Postharvest Handling of Mango

Assessing Maturity & Eating Quality Potential

- Maturity at harvest determines eating quality potential
- Skin color
  - Dark green to light green in some cultivars
  - Red color is not related to maturity or ripeness
- Fruit shape
  - Fullness of cheeks
  - Shape of shoulders
- Internal flesh color
  - Greenish-white to yellowish-orange

Skin Color

Skin color is not always related to internal color and ripeness!

Ataulfo Color Stages

1 2 3 4 5

Tommy Atkins Color Stages

1 2 3 4 5
Fruit Shape

- Fullness of cheeks
- Elevation of shoulders above the stem attachment

European (OECD) Standards: Mango Maturity

- Not allowed
- Not allowed
- ALLOWED
- Not allowed

Underdeveloped mango
- Not sufficiently mature to continue ripening process
- Mature mango
- Overripe mango

Changes Associated with Mango Ripening

- Skin color changes from green to yellow (in some cultivars)
- Flesh color changes from greenish-yellow to yellow to orange (in all cultivars)
- Decrease in flesh firmness and increased juiciness
- Starch is converted into sugars
- Increase in soluble solids content
- Increase in carotenoids and decrease in chlorophyll content
- Increase in characteristic aroma volatiles

Changes with Ripening

- Changes in total soluble solids content and firmness during ripening of 'Keitt' mangoes

<table>
<thead>
<tr>
<th>Days after harvest at 68°F (20°C)</th>
<th>Total soluble solids (%)</th>
<th>Firmness (lbs-force)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>8</td>
<td>Very Hard (1)</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>Sprung (2)</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>Near Ripe (3)</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>Ripe (4)</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Harvest

- Mangos are harvested when the fruit have reached their full size and have begun to ripen, which starts inside the fruit
- The fruit are carefully detached so that they don’t fall to the ground, and are collected in plastic field crates
Harvest tools that allow retention of stem prevent latex staining. Angle of the hook is important to ensure snapping the fruit with stem.

**Mango Manila Harvest**
**Veracruz, Mexico**
**Marita Cantwell**

**Washing and Pre-sizing**
- First the mangos are washed, then they are pre-sized according to guidelines for quarantine treatment, when required.

**Hot Water Quarantine Treatment**
- Mangos exported to the U.S. must be immersed in 46°C/115°F water for 60 to 110 minutes depending on variety and fruit size in USDA APHIS-certified hot water treatment systems.

**Hydro-cooling & Staging for Packing**
- After their hot bath, the mangos are cooled in water that is no cooler than 21°C/70°F as prescribed by APHIS
  - cool enough to guard against hot water injury
  - not too cool to counteract the hot water treatment’s effectiveness against fruit flies
- Fruit should be packed immediately or placed temporarily in cold room at 12C

**Forced Hot Air Treatment**
Heat fruit to 117F (47C), hold 20-30 min

**Irradiation for Control of Fruit Flies**

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Min. Dose (Gy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oriental fruit fly</td>
<td>Bactrocera dorsalis</td>
<td>250</td>
</tr>
<tr>
<td>Med. fruit fly</td>
<td>Ceratitis capitata</td>
<td>225</td>
</tr>
<tr>
<td>Melon fly</td>
<td>Bactrocera cucurbitae</td>
<td>210</td>
</tr>
<tr>
<td>Caribbean fruit fly</td>
<td>Anastrepha suspensa</td>
<td>150</td>
</tr>
<tr>
<td>Mexican fruit fly</td>
<td>Anastrepha ludens</td>
<td>150</td>
</tr>
<tr>
<td>West Indian fruit fly</td>
<td>Anastrepha oblique</td>
<td>150</td>
</tr>
<tr>
<td>Sapote fruit fly</td>
<td>Anastrepha serpentine</td>
<td>150</td>
</tr>
<tr>
<td>Queensland fruit fly</td>
<td>Bacterocera tryoni</td>
<td>150</td>
</tr>
<tr>
<td>No common name</td>
<td>Bacterocera jarvisi</td>
<td>150</td>
</tr>
</tbody>
</table>
Packing

