Postharvest Handling
Melons, Winter Squash

Marita Cantwell, UC Davis
micantwell@ucdavis.edu
http://postharvest.ucdavis.edu

**Ripe Melon Characteristics**

<table>
<thead>
<tr>
<th></th>
<th>HoneyDew</th>
<th>HoneyLoupe</th>
<th>Canary</th>
<th>Casaba</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days from anthesis</td>
<td>55</td>
<td>53</td>
<td>43</td>
<td>60</td>
</tr>
<tr>
<td>Weight, g</td>
<td>2200</td>
<td>1400</td>
<td>2250</td>
<td>3000</td>
</tr>
<tr>
<td>Respiration, µL/g-h</td>
<td>16</td>
<td>23</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Internal Ethylene, ppm</td>
<td>4-15</td>
<td>25-45</td>
<td>&lt;1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Firmness, kg/cm²</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Soluble solids, %</td>
<td>15</td>
<td>14</td>
<td>13</td>
<td>11</td>
</tr>
</tbody>
</table>

Extreme genetic variation among the melons
Melon Quality Attributes

• Flavor
• Color
• Texture

These quality attributes may vary due to: varieties, growing conditions, season, maturity at harvest, number of harvests, harvest & handling, storage conditions and period……..

Focus on maturity/ripeness at harvest since this continues to be problematic

Cantaloupe Maturity/Ripeness

• Fruit begins to separate from stem
  – abscission zone; “slip”
• External color between net
• Net well developed with wax
• Subtending leaf dries up
• Internal color, firmness, soluble solids

½ slip

full slip

The slip is a very useful attribute; applicable to old & new cvs.
Characterization of cantaloupe melons (cv. Laredo) harvested at 2 maturity stages. Data are averages of 12 melons per stage.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>½ slip</th>
<th>Full slip, hard ripe</th>
<th>LSD.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (g)</td>
<td>1367</td>
<td>1398</td>
<td>ns</td>
</tr>
<tr>
<td>External color score(^1)</td>
<td>2.8</td>
<td>3.3</td>
<td>ns</td>
</tr>
<tr>
<td>Internal CO2 (%)</td>
<td>1.02</td>
<td>1.08</td>
<td>ns</td>
</tr>
<tr>
<td>Internal ethylene (ppm)</td>
<td>2.42</td>
<td>4.24</td>
<td>0.7</td>
</tr>
<tr>
<td>Internal color (chroma)</td>
<td>35.2</td>
<td>35.4</td>
<td>ns</td>
</tr>
<tr>
<td>Pulp firmness (N-f, 5mm probe)</td>
<td>12.7</td>
<td>13.1</td>
<td>ns</td>
</tr>
<tr>
<td>Soluble solids (%)</td>
<td>12.5</td>
<td>12.2</td>
<td>ns</td>
</tr>
</tbody>
</table>

\(^1\) external color score 1=green, 2=slight yellow, mostly green, 3=yellow-green, 4=greenish yellow 5=yellow or yellow-orange

Evaluate melon varieties based on minimal changes

MELON FLAVOR

**Sugars** (>50% sucrose, 20% glucose, 26% fructose):
At harvest, % soluble solids correlates well with extracted sugars
For good flavor: Cantaloupe 10% & Honeydew 11-12% S.S.
Sugar content determined at harvest

**Acids** <0.1%, important for good flavor?

**Aroma volatiles** specific compounds for characteristic flavors

Sugar Measurement
- Destructive: % S.S.
- Nondestructive
  - IR analysis

Temperature compensated refractometer
Digital readout eliminates errors

Concentration gradients
Sampling problems
Sugar loss in fresh-cut cantaloupe may be considerable, but soluble solids do not change much; sugar loss typically is not as extreme as in this example.

Typical loss over 10 days at 5°C (41°F):

- S.S. 0-10%
- Sugars 10-20%

(98 yen/dollar; ~$50 U.S.)
Are these melons at optimum maturity/ripeness?

Fresh Plaza
28June2012 Italy

External and internal appearance of Galia melons (cv. Deneb) harvested at 3 stages of maturity (California, 2003).

