.21±0.17. Likewise, for T\(_1\) (Chitosan 2%) and T\(_4\) (Alginate 2%), recorded values were 6.12±0.22 and 6.15±0.26, respectively. The least value for the parameter was assessed in T\(_3\) (Chitosan 3%) as 5.97±0.23.

During storage, a gradual increase in pH values was reported ranged from 5.91±0.24 at initiation to 6.25±0.28 at termination. However, reported values for pH were 6.04±0.23, 6.13±0.19 and 6.20±0.17 at 3\(^{rd}\), 6\(^{th}\) and 9\(^{th}\) days, respectively. Similarly, among treatments persistent increase in the values for the trait was noticed with the ingress in storage. It can be followed that the maximum increase in the values was noted in T\(_0\) and T\(_7\) as 5.97±0.21 to 6.41±0.18 and 5.95±0.23 to 6.37±0.23 at 0 to 12 days, respectively. Likewise, variations for T\(_1\), T\(_3\) and T\(_6\) ranged from 5.94±0.23 to 6.28±0.18, 5.87±0.19 to 6.11±0.21 and 5.86±0.22 to 6.05±0.21 at 0 to 12 days, respectively.

The findings of instant investigation are in accordance with the work of Oms-Oliu et al., (2008) they explored alginate, pectin and gellan-based edible coatings on the shelf-life of fresh-cut ‘Piel de Sapo’ melon. In their findings, they noticed that gas exchange, pH, acidity and color were adequately maintained. In addition, sensory attributes were greatly enhanced by the coating application. Recently, Martínón et al., (2014) narrated that multilayered edible coating with antimicrobial agent extended shelf life of fresh-cut cantaloupe stored at 4 °C. It was noticed that moisture, acidity and pH was maintained significantly. Previously, Cong et al. (2007) enumerated chitosan based antibiotic coatings on melon dices and observed that weight loss was considerably controlled together with maintained pH and acidity of the coated fruit. Moreover, ascorbic acid values were retained appreciably by the coating application.
1: Means for moisture loss (%) of edible coated melon dices kept at controlled climate chamber

<table>
<thead>
<tr>
<th>Days</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 days</td>
<td>10.82±0.27\textsuperscript{d}</td>
<td>4.50±0.11\textsuperscript{c}</td>
<td>3.16±0.08\textsuperscript{m}</td>
<td>2.94±0.07\textsuperscript{y}</td>
<td>5.91±0.15\textsuperscript{g}</td>
<td>5.67±0.14\textsuperscript{i}</td>
<td>3.48±0.09\textsuperscript{a}</td>
<td>10.44±0.26\textsuperscript{b}</td>
<td>5.87±0.21\textsuperscript{c}</td>
</tr>
<tr>
<td>6 days</td>
<td>17.59±0.44\textsuperscript{d}</td>
<td>6.83±0.17\textsuperscript{m}</td>
<td>6.13±0.15\textsuperscript{m}</td>
<td>5.01±0.13\textsuperscript{y}</td>
<td>9.10±0.23\textsuperscript{i}</td>
<td>8.53±0.22\textsuperscript{j}</td>
<td>6.42±0.16\textsuperscript{p}</td>
<td>17.18±0.43\textsuperscript{d}</td>
<td>9.60±0.34\textsuperscript{b}</td>
</tr>
<tr>
<td>9 days</td>
<td>21.70±0.55\textsuperscript{c}</td>
<td>7.86±0.23\textsuperscript{k}</td>
<td>7.21±0.18\textsuperscript{m}</td>
<td>6.26±0.16\textsuperscript{p}</td>
<td>10.31±0.26\textsuperscript{gh}</td>
<td>10.21±0.26\textsuperscript{gh}</td>
<td>7.44±0.19\textsuperscript{im}</td>
<td>21.31±0.54\textsuperscript{c}</td>
<td>11.54±0.43\textsuperscript{a}</td>
</tr>
<tr>
<td>12 days</td>
<td>24.88±0.63\textsuperscript{a}</td>
<td>9.96±0.25\textsuperscript{h}</td>
<td>7.85±0.23\textsuperscript{kl}</td>
<td>7.11±0.18\textsuperscript{m}</td>
<td>11.88±0.31\textsuperscript{e}</td>
<td>10.58±0.27\textsuperscript{fg}</td>
<td>8.30±0.21\textsuperscript{j}</td>
<td>22.96±0.58\textsuperscript{b}</td>
<td>12.94±0.45\textsuperscript{a}</td>
</tr>
<tr>
<td>Means</td>
<td>15.01±0.52\textsuperscript{a}</td>
<td>5.83±0.28\textsuperscript{d}</td>
<td>4.87±0.17\textsuperscript{c}</td>
<td>4.26±0.15\textsuperscript{c}</td>
<td>7.44±0.26\textsuperscript{c}</td>
<td>7.02±0.24\textsuperscript{c}</td>
<td>5.13±0.18\textsuperscript{d}</td>
<td>14.38±0.53\textsuperscript{b}</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a,b,c,d,e,...} - Letters indicate significant differences among treatments.

