Maintaining Quality & Marketability of Fresh Mangoes

Date: Tuesday March 17, 2009
Time: 10am PT / 1pm ET

Mango Resources For You
Wendy McManus, National Mango Board

Mango Handling ABC's
Jeff Brecht, University of Florida

Assessment of Mango Quality
Beth Mitcham, UC Davis

Distribution Center and Retail Best Handling Practices
Steve Sargent, UF & Adel Kader, UC Davis

General Q&A

Webinar Agenda

Webinar Overview

Education is a first step to improving quality
- Awareness and knowledge
- Better handling practices
- Improved quality delivered to consumers
- Better mango eating experience
- Happier customers
- Repeat mango purchases
- Increased mango movement

Topics we will cover today include
- Mango Handling ABC's: the mango’s journey from the field to the consumer
- Assessment of Mango Quality: how quality, maturity and ripeness fit together; cultivar differences; and tools for assessing mangos
- Warehouse/Distribution Center and Retail Best Handling Practices: specific recommendations to improve quality through better handling

Tools You Can Use

The National Mango Board has many resources for you
- Mango Marketing Toolkit
- POS materials
- Crop forecast
- Category development
- Mango handling best practices
- Searchable mango supplier database
- Variety and availability information
- Mango.org web site is your portal for all of these resources

Mango Resources For You
Wendy McManus
Director of Marketing
National Mango Board

Webinar Overview

Tools You Can Use
Mango Marketing Toolkit
Available online at www.mango.org/graphics
- Mango beauty and variety shots
- Recipes with professional photographs
- Images of people with mangos
- Mango selection images and instructions
- How-to-cut images and instructions
- Nutrition facts panel and USDA approved nutrition messages
- Other key marketing messages

Point-of-Sale Materials
Order form available at www.mango.org/graphics
- Recipes with tear pads
- Mango selection and ripening
- Mango cutting

Category Development
In development, and available soon in the RETAILERS section of www.mango.org
- Merchandising best practices
- Scan data, regional trends and performance benchmarks
- Consumer insights

Questions?

“Monitoring & Evaluation of the Mango Supply Chain to Improve Mango Quality”
AKA – “The Mango Quality Project”
- A team led by the University of Florida, including colleagues from the University of California Davis, UC Riverside, Univ. Queretaro (Mexico), Univ. Del Valle (Guatemala), EMBRAPA (Brazil), and PEB Commodities (perishables transportation consulting)
- Monitored mango export harvest & handling – from the main production regions in Ecuador, Peru, Mexico, Central America, and Brazil to the supermarket - to find ways to improve mango quality
- Evaluated mango export handling operations
- Conducted mango shipping trials from each country to importers and retailers in the U.S.
- Monitored retail mango displays and evaluated hundreds of mango quality samples taken at the supermarket (consumer) level

MANGO HANDLING ABCs
Dr. Jeff Brecht
University of Florida

AKA – “The Mango Quality Project”
How Does a Mango Get From the Tree to the Supermarket?

Let’s go through the steps that it takes to get a great tasting mango from its country of origin to a retail store in the U.S.

- There are variations from country-to-country, and among companies, but mangos go through a number of common steps.
- I will emphasize the practices that members of the mango industry commonly follow to ensure that the best quality mangos possible are provided to their customers.

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 mangos are transported from the farm to the packinghouse by truck.
- The fruit may need to be covered to protect them from the sun.

Reception at the Packinghouse

- Upon arrival at the packinghouse, the mangos are unloaded to a shaded area and handled in turn.
- The mangos are inspected by USDA APHIS phytosanitary inspectors and by packinghouse quality control personnel and must pass both inspections before they can proceed.

Washing and Pre-sizing

- First the mangos are washed, then they are pre-sized according to USDA APHIS guidelines for quarantine treatment.
### Hot Water Quarantine Treatment
- Mangos exported to the U.S. must be immersed in 115°F (46°C) 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 70°F (21°C) 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.
- Now the mangos are ready to be packed!

### Packing
- The mangos are 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 U.S. market.
- Most mangos are hand sized as the cartons are filled.

### Palletization
- Mangos are unitized onto pallets for subsequent handling for:
  - Increased efficiency
  - To reduce unnecessary handling that increases injuries.

### Forced-Air Cooling & Refrigerated Storage
- Mangos are cooled to their optimum storage and transport temperature of 54°F (12°C).
- Mangos may be stored at 54°F (12°C), but only long enough to accommodate shipping schedules.

### Loading onto Transport Vehicles
- Mangos from South and Central America are transported in marine containers by boat to the U.S.
- Mangos from Mexico are transported to the U.S. by truck.
Transport to the U.S.

