IMPACT OF STORAGE TEMPERATURE (7°C) AND POST-HARVEST PRE-TREATMENTS ON QUALITY CHARACTERISTICS AND STORAGE LIFE OF TOMATO (LYCOPERSICON ESCULENTUM) FRUITS

G. MOHAN NAIK1, R. F. SUTAR2 & R. JAGAN MOHAN3

1,3 Indian Institute of Food Processing Technology, Thanjavur, Tamil Nadu, India
2 College of Food Processing Technology and Bio-Energy, AAU, Anand, Gujarat, India

ABSTRACT

Temperature has a remarkable effect on the rate of metabolic processes and quality characteristics of fruits and vegetables. Various post-harvest and pre-harvest treatments are applied to fruits and vegetables in order to extend the shelf life and preserve the quality characteristics for the longer duration of time. Each method has its own advantages and limits. The present study was carried out with an objective to evaluate the impact of storage temperature and post-harvest treatments like edible coating, pre-cooling and combination of these on storage life and quality characteristic tomato fruit. Pre-treated fruits were stored at 7°C and evaluate the quality parameters like physiological weight loss (PLW), pH, TSS, titratable acidity, lycopene content and percentage of spoilage at the interval of three days during storage. It was noticed that increase in PLW (4.52%), TSS (3.7 box), lycopene content (1.67 mg/100g), percentage of spoilage (15.55%) and decrease in pH (4.0), titratable acidity (0.29 % citric acid) was noticed at the end of shelf life. All treated samples shows little resistance to chilling injury compared to control samples. Sample T3C0 (Hydro-cooling at 8°C + without coating) have 18 days storage life with minimum spoilage. The activity of edible coating was reduced due to the effect of storage temperature, at this condition coating lose its stability and easily separated from the product. It can be concluded that post-harvest treatments play important role in order to extend the shelf life due to the effect of low temperature storage (7°C) fruits are very susceptible to chilling injury and spoiled rapidly.

KEYWORDS: Temperature, Post-Harvest, Pre-Harvest, Shelf Life & Chilling Injury

INTRODUCTION

Tomato is the second most important crop in the world next to the potato. Fruits are frequently harvested at the mature green stage to minimize the losses during handling, processing and storage. Tomatoes are a good source of potassium, iron, phosphorus, vitamins C, E, B, and dietary fiber. Ripe tomatoes are red in color because lycopene pigment, an antioxidant (Kucuk et al., 2002). Generally, fruits and vegetables are highly perishable commodities and deteriorate very quickly hence, that require to be handled with care to minimize losses. Due to improper storage and handling postharvest losses range from 20-50 percent in developing countries (Kader, 1992). During off-seasons when horticultural crops arrive in plenty at the market, prices slump is bringing the farmer less profit. These post-harvest losses can be minimized by using various post-harvest and pre-harvest technologies through proper handling, processing and storage.

Fruits and vegetables can be prolonged by low-temperature storage, it mainly reduces the respiratory metabolism, biochemical changes, microbial development and hence extending their shelf life (Wills et al., 1998).
Storage temperatures ranged from 10-15°C and 85-95% relative humidity could extend the postharvest life of fruits. Chilling injury and ripening rate are minimal at these temperatures.

Pre-cooling is the method followed to remove the field heat from freshly harvested fruits and vegetables. Considerably metabolic activity and consequently respiration rate and ethylene production of the fruits were reduced. Hydro-cooling is a procedure in which, fruits are either sprayed with or immersed in cold water to reduce their temperature/field heat. In hydro-cooling treatment, water is not lost from produce surfaces, but rather absorbed by them (Bartz 1988).

Edible coatings are thin layers of edible material (protein, carbohydrate, lipid based) applied to the product surface in addition to or as a replacement for natural protective waxy coatings and provide a barrier to moisture, oxygen and solute movement for the food. They are applied directly on the food surface by dipping, spraying or brushing to create a modified atmosphere (McHugh and Senesi, 2000).

Post-harvest treatments like pre-cooling, edible coating, MAP, CAS and low temperature storage plays a prominent role in order to increase the shelf life of the product as well as maintain good quality characteristics. The objectives of this study were to investigate the effects of storage temperature, pre-cooling and edible coating on quality characteristics and storage life of tomato fruit.

**MATERIALS AND METHODS**

**Collection of Samples and Preparation**

Breaker stage tomatoes (cv. Narendra-2) were freshly harvested from the local farmer's field and further washed with 500 ppm sodium hypochlorite solution for surface cleaning. Edible coating materials like corn starch, glycerol and oleic acid purchased from certified suppliers.

