Overview Melon Quality & Postharvest Handling

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MELON COLOR
Color due to pigments
Orange-flesh fruit: carotenoids, especially beta-carotene (85%)
Green-flesh fruit: chlorophyll & low content of carotenoids

Pigment content determined at harvest
Color measurement: extraction of pigments or by color meters

L* = Lightness/darkness
Chroma = intensity, brightness
Hue = true “color”

Example of a reflectance colorimeter
Values define a point in a 3-D color space
Melon Texture

**Force to Rupture**

- **probe shape**
- **probe diameter**

Units of force

- N=Newtons
- 1 N= 9.81 kilogram-force
- 1 N= 4.45 pound-force

- **Rupture force related to whole fruit nondestructive compression firmness**

- **Postharvest/postcutting changes:**
  - inconsistent among melon varieties
  - variable, gradient within a fruit

Sugar Measurement

- **Destructive**
  - % SS
  - Total sugars by colorimetry
  - HPLC for individual sugars

- **Nondestructive**
  - Infrared on-line analysis
**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% SS
  - Sugar content determined at harvest

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

- **Aroma volatiles**
  - Specific compounds for characteristic aromas/flavors

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**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

The “slip” is a very useful attribute & applicable to old & new cantaloupe varieties
Half to 3/4 slip stages of maturity or ripeness produce good eating quality melon; good for fresh-cut product.
### Table 1. Evaluations at harvest of 4 varieties harvested at 2 stages of maturity. Data are averages of 4 fruit per stage. (2003)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Maturity</th>
<th>Weight, g</th>
<th>External Color score</th>
<th>Internal ethylene (ppm)</th>
<th>Texture, N-force, 5mm probe</th>
<th>Soluble Solids, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandstone “Expt.”</td>
<td>½-pull</td>
<td>1810</td>
<td>1</td>
<td>0.97</td>
<td>17.4</td>
<td>7.8</td>
</tr>
<tr>
<td></td>
<td>Full slip, pull</td>
<td>1578</td>
<td>4.2</td>
<td>6.73</td>
<td>11.3</td>
<td>11.6</td>
</tr>
<tr>
<td>Impact</td>
<td>½-pull</td>
<td>1875</td>
<td>1</td>
<td>1.93</td>
<td>9.3</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>Full slip, pull</td>
<td>1728</td>
<td>3.8</td>
<td>20.83</td>
<td>5.2</td>
<td>11.2</td>
</tr>
<tr>
<td>Western Express</td>
<td>½-pull</td>
<td>1915</td>
<td>1</td>
<td>1.45</td>
<td>12.0</td>
<td>9.7</td>
</tr>
<tr>
<td></td>
<td>Full slip, pull</td>
<td>1850</td>
<td>4</td>
<td>17.42</td>
<td>8.0</td>
<td>11.1</td>
</tr>
<tr>
<td>Ocotillo</td>
<td>½-pull</td>
<td>1581</td>
<td>1</td>
<td>1.91</td>
<td>12.5</td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td>Full slip, pull</td>
<td>1674</td>
<td>3.8</td>
<td>11.49</td>
<td>12.0</td>
<td>10.6</td>
</tr>
<tr>
<td>LSD.05</td>
<td>ns</td>
<td>0.7</td>
<td>5.5</td>
<td>2.0</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

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 score¹</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

Cantwell, 2003 MCP#3
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**
- Class 1: **Mature, but Unripe**
  Ground color greenish-white; peel fuzzy; no aroma; 10% soluble solids; flesh crisp, melon splits when cut; minimum commercial harvest maturity
- Class 2: **Mature, Ripening**
  Ground color white; begins to develop surface wax; pulp crisp, melon splits
### Maturity and Ripeness Classes for Honeydew melons

<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*

(average 4 cultivars; Cantwell, unpublished)

### Honeydew Melons

**Fruit Characteristics at 4 Stages of Ripeness**

<table>
<thead>
<tr>
<th>Stage Ripeness</th>
<th>Internal C$_2$H$_4$ ppm</th>
<th>Soluble Solids %</th>
<th>Firmness* Newtons</th>
<th>Firmness* Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.6</td>
<td>9.0</td>
<td>42</td>
<td>9.4</td>
</tr>
<tr>
<td>1</td>
<td>2.4</td>
<td>10.8</td>
<td>38</td>
<td>8.6</td>
</tr>
<tr>
<td>2</td>
<td>4.0</td>
<td>12.4</td>
<td>38</td>
<td>8.5</td>
</tr>
<tr>
<td>3</td>
<td>16.3</td>
<td>12.3</td>
<td>25</td>
<td>5.7</td>
</tr>
</tbody>
</table>

*cv. Morning Ice

▲ = typical commercial maturity

* Maximum rupture force with 8 mm probe

Cantwell & Suslow, UC Davis. 1999
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)

![Pulp Firmness Chart]

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.

![Sugar Loss Charts]

Typical loss over 10 days at 5°C (41°F):
- S.S. 0-10%
- Sugars 10-20%
External and internal appearance of Galia melons (cv. Deneb) harvested at 3 stages of maturity (California, 2003).