<table>
<thead>
<tr>
<th>Maturity/Ripeness Stage</th>
<th>% Soluble solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stage 1 = 9.3</td>
</tr>
<tr>
<td></td>
<td>2 = 10.4</td>
</tr>
<tr>
<td></td>
<td>3 = 10.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Aroma score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>2 = 2.8</td>
</tr>
<tr>
<td></td>
<td>2 = 4.2</td>
</tr>
<tr>
<td></td>
<td>3 = 5.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Pulp firmness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>26.9 N</td>
</tr>
<tr>
<td></td>
<td>2 = 27.2</td>
</tr>
<tr>
<td></td>
<td>3 = 10.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Internal Ethylene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>0.2 ppm</td>
</tr>
<tr>
<td></td>
<td>2 = 0.8</td>
</tr>
<tr>
<td></td>
<td>3 = 1.1</td>
</tr>
</tbody>
</table>
Melon Maturity & Quality Factors

- External Color
- Firmness (blossom end)
- Surface hairs, smoothness, wax
- Aroma
- Internal cavity condition
- Pulp color and firmness
- Sugar content (soluble solids)
- Aroma and flavor

Honeydew and Orange Flesh Melons
Maturity and Ripeness Classes

- **Class 0: Immature**
  - Ground color greenish-white; peel fuzzy; no aroma; 10% soluble solids; flesh crisp, melon splits when cut; minimum harvest maturity

- **Class 1: Mature, but Unripe**
  - Ground color white; begins to develop surface wax; pulp crisp, melon splits

- **Class 2: Mature, Ripening**
  - Ground color white; begins to develop surface wax; pulp crisp, melon splits

<table>
<thead>
<tr>
<th>Class</th>
<th>Int. C₂H₄, ppm</th>
<th>Pulp firm., kg-f</th>
<th>Sol. solids, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Immature</td>
<td>&lt;0.2</td>
<td>3.8</td>
<td>&lt;10</td>
</tr>
<tr>
<td>1 = Mature, Unripe</td>
<td>0.8</td>
<td>3.1</td>
<td>10</td>
</tr>
<tr>
<td>2 = Mature, Ripening</td>
<td>5.2</td>
<td>2.1</td>
<td>11-12</td>
</tr>
<tr>
<td>3 = Ripe</td>
<td>27.1</td>
<td>1.5</td>
<td>12-14</td>
</tr>
<tr>
<td>4 = Overripe</td>
<td>29.4</td>
<td>1.1</td>
<td>14-15</td>
</tr>
</tbody>
</table>

firmness: 1.1 cm probe
Development & Ripening of Honeydew Melons Harvested at Different Stages

Honeydew melons: Soluble Solids
Fruits of different ripeness classes
stored 18 days plus 3 days at 20°C (68°F)
Honeydew melons: Pulp Firmness
Fruits of different ripeness classes stored 18 days plus 3 days at 20°C (68°F)

<table>
<thead>
<tr>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>2.5°C 36°F</td>
<td>5°C 41°F</td>
</tr>
</tbody>
</table>

Determination of watermelon maturity is difficult

Internal appearance of **immature** cv. Tri-X 313 Watermelon.

Internal appearance of **mature** cv. Tri-X 313 Watermelon.

Internal appearance of **overmature or ethylene exposed** cv. Tri-X 313 Watermelon.
# Melon Storage Conditions

- **Cantaloupes**
  - 2.5°C (36°F), 90-95% RH
  - 3-5% Oxygen + 10-15% carbon dioxide
  - 2-3 weeks

- **Honeydew, Specialty Melons**
  - 5 to 15°C (41 to 59°F), 80-90% RH
  - optimum temperature depends on ripeness
  - 2-6 weeks

- **Watermelon**
  - 10-20°C (50-68°F)
  - Sensitive to ethylene
  - 1-3 weeks

Galia melons (cv Deneb) stored 4 weeks at 10°C (upper) or 7.5°C (lower) and then after transferred to 20°C for 2 days.
Decay Control: Cantaloupe

- Minimize physical injury
- Storage temperature: 2-3°C (34-36°F)
- Chlorinated water wash (100 ppm)
- Fungicide in wax
- Hot water dip (135°F for 3 min)
- High CO2 concentrations (10-15%)