T\textsubscript{0} = Control
T\textsubscript{1} = Chitosan 2%
T\textsubscript{2} = Chitosan 2.5%
T\textsubscript{3} = Chitosan 3%
T\textsubscript{4} = Alginate 2%
T\textsubscript{5} = Alginate 2.5%
T\textsubscript{6} = Alginate 3%
T\textsubscript{7} = Wax
<table>
<thead>
<tr>
<th>Days</th>
<th>Treatments</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T₀ Control</td>
<td>5.97±0.21&lt;sup&gt;c,i&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>T₁ Chitosan 2%</td>
<td>5.94±0.23&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>T₂ Chitosan 2.5%</td>
<td>5.87±0.19&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>T₃ Chitosan 3%</td>
<td>5.86±0.22&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>T₄ Alginate 2%</td>
<td>5.93±0.24&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>T₅ Alginate 2.5%</td>
<td>5.91±0.25&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>T₆ Alginate 3%</td>
<td>5.89±0.29&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>T₇ Wax</td>
<td>5.95±0.23&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
<tr>
<td>0 day</td>
<td></td>
<td>5.91±0.24&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
<tr>
<td>3 days</td>
<td></td>
<td>6.13±0.23&lt;sup&gt;a,i&lt;/sup&gt;</td>
</tr>
<tr>
<td>6 days</td>
<td></td>
<td>6.30±0.25&lt;sup&gt;a,c,e&lt;/sup&gt;</td>
</tr>
<tr>
<td>9 days</td>
<td></td>
<td>6.39±0.20&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>12 days</td>
<td></td>
<td>6.41±0.18&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Means</td>
<td></td>
<td>6.24±0.25&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Table 2: Means for pH of edible coated melon dices kept at controlled climate chamber

T₀= Control
T₁= Chitosan 2%
T₂= Chitosan 2.5%
T₃= Chitosan 3%
T₄= Alginate 2%
T₅= Alginate 2.5%
T₆= Alginate 3%
T₇= Wax
### Table 3: Means for Total Soluble Solids (°Brix) of edible coated melon dices kept at controlled climate chamber

