Impact of Ripening & Storage Conditions on Ripe Tomato Quality

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Factors that influence U.S. Consumers’ Produce Purchases

Table 1. Effect of temperature on ripening rates of conventional tomatoes.

<table>
<thead>
<tr>
<th>Ripeness stage</th>
<th>Days to full red color at indicated temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12.5°C</td>
</tr>
<tr>
<td>Mature-green</td>
<td>18</td>
</tr>
<tr>
<td>Breaker</td>
<td>16</td>
</tr>
<tr>
<td>Turning</td>
<td>13</td>
</tr>
<tr>
<td>Pink</td>
<td>10</td>
</tr>
</tbody>
</table>

Maturity & Ripening Stages

1. **GREEN** The tomato surface is completely green. The shade of green may vary from light to dark.

2. **BREAKERS** There is a definite break of color from green to bruised fruit Tannish-yellow, pink or red or 10% or less of the tomato surface.

3. **TURNING** Tannish-yellow, pink or red color shows on over 10% but not more than 30% of the tomato surface.

4. **PINK** Pink or red color shows on over 30% but not more than 90% of the tomato surface.

5. **LIGHT RED** Pinkish-red or red color shows on over 60% but red color covers not more than 90% of the tomato surface.

6. **RED** Red means that more than 90% of the tomato surface, in aggregate, is red

http://www.tomato.org/
http://www.floridatomatoes.org/

Ethylene Treatment for Ripening MG fruit

- **Ethylene concentration:** 10-100 ppm
- **Temperature:** 15-25°C (60 to 77°F)
- **Relative humidity:** 90-95%
- **Duration:** 24 to 72 hours
- **Air circulation:** sufficient for distribution of ethylene in ripening room
- **Ventilation:** sufficient to prevent accumulation of CO2 which reduces effectiveness of ethylene
Tomato photos: http://www.tomato.org/food/color.html

<table>
<thead>
<tr>
<th>Time</th>
<th>Relative Value</th>
<th>Color rojo</th>
<th>Color amarillo</th>
<th>Aroma</th>
<th>Sabor</th>
<th>Azúcares</th>
<th>Pectinas solubles</th>
<th>Fenoles polimerizados</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Acidez</th>
<th>Almidón</th>
<th>Firmeza</th>
<th>Pectinas insolubles</th>
<th>Fenoles sencillos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verde</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sazón</td>
<td>Quebrante</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cambiante</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosado</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rojo Claro</td>
<td></td>
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</tr>
<tr>
<td>Rojo</td>
<td></td>
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</tbody>
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Effect of temperature on Tomato fruit ripening

Good temperature range: 15-25°C (59-77°F)
Best temperature: 20°C (68°F)

15°C allows ripening to continue but at much slower rate than at 20°C
Similar to ripening bananas and other fruits

Storage of Tomatoes

- 12.5°C (55°F)
- No lower than 10°C (50°F)
- 2-3 weeks
- Controlled atmospheres
  3% O2, <3% CO2
Relative humidity ~85%

http://postharvest.ucdavis.edu/Produce/ProduceFacts/Veg/Tomato.shtml
Avoid chilling temperatures for tomatoes

Too low temperature (<10°C <50°F)
Reduces flavor
Reduces aroma volatiles
Affects ability to ripen
Increases decay

Low temperatures reduce aroma volatiles
z-3 hexanal as example of important volatile

Table-ripe tomatoes stored for 6 days

Storage temperature, ºC
5 10 15 20
z-3 hexanal, ppm

5 10 15 20

Consequences of Storing Tomatoes Below Recommended Temperatures

- Round Tomatoes, cv Bobcat, color stage 2-3
- Stored at 5, 7.5, 10 and 12.5C for up to 3 weeks
- Transferred to 20°C to complete ripening maximum 7 days
- Evaluate
  respiration and ethylene production rates
  weight loss, decay, firmness, color
  composition (%SS, acidity, sugars, lycopene, Vitamin C)
- Several experiments on rounds & grape tomatoes
**Ethylene Production Rates**

During storage and after transfer to 20°C at 7, 14 and 21 days.