The edible coating emulsion was prepared by using three different level coating material, i.e. corn starch (2.5, 5.0 & 7.5%), glycerol 2% and oleic acid 2%. Coating emulsion was prepared by boiling the materials with the addition of distilled water. The coating was done by dipping the fruits in coating emulsion and keep it rested in 10-15 second in coating emulsion. Pre-cooling was done by using hydro-pre cooler with three different cooling medium temperature i.e. 4, 6 and 8°C. A further study was carried out according to the treatment combination given below in Table 1. Treated samples were kept at a storage room temperature maintained 7°C. At the interval of three days parameters like weight loss, percent spoilage, pH, tetra table acidity, total soluble solids, and lycopene content were examined throughout storage.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Treatment Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T₀C₀</td>
<td>Without pre-cooling + without coating (Control)</td>
</tr>
<tr>
<td>2</td>
<td>T₀C₁</td>
<td>Without pre-cooling + (Corn starch 2.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>3</td>
<td>T₀C₂</td>
<td>Without pre-cooling + (Corn starch 5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>4</td>
<td>T₀C₃</td>
<td>Without pre-cooling + (Corn starch 7.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>5</td>
<td>T₁C₀</td>
<td>Hydro-cooling at 4 °C + Without coating</td>
</tr>
</tbody>
</table>
Impact of Storage Temperature (7°C) and Post-Harvest Pre-Treatments on Quality Characteristics and Storage Life of Tomato (Lycopersicon Esculentum) Fruits

### Table 1: Con’td

<table>
<thead>
<tr>
<th></th>
<th>TᵢCᵢ</th>
<th>Treatment Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>T₁C₁</td>
<td>Hydro-cooling at 4 °C + (Corn starch 2.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>7</td>
<td>T₁C₂</td>
<td>Hydro-cooling at 4 °C + (Corn starch 5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>8</td>
<td>T₁C₃</td>
<td>Hydro-cooling at 4 °C + (Corn starch 7.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>9</td>
<td>T₁C₀</td>
<td>(Hydro-cooling at 6 °C + Without coating)</td>
</tr>
<tr>
<td>10</td>
<td>T₂C₁</td>
<td>Hydro-cooling at 6 °C + (Corn starch 2.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>11</td>
<td>T₂C₂</td>
<td>Hydro-cooling at 6 °C + (Corn starch 5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>12</td>
<td>T₂C₃</td>
<td>Hydro-cooling at 6 °C + (Corn starch 7.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>13</td>
<td>T₂C₀</td>
<td>Hydro-cooling at 8 °C + without coating</td>
</tr>
<tr>
<td>14</td>
<td>T₃C₁</td>
<td>Hydro-cooling at 8 °C + (Corn starch 2.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>15</td>
<td>T₃C₂</td>
<td>Hydro-cooling at 8 °C + (Corn starch 5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
<tr>
<td>16</td>
<td>T₃C₃</td>
<td>Hydro-cooling at 8 °C + (Corn starch 7.5% (W/V) + Glycerol 2% (V/V) + Oleic acid 2% (V/V) + Distilled water for balance)</td>
</tr>
</tbody>
</table>

#### Physiological Weight Loss (PLW)

The weight loss of the tomato fruit sample was calculated by differences between initial weight and final weight divided by initial weight.

\[
\text{PLW (\%)} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100
\]

#### pH & TSS

pH was measured by using a digital pH meter and TSS by using an PAL-1 handheld refractometer (ATAGO, Japan) at temperature of 20°C.

#### Titra Table Acidity

The titra table acidity of the sample was determined by the method described by Rangana (1986).

#### Lycopene Content

Lycopene was extracted and analysed according to Thimmaih (1999). The lycopene content (mg/100g) was calculated using molar extinction coefficient \( \Sigma = 17.2 \times 10^4 \text{ M}^1\text{cm}^{-1} \).

\[
\text{Lycopene (mg/100g)} = \frac{3.1 \times 10^8 \text{ of sample} \times \text{Volume of solution}}{\text{Weight of sample} \times 10^3} \times 100
\]
Spoilage (%)

Spoilage or rotting was determined by the visual observation, i.e. When 40 percent of fruits showed symptoms of spoilage, the fruits were considered to have reached the end of the shelf life (Rai et al., 2012).

Statistical Analysis

Done by using completely randomized design (CRD). The critical difference value at 5% level of probability was used for comparison among treatment means.

RESULTS AND DISCUSSIONS

Effect of Low Temperature and Post-Harvest Treatment on Physiological Loss in Weight (PLW %), pH, TSS, Titratable Acidity, Lycopene Content and Spoilage (%) of Tomato

The results of physiological loss in weight of tomato stored at the 7°C for the various pre-treatments are depicted in Figure 1. It was observed that minimum weight loss was observed in treatment T₂C₃ (0.34%) and higher in T₃C₀ (4.52%). All the treatments were significantly different from treatment mean at the end of storage life. During storage it was observed that the combination of low temperature storage and post-harvest treatments greatly reduces the physiological loss in weight by inhibiting transpiration and respiration mechanism. Weight loss progressively increased with the increasing storage time. Our results are in agreement with Castro et al. (2006) who tested different storage temperatures and demonstrated that weight loss was proportional to the storage period and storage temperature.