<table>
<thead>
<tr>
<th>Days</th>
<th>T₀</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>T₄</th>
<th>T₅</th>
<th>T₆</th>
<th>T₇</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 day</td>
<td>10.80±0.12³&lt;sup&gt;x&lt;/sup&gt;</td>
<td>10.69±0.13³&lt;sup&gt;y&lt;/sup&gt;</td>
<td>10.64±0.15³&lt;sup&gt;y&lt;/sup&gt;</td>
<td>10.61±0.19³</td>
<td>10.75±0.18³&lt;sup&gt;y&lt;/sup&gt;</td>
<td>10.71±0.22³&lt;sup&gt;w&lt;/sup&gt;</td>
<td>10.67±0.19³&lt;sup&gt;y&lt;/sup&gt;</td>
<td>10.78±0.17³&lt;sup&gt;y&lt;/sup&gt;</td>
<td>10.71±0.32³&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>3 days</td>
<td>11.15±0.13³&lt;sup&gt;m&lt;/sup&gt;</td>
<td>10.98±0.11³&lt;sup&gt;u&lt;/sup&gt;</td>
<td>10.87±0.11³&lt;sup&gt;u&lt;/sup&gt;</td>
<td>10.82±0.12³&lt;sup&gt;o&lt;/sup&gt;</td>
<td>11.08±0.13³&lt;sup&gt;o&lt;/sup&gt;</td>
<td>11.03±0.14³&lt;sup&gt;q&lt;/sup&gt;</td>
<td>10.93±0.15³&lt;sup&gt;v&lt;/sup&gt;</td>
<td>11.12±0.14³&lt;sup&gt;p&lt;/sup&gt;</td>
<td>11.03±0.33³&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>6 days</td>
<td>11.44±0.12³&lt;sup&gt;g&lt;/sup&gt;</td>
<td>11.24±0.16³&lt;sup&gt;k&lt;/sup&gt;</td>
<td>11.10±0.11³&lt;sup&gt;n&lt;/sup&gt;</td>
<td>11.05±0.17³&lt;sup&gt;p&lt;/sup&gt;</td>
<td>11.32±0.11³&lt;sup&gt;m&lt;/sup&gt;</td>
<td>11.28±0.11³&lt;sup&gt;n&lt;/sup&gt;</td>
<td>11.19±0.12³&lt;sup&gt;q&lt;/sup&gt;</td>
<td>11.37±0.13³&lt;sup&gt;i&lt;/sup&gt;</td>
<td>11.25±0.39³&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>9 days</td>
<td>11.76±0.11³&lt;sup&gt;d&lt;/sup&gt;</td>
<td>11.50±0.13³&lt;sup&gt;i&lt;/sup&gt;</td>
<td>11.28±0.12³&lt;sup&gt;j&lt;/sup&gt;</td>
<td>11.23±0.12³&lt;sup&gt;k&lt;/sup&gt;</td>
<td>11.64±0.15³&lt;sup&gt;d&lt;/sup&gt;</td>
<td>11.57±0.13³&lt;sup&gt;o&lt;/sup&gt;</td>
<td>11.38±0.11³&lt;sup&gt;j&lt;/sup&gt;</td>
<td>11.72±0.14³&lt;sup&gt;de&lt;/sup&gt;</td>
<td>11.51±0.45³&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>12 days</td>
<td>12.21±0.14³&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.75±0.12³&lt;sup&gt;de&lt;/sup&gt;</td>
<td>11.41±0.11³&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.28±0.15³&lt;sup&gt;j&lt;/sup&gt;</td>
<td>11.96±0.12³&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>11.80±0.13³&lt;sup&gt;id&lt;/sup&gt;</td>
<td>11.62±0.11³&lt;sup&gt;dg&lt;/sup&gt;</td>
<td>12.11±0.12³&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>11.77±0.41³&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Means</td>
<td>11.47±0.47³&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.23±0.33³&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>11.06±0.38³&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.01±0.39³&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.35±0.46³&lt;sup&gt;c&lt;/sup&gt;</td>
<td>11.28±0.35³&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>11.16±0.32³&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.42±0.43³&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

T₀ = Control  
T₁ = Chitosan 2%  
T₂ = Chitosan 2.5%  
T₃ = Chitosan 3%  
T₄ = Alginate 2%  
T₅ = Alginate 2.5%  
T₆ = Alginate 3%  
T₇ = Wax
**Table 4: Means for ascorbic acid (mg/100g) of edible coated melon dices kept at controlled climate chamber**