- **5°C**
- **7.5°C**
- **10°C**
- **12°C**

**Days**

3 6 9 12 15 18 21 24 27

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**Color Changes**

During storage and after transfer to 20°C at 7, 14 and 21 days.

- **5°C**
- **7.5°C**
- **10°C**
- **12°C**

**Color score**

1 2 3 4 5 6 7 8

**6 = full red**

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**Test#2 (cv Bobcat)**

- **Color stage 2-3**
- **10-30% color**
- **Fruit stored**
- **At 4 temperatures**
- **For up to 3 weeks.**
- **After storage,**
- **Complete ripening**
  - **For 6 days at 20°C.**

**A. Hue (lower, the redder)**

**B. Lycopene**

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**Round Tomato (cv Bobcat) stored 4 weeks + 2 days**

- **10°C (50°F)**
- **7.5°C (45°F)**
- **5°C (41°F)**

**Greenhouse Round LSL Tomato stored at 5 and 10°C**

- **No changes over 2 weeks in 5**
  - soluble solids, sugars, pH or acidity
- **Decrease in firmness but no significant**
  - difference between temperatures
- **Increase in weight loss and different between**
  - temperatures (1.3 and 0.7% after 2 wk at 10 and 5°C)
- **Differences in red color values, lycopene,**
  - Vitamin C contents due to storage temperature
Greenhouse Round LSL Tomato stored at 5 and 10°C

Initial color stage =5

Week storage

Lycopene, mg/kg

5°C (41°F) 10°C (50°F)

LSD.05

Vitamin C

5°C (41°F) 10°C (50°F)

LSD.05

Tomato Type & Composition

<table>
<thead>
<tr>
<th>Tomato Type</th>
<th>% Soluble Solids</th>
<th>% Titratable Acidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grape</td>
<td>7.55</td>
<td>0.62</td>
</tr>
<tr>
<td>Cherry</td>
<td>8.25</td>
<td>0.67</td>
</tr>
<tr>
<td>Orange Cluster</td>
<td>4.70</td>
<td>0.44</td>
</tr>
<tr>
<td>Round</td>
<td>4.65</td>
<td>0.33</td>
</tr>
<tr>
<td>Roma</td>
<td>4.25</td>
<td>0.31</td>
</tr>
<tr>
<td>Round Cluster</td>
<td>4.20</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Data 2006 Test#2

Storage of Grape Tomatoes

- Grape tomatoes respond to storage temperatures as do other tomatoes
- However, new marketing opportunities involve holding grape tomatoes at 5°C for long periods (as component of vegetable trays for example)
- Also grape tomatoes are very susceptible to water loss and symptoms of shrivel
- Therefore, as shown in some of the following data, fruit can be acceptable when stored at 5°C; transfer to a warm temperature after low temperature storage results in the expected chilling injury symptoms and decay

Visual quality of packaged grape tomatoes after 9 days.
Grape tomatoes and consequences of weight loss

1-MCP and Tomatoes
Considerations for effective use
- Tomato type and cultivar
- Stage of maturity/ripeness
- 1-MCP concentration
- Temperature

1-MCP results in increased time to ripen

Concerns
- Increased weight loss
- May decrease firmness
- Fruit less shiny
Tomatoes and 1-MCP (SmartFresh™)

- 300ppb 1-MCP at 20°C ~ 12.5°C Storage
- 1-MCP is a powerful regulator of tomato fruit ripening
- Easy to overdose and have poor final quality
- Important to determine where 1-MCP can add value to the tomato category


IMPORTANT FACTORS FOR Postharvest Quality of Tomatoes

- Variety
- Maturity at harvest
- Minimize physical injury
- Storage: temperature & duration
- Ripening conditions