![Figure 1: PLW (%) of Tomato Fruit Stored at 7°C](image)

The influence on pH by pre-treatment and storage temperature are depicted in Figure 2. It was observed that the pH of tomato increased throughout the shelf life. It was maximum in T₂C₁ (4.0) and minimum in T₁C₀ (3.57) followed by T₃C₂ (3.69). At the end of storage, it was found that all the treatment was founded significance during storage of tomato. It was noticed that the rate of increase in pH was low in case of at the 5% level except T₀C₀, T₀C₁, T₁C₀, T₂C₁, T₂C₂ and T₃C₂. Rai et al. (2012) also reported similar results sample stored at low temperature storage.
Impact of Storage Temperature (7°C) and Post-Harvest Pre-Treatments on Quality Characteristics and Storage Life of Tomato (Lycopersicon Esculentum) Fruits

Total soluble solids influenced by pre-treatments and 7°C storage temperature are depicted in Figure 3. Highest total soluble solids were found in T₀C₀ (3.70°brix) whereas lowest in T₁C₃ (3.31°brix) at the end of storage period. From the treatment mean it was found that all the treatments were at par at 5% significance level except T₀C₁, T₂C₂, T₂C₃, and T₃C₁ at the end of storage at 7°C. The total soluble solids increased during the ripening due to degradation of polysaccharides to simple sugars thereby causing a rise in TSS (Naik et al., 1993). At the time of storage, increase in TSS was found in all treatments. This result is in confirmation with the result of Bhaumik et al. (2015).

Influence on titratable acidity by pre-treatment and storage temperature are depicted in Figure 4. It was found that with the advancement of ripening and storage period acidity decreased. It was noted that titratable acidity was minimum in T₀C₁ (0.19) followed by T₀C₃ (0.19) and maximum in T₃C₃ (0.29) at the end of storage period. From the treatment, mean it was observed that all the treatments were significant at (P = 0.05) 5% level. The higher loss of titratable acidity during the storage time could be related to higher respiration rate as ripening advances where organic acids are used as substrate in respiration process (Lurie and Klein, 1990)

The data pertaining to the lycopene content of tomato for different pre-treatments and storage temperature are depicted in Figure 5. It was found that during advancement of ripening and storage period, the rate of synthesis of lycopene...
content was slower. It was found that the lycopene content was maximum in T₁C₀ (1.67 mg/100g) and minimum in T₃C₃ (0.56 mg/100g). From the treatment, mean it was observed that all the treatments were significance at (P = 0.05) 5% level. Raiet al. (2012) stated that the increase in the level of lycopene during storage might be due to ripening advancements of tomato fruits and conversion of chloroplasts.

![Figure 4: Changes in Titratable Acidity of Tomato Stored at 7 °C](image)

![Figure 5: Changes in Bio-Synthesis of Lycopene Content of Tomato Stored at 7 °C](image)

The spoilage of tomato stored at 7 °C for different pre-treatments are depicted in Figure 6. It was observed that the spoilage of tomatoes due to chilling injury is more common. It was highest in T₀C₀ (15.55%) followed by T₁C₁ (13.33%) and lowest in T₂C₃ (3.33%) followed by T₁C₀ (4.44%) at the end of storage period. From the treatment mean, it was found that all the treatments were significantly par at (P = 0.05) 5% level of significance except T₀C₂, T₁C₂, T₁C₀, T₂C₂, T₃C₀ and T₃C₁. It was observed that fruits were spoiled rapidly due to the effect of low temperature which cause chilling injury and make unacceptable. At this temperature coating material not with stand and easily peeled out and coating materials doesn’t shows their activity to the expected level. Finally, this results is in agreement with the study of Castro (2006) which signifies that the temperature plays an important role in the spoilage of the fruits.
CONCLUSIONS

It would be concluded from the present study that quality characteristics and shelf life of tomato fruits varies with the treatment to treatments. During storage, control samples showed quick symptoms of chilling injury after three days of storage, while edible coated sample shows little resistance to chilling injury. The activity of edible coating on fruit quality directly depends on storage temperature. At low temperature (7°C), edible coating is easily peeled out because of hygroscopic nature of corn starch; it would lose its film stability and integrity. Chilling injury is very common and this condition is not recommended to store the tomato fruits for a longer period of time.

ACKNOWLEDGEMENTS

Support from College of Food Processing Technology and Bio-Energy, and Department of Agricultural Statistics, B.A. College of Agriculture, Anand Agricultural University, gratefully acknowledged.

REFERENCES