<table>
<thead>
<tr>
<th>Days</th>
<th>Treatments</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T_0$</td>
<td>$T_1$</td>
</tr>
<tr>
<td>0 day</td>
<td>17.47±0.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.66±0.44&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>3 days</td>
<td>15.67±0.39&lt;sup&gt;c-e&lt;/sup&gt;</td>
<td>16.46±0.41&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>6 days</td>
<td>14.11±0.35&lt;sup&gt;i&lt;/sup&gt;</td>
<td>15.33±0.38&lt;sup&gt;d-g&lt;/sup&gt;</td>
</tr>
<tr>
<td>9 days</td>
<td>13.15±0.33&lt;sup&gt;m&lt;/sup&gt;</td>
<td>15.08±0.37&lt;sup&gt;c-j&lt;/sup&gt;</td>
</tr>
<tr>
<td>12 days</td>
<td>12.32±0.31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.53±0.36&lt;sup&gt;h-i&lt;/sup&gt;</td>
</tr>
<tr>
<td>Means</td>
<td>14.54±0.51&lt;sup&gt;d&lt;/sup&gt;</td>
<td>15.81±0.55&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

$T_0$= Control  
$T_1$= Chitosan 2%  
$T_2$= Chitosan 2.5%  
$T_3$= Chitosan 3%  
$T_4$= Alginate 2%  
$T_5$= Alginate 2.5%  
$T_6$= Alginate 3%  
$T_7$= Wax
Total Soluble Solids

Mean squares regarding total soluble solids in edible coated melon dices kept at controlled climate chamber depict that significant variations were reported with respect to the effect of treatments, storage and their interaction. From means, it is inferred that (Table 3) the maximum value for total soluble solids was recorded in \( T_0 \) (Control) and \( T_7 \) (Commercial wax) as 11.47±0.47 and 11.42±0.43 ºBrix, respectively. However for the Table treatments \( T_1 \) (Chitosan 2%), \( T_4 \) (Alginate 2%) and \( T_5 \) (Alginate 2.5%), observed values for the trait were 11.23±0.33, 11.35±0.46 and 11.28±0.35 ºBrix, respectively. However, the lowest recorded values for the trait were noticed in both \( T_1 \) (Chitosan 3%) and \( T_6 \) (Alginate 3%) as 11.01±0.39 and 11.16±0.32 ºBrix, respectively. During storage, a gradual increase in the values for total solids was observed ranged from 10.71±0.32 ºBrix at the launch of the trial that improved to 11.03±0.33 and 11.25±0.39 °Brix at 3rd and 6th days, respectively. With further developments, total soluble solids were recorded as 11.51±0.45 and 11.77±0.41 °Brix at 9th and 12th days, respectively. Likewise, among treatments a similar increase in TSS was reported that ranged from 10.69±0.13 to 10.98±0.11 and 11.75±0.12 ºBrix & 10.64±0.15 to 10.87±0.11 and 11.41±0.11 ºBrix for \( T_1 \) and \( T_2 \) at 0, 3rd and 12th days, respectively. Moreover, for \( T_4 \) (Chitosan 2%) and \( T_5 \) (Chitosan 2.5%) increment in values for total solids ranged from 10.75±0.18 to 11.96±0.12 ºBrix and 10.71±0.22 and 11.80±0.13 ºBrix at initiation to termination, respectively. Among treatments, the maximum increase in total solids was found in both \( T_0 \) and \( T_7 \) ranging from 10.80±0.12 and 10.78±0.17 ºBrix to 12.21±0.14 and 12.11±0.12 ºBrix at 0 to 9 days, respectively. It can be followed that the maximum retention in the values for total soluble solids was recorded in \( T_3 \) varying from 10.61±0.19 ºBrix at initiation to 10.82±0.12 and 11.28±0.15 ºBrix at 3rd and 12th days, respectively.