- Marine containers are accumulated at a port container facility
- The transit time to reach the U.S. varies from 2 days for northern Mexico to as long as 3 weeks for Brazil

Handling at U.S. Border/Port Facility

- Upon reaching the U.S., the mangos must pass through customs and may be inspected
- APHIS inspectors look for any evidence of pests like fruit flies

Importer

- Now the mangos go to the importer’s warehouse
- Before the pallets are racked, a QC inspection is performed
- The mangos may be re-worked to meet buyer specifications

Fresh-cut Processing

- Fresh-cut processing of mangos
  - Specialized companies may process mangos into fresh-cut products for sale to retailers and food service companies
  - In contrast to whole mango fruit that are best held at 54°F (12°C), fresh-cut mangos are best held at 41°F (5°C)

Retailer Distribution Center

- Finally, the mangos reach the retailer’s distribution center, where they are unloaded and another QC inspection is conducted before the mangos are accepted

Delivery to Retail Store

- Mangos are delivered to the retail stores as part of the stores’ daily orders
- Mangos should still be held at 54°F (12°C) or warmer, even at the store
Retail Display

- Mangos are usually displayed on free-standing displays that allow the fruit to continue ripening and develop great aroma!
- Attention to rotating the display keeps the most desirable mangos available for customers

Questions?

Assessment of Mango Quality

Beth Mitcham
UC Davis

Mango Maturity, Ripeness & Quality

- Maturity
  - The stage of development after which harvested fruit can continue to ripen normally and attain good eating quality
  - Best determined by internal color
- Ripeness
  - Degree of fruit softness is best indicator of progress to fully ripe stage
- Quality
  - The degree of excellence or superiority
  - The characteristics that make a mango a mango
  - Sugars, acids and aroma content, texture

Assessing Maturity & 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
- 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

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

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 conversion 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
  - Approximately 7-9% at harvest; 13-20% in ripe fruit
  - Depending on growing conditions
  - 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

Tools to Assess Quality

1. Refractometer – estimate of sugar content
2. Penetrometer – fruit firmness, degree of ripeness
3. Visual color – for skin and flesh color
**Soluble Solids Content**

- Collect flesh tissue
  - Entire half of fruit
  - Plug taken down to seed
- Juice pieces of flesh, place drop into refractometer
- Will continue to increase in fruit not yet ripe

**Hand Firmness**

1 = Very hard. No “give” in the fruit
2 = Sprung. can feel the flesh deform 2 – 3 mm (break) under extreme finger force, very rubbery
3 = Near Ripe. 2 – 3 mm deformation achieved with slight finger pressure, fruit deforms with extreme hand pressure
4 = Ripe or eating soft. whole fruit deforms with moderate hand pressure
5 = Over-ripe. whole fruit deforms with slight hand pressure

**Relationships Among Quality & Maturity Factors**

- Upon fruit arrival, check internal color, firmness and soluble solids content
  - Penetrometer will be much more accurate than hand feel
  - Internal flesh should be at least yellow in color; better with 50% orangish-yellow color
  - Soluble solids content will vary depending on stage of ripeness
    - Remember, soluble solids increase as the fruit soften further
    - Very firm mangos should have approximately 7 to 9% SSC
    - Fully ripe mangos generally have as much as 13 to 20% SSC
- Check for defects

**Firmness**

- Penetration Force
- Use 5/16-inch (8-mm) tip
- Fruit Texture Analyzer (FTA) Güss Manufacturing

**Changes with Ripening**

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

**Common Defects**

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

Symptoms on Mangos
- Uneven ripening
- Poor color and flavor development
- Surface pitting and lenticel spotting
- Grayish scalid-like skin discoloration
- Flesh browning in severe cases

Mango Storage Temperatures
- Mature green mangos
  - Store/ship at 54°F (12°C)
- Ripe mangos
  - Store/ship at 46°F (8°C) to 50°F (10°C)
Distribution Center and Retail Best Handling Practices

Steven A. Sargent and Adel A. Kader
University of Florida and UC Davis

Importer/Distribution Center

Unloading
- Leave trailer refrigeration running when dock is at or below 54°F (12°C)
- Turn off refrigeration when dock is warmer than 54°F (12°C)
- Move pallets directly to the cold
- Inspect fruit inside the cold storage area prior to placing the pallets on racks

Importer/Distribution Center

Initial Inspection
- Only 1 or 2 QC inspectors for uniform results
- Sample procedure
  - By lot: variety, grade
  - By location: front, middle, rear, top, center, bottom on both sides
- Immediately measure pulp temperature
- Photograph fruit, cartons and pallets

Importer/Distribution Center

Initial Inspection – evaluating the fruit
- Overall condition and ripeness
- Flesh color, firmness and °Brix
- Incidence and severity of defects, damage, disorders and decay, external and internal

Importer/Distribution Center

Reworking
- Wash hands anytime fruit is handled; gloves optional
- Set tables at a comfortable height; adequate lighting
- Rotate the fruit for increased speed and accuracy
- Handle the fruit gently to prevent impact injuries
- Return the fruit to same boxes to maintain trace-back
Importer/Distribution Center

Storage
• Store pallets on racks at 54°F (12°C) to 60°F (15°C)
• Maintain relative humidity at 90 to 95%
• Scrub ethylene gas from cold room or one fresh air exchange each day
• FIFO (First in, first out)

