Postharvest Handling of Mango

Cultivar Differences

Tommy Atkins Mango  Kent Mango  Keitt Mango

Haden Mango  Ataulfo 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

Tommy Atkins Color Stages
Fruit Shape

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

Immature  Mature

Mango Maturity and Ripening Charts

Kent

Tommy Atkins
Underdeveloped immature
Not sufficiently mature to continue ripening process
Mature Fruit
Overripe Fruit

European (OECD) Standards. Mango Maturity

Allowable 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

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 12°C
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

Stem-End Rot
Chilling Injury

Symptoms on Mangoes

- 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.

Brecht et al. 2013
Mango Storage Temperatures

- Mature green mangos
  - Store/ship at 54°F (12.2°C)

- Ripe mangos
  - Store/ship at 46°F (7.8°C) to 50°F (10°C)

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
Papaya

- **Latex**
  - In every part of plant
  - Contains two proteases
    - Papain and chymopapain
    - Sold as meat tenderizer
- **Tree trained to single trunk**
- **Fruit buds form progressively higher**
  - Oldest fruit is lowest

**Maturity – minimum 11.5% SS = 6% color**
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
- **1/2 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

![Image of papaya with external scalding](image)

![Graph showing relationship between pretreatment temperature and internal abnormalities](graph)
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
Initial washing and sorting by maturity
Hot Water Treatment for Anthracnose Control

Marking largest fruit before hot air treatment
Questions?