- The mangos may be coated with carnauba wax for appearance and for protection from water loss
- The mangos are sorted and graded to remove the fruit that are not good enough to satisfy the market
- Most mangos are hand sized as the cartons are filled

Forced-air cooling & Refrigerated Storage

- Mangos are cooled to their optimum storage and transport temperature of 12°C/54°F
- Mangos may be stored at 12°C/54°F, but only long enough to accommodate shipping schedules

Common Defects

- Latex staining (only affects appearance, not eating quality)
- Hot water injury
- Decay
  - Anthracnose
  - Stem-end rot
- Chilling injury

Latex Staining

Hot Water Injury
Anthracnose Decay

Decay Control
- Hot water immersion
  - 50 to 55°C for 1 to 5 minutes
- Fungicides, may be included in hot water
- Bagging before harvest
- Irradiation not very effective at doses allowed

Heat Treatment Reduces Anthracnose Incidence and Severity on Mangoes

Chilling Injury
- Uneven ripening
- Poor color and flavor development
- Surface pitting
- Grayish scald-like skin discoloration
- Flesh browning in severe cases

“Safe” chilling threshold temperatures* for different varieties/maturities of mangos (research is ongoing)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Maturity/Ripeness Stage**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Ataulfo**</td>
<td>&gt;55°F</td>
</tr>
<tr>
<td>Keitt</td>
<td>55°F</td>
</tr>
<tr>
<td>Kent</td>
<td>55°F</td>
</tr>
<tr>
<td>Tommy Atkins</td>
<td>55°F</td>
</tr>
</tbody>
</table>

*Based on continuous exposure for 3 weeks
**Ataulfo fruit developed chilling injury at all temperatures tested; a chilling threshold temperature was not established.

Source: Jeff Brecht, Univ. Florida
Mango Storage Temperatures

- Mature green mangos
  - Store/ship at 55ºF (13ºC)

- Ripe mangos
  - Store/ship at 46ºF (7.8ºC) to 50ºF (10ºC)

Ripening Conditions for Mangoes
Ethylene treatment accelerates ripening

- Fruit temperature: 20 to 22°C (68-72°F)
- Relative humidity: 90-95%
- Ethylene concentration: 100-150ppm
- Duration of exposure to ethylene: 12-48 hours
- Carbon dioxide: <1%

After ethylene treatment for 24 hours, mangos are ripe in 5-9 days at 18-22°C. Once ripe, can be held at 10-13°C for up to 1 week.

Papaya

Carica papaya

Maturity – minimum 11.5% SS = 6% color
Green Islands from Skin Abrasions

Chlorophyll retained
Accelerated water loss

Chilling Injury

- Mature green
  - 10 days at 2°C
  - 20 days at 7.5°C
- ½ yellow
  - 17 days at 2°C
- Preconditioning (partial ripening) reduces chilling sensitivity

Recommended Temperatures

- 13°C for mature green to ¼ yellow
- 10°C for partially ripe (1/4 to ½ yellow)
- 7°C for ripe (> ½ yellow)

Controlled Atmosphere Storage

- Limited research
- Optimum 3 to 5% O₂ + 5 to 8% CO₂
- Postharvest life at 13°C
  - 2 to 4 weeks in air
  - 3 to 5 weeks in CA
- Damaging atmospheres
  - < 2% O₂; > 8% CO₂

Quarantine Treatments

- Forced hot air
  - Multi-staged treatment
  - 48.5°C for 3 hours
- Irradiation
  - Slowed softening
  - Effect depends on fruit stage at treatment
    - MG – no effect on softening
    - 30% color – slower softening after 250 Gy

External Scalding of Papaya after Heat Treatment
Methods to Reduce Heat Sensitivity

- **Continuous**
  - Hold at temperature below 40°C for 2 to 4 hours
- **Heat Pulse**
  - 1 hour at 38°C, wait 3 hours, then treat
  - 30 min at 42°C, cool to 20°C, then treat
Marking largest fruit before hot air treatment

Questions?

UC Davis
Postharvest Technology