% Soluble solids
- Stage 1 = 9.3
- 2 = 10.4
- 3 = 10.2

Aroma score
- Stage 1 = 2.8
- 2 = 4.2
- 3 = 5.0

Pulp firmness
- Stage 1 = 26.9 N
- 2 = 27.2
- 3 = 10.0

Internal Ethylene
- Stage 1 = 0.2 ppm
- 2 = 0.8
- 3 = 1.1

Maturity/Ripeness Stage
1 2 3

Blossom end
A

Semi end
B

Equatorial peel
C

Equatorial slice
D
## Tuscan Style Cantaloupes

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Int $\text{C}_2\text{H}_4$ ppm</th>
<th>Ext Hue</th>
<th>Int Hue</th>
<th>Firmness N-f</th>
<th>Soluble Solids %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10.6</td>
<td>114.0</td>
<td>71.7</td>
<td>25.6</td>
<td>11.8</td>
</tr>
<tr>
<td>B</td>
<td>21.9</td>
<td>111.5</td>
<td>71.5</td>
<td>22.2</td>
<td>12.2</td>
</tr>
<tr>
<td>C</td>
<td>42.8</td>
<td>105.4</td>
<td>72.2</td>
<td>15.6</td>
<td>10.8</td>
</tr>
<tr>
<td>D</td>
<td>49.1</td>
<td>103.9</td>
<td>71.3</td>
<td>12.9</td>
<td>12.9</td>
</tr>
</tbody>
</table>

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
  – 2-4 weeks

• **Honeydew, Specialty Melons**
  – 5 to 15°C (41 to 59°F), 80-90% RH
  – optimum temperature depends on ripeness
  – 2-6 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
Relative Importance of Temperature and Modified Atmospheres for Fresh-cut melon

10 days

7.5°C (45°F)
5°C (41°F)
2.5°C (36°F)

Air 1% O2 Air + 10% CO2 1% O2 + 10% CO2

1-MCP and melons
Efficacy depends on the melon type

(From Tony Beltran/Rodrigo Cifuentes talk at IFPA, April 2004)
Mini watermelons: Example of storage changes in 2 cultivars, 2003.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Treatment</th>
<th>Firmness N force (8mm probe)</th>
<th>Soluble solids, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWT 8149</td>
<td>At harvest</td>
<td>7.9</td>
<td>12.8</td>
</tr>
<tr>
<td></td>
<td>2 weeks 10C air</td>
<td>6.5</td>
<td>11.3</td>
</tr>
<tr>
<td></td>
<td>1-MCP + 2 weeks 10C Air</td>
<td>7.7</td>
<td>11.1</td>
</tr>
<tr>
<td>Extazy</td>
<td>At harvest</td>
<td>16.2</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>2 weeks 10C air</td>
<td>8.9</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td>1-MCP + 2 weeks 10C Air</td>
<td>13.4</td>
<td>10.1</td>
</tr>
<tr>
<td>LSD.05</td>
<td></td>
<td>2.3</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Data are averages of 6 fruit per treatment. 1-MCP application, 12h 500ppb at 10°C. Fruit were not exposed to ethylene during storage.

Ripening Melons

- **Initial Maturity/ripeness**
- **Temperature**
- **Atmosphere**
- **Ethylene**
- **Time**
Ethylene effects on melons

- Improve color
- Improve aroma
- Increase pulp softening
- No effect on sweetness

Honeydew melon harvest and packing
Field packing cantaloupes

Forced air cooling

Hydrocooling
Field packed melons waiting to be cooled

Night harvest of cantaloupes

Forced air cooled
Gravity flow racks
Harvest into field bins

Place on conveyor for sizing by Photoelectric eye

Computer controlled sizer
Hand placed in Single layer cartons or Bins

Fruit stickered

Careful with propane forklifts
Watermelon sensitive to ethylene

Room cooling to about 15°C
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

<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
Internal damage to Honeydew due to drops

“Shaker” cantaloupes due to excessive rolling or dropping

Internal breakdown
Overmature

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) and speckles (C).

Mature or Winter Squash

- Green acorn squash
- Buttercup squash
- Turban squash
- Spaghetti squash
- Chinese winter squash
- Delicata squash
- Kabocha
- Ukrainian Winter squash
- Green Hubbard squash
- Red Kuri squash
- Butternut squash
Maturity at harvest is key
Careful Handling is key
Squash are chilling sensitive

Kabocha squash

Hue 78.03 74.80 68.39
Dry Weight (%) 11.2 13.9 14.9
Total Sugar (sucrose) (mg/g DW) 465.84 565.34 631.47
(mg/g FW) 52.29 77.83 94.82

October 2004
Stored in air
7 months

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Decay Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>10°C (50°F)</td>
<td>88% decay</td>
</tr>
<tr>
<td>12.5°C (55°F)</td>
<td>25% decay</td>
</tr>
<tr>
<td>15°C (59°F)</td>
<td>8% decay</td>
</tr>
<tr>
<td>20°C (68°F)</td>
<td>8% decay</td>
</tr>
</tbody>
</table>