Postharvest Handling of Mango

Many slides from Adel Kader and Marita Cantwell, UCD, and Jeff Brecht, UF

There are 100s of Mango Varieties

Assessing Maturity & Eating Quality Potential

- Climacteric Fruit
- 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
- Maturity at harvest determines eating quality potential
  - Consider that advances in skin and flesh color should have occurred during transit
Skin Color

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

Cultivar Differences

Tommy Atkins Mango  Kent Mango  Keitt Mango
Haden Mango  Ataulfo Mango

Fruit Shape

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

Immature  Mature
Flesh Color

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
Eating Quality

• Soluble solids content
  – Indication of sugar content
  – Minimum 7-9% at harvest; 16-20% in ripe fruit
  – Measure with refractometer
  – Increases with ripening from starch conversion
  – Affected by harvest maturity
• Firmness and texture
  – Degree of softening
  – Measured by hand feel or with penetrometer
• Aroma
  – Indication of ripening and eating quality

Changes with Ripening

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

Relationships Among Quality & Maturity Factors

• Upon fruit arrival, check internal color, firmness and soluble solids content
• Internal flesh should be at least yellow in color; better with 75% orangish-yellow color
• Soluble solids content will vary depending on stage of ripeness
  – Remember, soluble solids increases as the fruit soften
  – Very firm mangos should have minimum 7 to 9% SSC
  – Fully ripe mangos should have 16 to 20% SSC
• Check for defects
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

Transport to Packinghouse

- The mangoes are transported from the farm to the packinghouse by truck
- The fruit may need to be covered to protect them from the sun
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>Bactrocera tryoni</td>
<td>150</td>
</tr>
<tr>
<td>No common name</td>
<td>Bactrocera jarvisi</td>
<td>150</td>
</tr>
</tbody>
</table>

Indian Mangoes Exported to US since May 2007

Shashi Tharoor, whose "The Great Indian Novel" features one of the best descriptions of India's love affair with the mango: "After years of penury, where what passed for mangoes in American supermarkets was a travesty of the term, we at last have the real thing! I used to believe that true mango lovers could sue American groceries for false advertising – the tasteless, fibrous, tart and flavor-challenged fruit they sold did not deserve the name of mango. Now we should urge every American we know to try a real Indian mango. They'll never think of mangoes the same way again."

http://www.sajaforum.org/2007/05/usindia_affairs.html

Mango handling at wholesale market, Bangalore India, 2007
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
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

CONTROL KEITT MANGOES 1990 HEATED

STEM-END ROT

L. Transitioneae
**Chilling Injury**

Symptoms on Mangoes

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

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**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)

Class 1 Fruit

Class 1 fruit must be of good quality and well presented. Although the Class 1 requirements are less strict than Extra Class, Class 1 fruit must be carefully selected and presented.
Class 2 Fruit must be of marketable quality and suitably presented. Fruit must be ripe but not over-ripe so as to have off-flavors or insufficient shelf-life to satisfy market requirements. The fruit may have moderate defects.

Ripening Temperatures

- Ripening at 16-18°C (60-65°F) results in attractive skin color but flavor is tart; these fruit require an additional 2-3 days at 20-24°C (68-75°F) to attain sweet flavor.
- Ripening at 27-30°C (80-86°F) may result in mottled skin color and strong flavor; above 30°C (86°F) ripening is retarded.
- Best ripening temperature is 20-22°C (68-70°F)

Ripening Conditions for Mangoes

Ethylene treatment accelerates ripening

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
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<tbody>
<tr>
<td>Fruit temperature</td>
<td>20 to 22°C (68-72°F)</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>90-95%</td>
</tr>
<tr>
<td>Ethylene concentration</td>
<td>100-150ppm</td>
</tr>
<tr>
<td>Duration of exposure to ethylene</td>
<td>12-48 hours</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

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.
# Flesh Firmness vs. Ripeness Stage of Mangos

<table>
<thead>
<tr>
<th>Ripeness stage</th>
<th>Flesh firmness (lb-force with 5/16 inch tip penetrometer)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature-green</td>
<td>&gt;14</td>
<td>Treat with ethylene for 48 hours</td>
</tr>
<tr>
<td>Partially-ripe</td>
<td>10-14</td>
<td>Treat with ethylene for 24 hours</td>
</tr>
<tr>
<td>Firm-ripe</td>
<td>6-10</td>
<td>Best stage to send to retail stores</td>
</tr>
<tr>
<td>Soft-ripe</td>
<td>2-6</td>
<td>Best stage for eating</td>
</tr>
<tr>
<td>Over-ripe</td>
<td>&lt;2</td>
<td>Good for juice</td>
</tr>
</tbody>
</table>

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_Green mango, Philippines_  

_Ripe mango, Philippines_  

_National Mango Board_  
_Orlando, FL USA_