Ascorbic acid

It is clear from mean squares regarding ascorbic acid content in melon dices treated with various edible coatings and kept at controlled climate chamber that there were significant variations reported with respect to the effect of treatments and storage. Moreover, their interaction was also observed to be significant. From means, it is deduced that (Table 4) the maximum value for ascorbic acid was noted for \( T_3 \) (Chitosan 3%) as 16.12±0.56mg/100gm followed by \( T_2 \) (Chitosan 2.5%) as 15.89±0.56mg/100gm. However, for treatments \( T_1 \) (Chitosan 2%) and \( T_5 \) (Alginate 3%) the values for ascorbic acid were found as 15.81±0.55 and 15.81±0.55mg/100gm, respectively. Furthermore, the lowest of the values for the ascorbic acid levels were noted for both the \( T_0 \) (Control) and \( T_7 \) (Commercial wax) as 14.54±0.51 and 14.75±0.52mg/100gm, respectively.

Over the course of storage, a persistent decline in the levels of ascorbic acid were observed varied from 17.62±0.62mg/100gm at the launch of the trial, which lowered to 16.28±0.57 and 15.13±0.53 at 3rd and 6th days, respectively. Furthermore, with the ingress in storage, ascorbic acid levels deteriorated further and recorded as 14.54±0.51 and 14.11±0.49mg/100gm at 9th and 12th days, respectively.

Likewise, among treatments a similar dwindle in the ascorbic acid levels was also reported that in case of \( T_3 \) ranged from 17.75±0.44 to 15.56±0.39 and 16.12±0.56mg/100gm at 0, 6th and 12th days, respectively. Moreover, for treatments \( T_1 \) (Chitosan 2%) and \( T_2 \) (Chitosan 2.5%) the lowering in ascorbic acid levels ranged from 17.66±0.44 and 17.73±0.44mg/100gm at initiation to 16.46±0.41 and 16.61±0.45mg/100gm at 3rd day to 14.53±0.36 and 14.68±0.37mg/100gm at the termination of 12 days research, respectively. Similarity for alginate based coatings, ascorbic acid losses for \( T_4 \), \( T_5 \) and \( T_6 \) were witnessed as varied from 17.55±0.44 to 14.38±0.34mg/100g, 17.62±0.44 to 14.46±0.36mg/100gm and 17.69±0.44 to 14.58±0.32mg/100gm at 0 to 12 days, respectively. Among the treatments, the maximum decline in the levels of ascorbic acid were found in both \( T_0 \) and \( T_7 \) as differed from 17.47±0.44 and 17.51±0.44 to 12.32±0.31mg/100gm and 12.69±0.31mg/100gm at mentioned intervals, respectively.

The findings of instant investigation are in accordance with the work of Cong et al. (2007), who developed chitosan based edible coatings incorporated with antibiotics that helped resist fungal attack on melon dices. They were of the opinion that these coatings led to conservation of ascorbic acid contents in the coated produce. Moreover, sensory attributes were greatly improved by coating application. Instant study is in agreement with the results of Sangsuwan et al. (2008), they reported decrease in ascorbic acid contents of control and chitosan coated fresh cuts of cantaloupe and pineapple at the end of eight days storage. Moreover, they are of the view that the reduction in ascorbic acid contents at the end of storage was about half of the initial concentration. Furthermore, Oms-Oliu et al. (2008) reported that vitamin C retention was significantly affected by the coating composition and storage time. They illustrated that reduction in vitamin c contents was higher in control as compared to coated melon dices.

**CONCLUSION**

From the results, it is concluded that edible coatings are among vibrant preservation technologies that can
effectively be used to address the alarming incidence of high postharvest losses. In the instant study, alginate and chitosan based coatings were developed and applied on minimally processed melon kept at controlled climate chamber. There was noticed a significant decline in moisture loss %, whilst pH and total soluble solids content of the coated fruit were maintained quite diligently.

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