MA-stored cantaloupe; Bag in Box

Open bag to de-gas
Allow time (2-3 days, ambient) to change color, improve aroma
Conditioning or Ripening Melons
Honeydew Melon Example
Conclusions from a study on cv Emerald

- 12 hours 20-50 ppm ethylene
- Hold 2-3 days at 20°C (68°F)
- Maturity stage 2 (minimum ~11% SS)

- Improve external color
- Improve aroma

**BUT**
- Loss of texture
- No improvement in sugars

Honeydew melon harvest and packing
Field packing cantaloupes

Forced air cooled
4-8 hours required
Gravity flow racking

Field packed melons waiting to be cooled

Night harvest of cantaloupes
1-MCP & Melons

- Western shipping cantaloupes—not much benefit on firmness at storage temperature.
- Eastern shipping cantaloupes—maintain texture loss at warm temperatures.
- Galia; extend shelf-life, reduce firmness loss
- Watermelon—clear benefit; reduce firmness loss

Common Postharvest Defects: Cantaloupes

- Harvested immature
- Overripe
- Sunken areas on surface
  - scuffing, water loss
- Discolored surface areas
  - sunburn, scuffing
- Soft ground spot
- Decay, especially on stem end
- “Shaker” melons
Melon Defects and Internal Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Good Quality</th>
<th>Ground Spot</th>
<th>Sunburn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firmness (N)* (LSD=0.3)</td>
<td>10.7</td>
<td>9.3</td>
<td>6.3</td>
</tr>
<tr>
<td>Soluble Solids (%) (0.6)</td>
<td>11.5</td>
<td>10.5</td>
<td>7.9</td>
</tr>
<tr>
<td>Color (chroma) (0.7)</td>
<td>32.4</td>
<td>32.2</td>
<td>31.7</td>
</tr>
</tbody>
</table>

* 5 mm diameter probe

Melon visual quality after delays to cool at 37°C storage at 10d 5°C + 4d 20°C
Suture Browning associated with increased water loss

<table>
<thead>
<tr>
<th>Time</th>
<th>Total Weight loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 h</td>
<td>2.4%</td>
</tr>
<tr>
<td>8 h</td>
<td>3.2%</td>
</tr>
<tr>
<td>16 h</td>
<td>4.0%</td>
</tr>
<tr>
<td>24 h</td>
<td>4.8%</td>
</tr>
</tbody>
</table>
Internal damage to Honeydew due to drops

“Shaker” cantaloupes due to excessive rolling or dropping

Common Postharvest Defects: Honeydews

- Harvested immature
- Overripe
- Chilling injury
- Brown blotch
- Decay
- Internal breakdown
  - dropping
  - impact injuries
External appearance of stored honeydew melons:

Excellent appearance (A)
Severe surface discoloration (B)
Speckles (C).

Golden Honeydew
 Stored 1 month 10°C

Fusarium sp.

Epicoccum sp

Sclerotinia sp.

Botryodiplodia sp

Penicillium sp
Maturity at harvest is key  
Careful Handling is essential  
Curing important for storage life  
Squash are chilling sensitive
<table>
<thead>
<tr>
<th>Description</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hue</td>
<td>78.03</td>
<td>74.80</td>
<td>68.39</td>
</tr>
<tr>
<td>Dry Weight (%)</td>
<td>11.2</td>
<td>13.9</td>
<td>14.9</td>
</tr>
<tr>
<td>Total Sugar (sucrose)</td>
<td>(mg/g DW)</td>
<td>465.84</td>
<td>565.34</td>
</tr>
<tr>
<td></td>
<td>(mg/g FW)</td>
<td>52.29</td>
<td>77.83</td>
</tr>
</tbody>
</table>

Stem integrity is important to reduce decay.
Respiration rates of Butternut Squash

Changes in physiology precede postharvest decay problems

Cantwell and Zacchari, 2004
Winter Squash and Pumpkin Storage Conditions

• Well cured
• Temperature: 12.5-15°C (55-59°F)
• RH: 50-70% with 60% usually considered optimum
• 2-6 months
• Avoid ethylene
• Modified atmosphere not beneficial