Importer/Distribution Center

Staging for Loading
• Refrigerate staging area at 54°F (12°C) to 60°F (15°C)
• If the dock cannot be properly refrigerated, stage loads in cold storage area; protect dock staging area from the sun
• Load pallets directly from the cold room into the trailer to avoid warming

Importer/Distribution Center

Reworking Prior to Transport to Retail Stores
Workers must be thoroughly trained in mango handling practices and fruit clarification, especially for sorting
• Recognize important external defects
• Able to pack by fruit size and position in carton
• Able to stack and secure pallets properly
• Refrigerate staging area at 54°F (12°C) to 60°F (15°C)
• If the dock cannot be properly refrigerated, stage loads in cold storage area; protect dock staging area from the sun
• Load pallets directly from the cold room into the trailer to avoid warming

Importer/Distribution Center

Loading - 1
• Inspect each trailer for cleanliness; clean, sanitize if necessary
• Schedule routine trailer inspection for damage, water leaks, reefer unit operation
• Develop a loading plan to ensure best location for mixed loads

DC Ripening Rooms Can Be Used for Mangos
Most distribution centers have special rooms for fruit ripening that are used extensively for bananas and may also be used for avocados, kiwifruit, tomatoes, stone fruit and European pears. Pressurized or forced-air ripening rooms maintain fairly uniform product temperatures. These rooms can be used to ripen mature-green mangos
Fruit temperature is the most important factor in ripening mature mangos. The best temperature range for ripening mangos is 68°F (20°C) to 72°F (22°C). Ripening at 60°F (15.5°C) to 65°F (18°C) may result in the most attractive skin color, but flavor remains tart; these mangoes require an additional 2-3 days at 70°F (21°C) to 75°F (24°C) to attain sweet flavor. Ripening at 80°F (27°C) to 86°F (30°C) may result in mottled skin and strong, undesirable flavor and ripening is retarded above 86°F (30°C).

Optimal Conditions for Mango Ripening-1

The optimal relative humidity range is 90 to 95% to prevent excessive water loss and shrivel. Ethylene (100 ppm) treatment for 24 to 48 hours (depending on maturity since less mature mangos require longer duration) induces faster and more uniform ripening, provided that carbon dioxide concentration is kept below 1% by ventilating the rooms with outside air once per day. After triggering ripening with ethylene for 24 hours, mangos kept at 65°F (18°C) to 72°F (22°C) will ripen in 5-9 days. Once ripened, mangos can be kept at 50°F (10°C) to 55°F (13°C) and 90-95% relative humidity for up to one week.

Optimal Conditions for Mango Ripening-2

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Exposure time (hours)1 To 100ppm ethylene</th>
<th>Range of ripening temperatures2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avocado</td>
<td>8-48</td>
<td>59-68°F/15-20°C</td>
</tr>
<tr>
<td>Banana</td>
<td>24-48</td>
<td>58-65°F/14-18°C</td>
</tr>
<tr>
<td>Kiwifruit</td>
<td>12-24</td>
<td>54-72°F/12-22°C</td>
</tr>
<tr>
<td>Mango</td>
<td>24-48</td>
<td>68-72°F/20-22°C</td>
</tr>
<tr>
<td>Pear</td>
<td>24-48</td>
<td>68-72°F/20-22°C</td>
</tr>
<tr>
<td>Tomato</td>
<td>24-72</td>
<td>65-68°F/18-20°C</td>
</tr>
</tbody>
</table>

1 Shorter duration for more mature fruit
2 Faster ripening rate at higher temperatures

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>

Retail Store

Unloading/Holding on Docks
- Minimize the time when trailer doors open at the store
- Train retail store personnel proper temperature management
- Designate retail store personnel to help in product
- Perform QC inspection at the retail store upon delivery
- Provide prompt feedback to inspection results to the DC

Fresh-cut Mangos
- Growing market for fresh-cut mangos
- Fruit are handled at lower temperatures, 41°F (5°C), and have different BMP’s than those for whole fruit markets
Retail Store

Storage in Walk-In Coolers

Produce Managers should regularly inspect back room and cooler area
- Minimize time that walk-in cooler doors are open
- Use strip curtains on walk-in cooler doors
- Properly place calibrated thermometers in back room and cooler
- Store all product at proper temperature; mangos not below 10°C
- If no cooler space, store in back room; order mangos more frequently

Retail Store

Stocking and Display Preparation/Rotation
- Avoid storing mangos at the store; display upon delivery
- Display at ambient temperature, by size, ripeness stage and variety
- Inspect display several times a day; remove out-of-grade fruit

Retail Store

A Note on Recordkeeping

Keeping records is an important part of a quality assurance program to show inspectors.
- Assign an employee for the quality control (QC) program
- Prepare a list of all operations and procedures (such as those described in the Mango Best Handling Practices document)
- Develop a form to record all operations and procedures and when performed

Questions?

Maintaining Quality & Marketability of Fresh Mangos

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