Ripening Temperature Management

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Why Ripen?

Ripening Effect on Consumer Acceptance of Fresh Fruit Crops

Why Temperature Management is Important for Fruits

#1 is to prolong Shelf Life (= maintain initial quality)
- The rate of biochemical reactions varies with temperature
- Fast and efficient cooling after harvest is required to reach the optimum temperatures for maintaining quality
- Maintain the cold chain (avoid re-warming)

Passive Pallet Warming/Cooling

FAST COOLING
(within 6-8 Hours)
Banana Pressure

Ripening

Why Temperature Management is Important for Fruits

#2 is to avoid Chilling Injury

- Fruits of subtropical/tropical origin (e.g., avocado, banana, mango, etc.)
- Time-temperature relationship
- Maturity and variety influence chilling injury susceptibility and symptoms

Chilling Injury

Fruits & vegetables of subtropical or tropical origin are sensitive to low temperatures

- The temperatures that cause chilling injury fall below 45 to 59°F (7.2 to 15°C), depending on the species and variety
- 45 to 59°F are the “threshold” temperatures, at or above which no chilling injury will occur

Less mature fruit are more susceptible to chilling injury

Mango Chilling Injury Symptoms

- Loss of aroma develops first and may never be recovered
- Lenticel discoloration is the earliest visual symptom
- Skin discoloration (gray or brown appearance) and vascular (internal) browning are the next symptoms
- Scald-like skin collapse and pitting appear last

Why Temperature Management is Important for Fruits

#3 is to manage Ripening

- Temperature influences ripening changes
  - Color (which pigments are favored)
  - Texture (enzymatic cell wall changes)
  - Flavor (taste and aroma compounds biosynthesis)
- There are different optimum ripening temperatures for different fruits to achieve optimum quality
- Higher temperatures can inhibit ripening or cause heat injury

C. Crisosto
When Is Temperature Management Important with Regard to a Ripening Program?

1. Before ripening
   - Avoid chilling; precondition fruit
2. During ripening
   - Achieve the best combination of quality attributes
3. After ripening
   - Avoid overripening

Pre-Ripening Temperature Effect on Ripening

- Short cold storage can overcome ethylene needs (e.g., Kiwifruit and European pears).
- Practical implications of low or high pre-ripening temperatures.

Post-Ripening Temperature Management

Unless you want the fruit to continue ripening, store them at their **lowest safe temperature** until ready for retail display:

- 32°F (0°C) for non-chilling sensitive fruits
- 36 to 58°F (2.2 to 14.4°C) for chilling sensitive fruits (the specific temperature depends on the type of fruit)
- These are lower temperatures than for the unripe fruit!
Temperature-related Best Handling Practices (BHPs) for Mangos

- Harvesting and Packinghouse
- Transport
- Importers & DCs
- Retail Stores

Harvest
- Harvest during the cooler parts of the day
- Keep harvested mangos shaded

Transport to the Packinghouse
- Cover the fruit to protect them from the sun
- Minimize delays after harvest

Reception at the Packinghouse
- Minimize delays before unloading
- Unload the fruit to a shaded area and handle them in the order they are received

Hot Water Quarantine Treatment
- Mangos exported to the U.S. must be immersed in 115°F (46.1°C) water for 65 to 110 minutes depending on variety and fruit size in USDA APHIS-certified hot water treatment systems

Hydrocooling & Staging for Packing
- After heat treatment, the mangos can (and should) be cooled in water that is no cooler than 70°F (21.1°C) as prescribed by APHIS
- Stage the mangos in a shaded area
Sorting & Packing
- The most important temperature management practice during this step is to minimize the time for sorting & packing

Forced-air Cooling & Refrigerated Storage
- Quickly cool mangos to their optimum storage and transport temperature of 55°F (12.8°C)
- Mangos should be held only long enough to accommodate shipping schedules

Staging and Loading for Transport
- Cool mangos to the shipper-specified carrying temperature before loading refrigerated containers and trailers
- Pre-cool container, then turn off reefer unit
- Load mangos to facilitate airflow
- Install temperature recorders (front, middle, rear)

Transport to the U.S.
- Marine containers are accumulated and held at port container facilities until loaded onto a vessel
- The transit time to reach the U.S. varies from 2 days over land from northern Mexico to 3 weeks by ocean from Brazil

Shipment from Sinaloa, Mexico to Texas (2 days); setpoint 50°F (10°C)
- Fruit pulp temperatures ranged from 7°C to 29°C when loaded into the trailer

Shipment from Brazil to New Jersey (20 days); setpoint 50°F (10°C)
- Fruit pulp temperatures ranged from 9°C to 11°C when loaded into the container
Importer/Distribution Center

Unloading on Arrival
- Refrigerated dock
  - Leave trailer refrigeration running when the dock is at or below 55°F (12.8°C)
  - Turn off refrigeration when the dock is warmer than 55°F (12.8°C)
- Move pallets directly from the dock to the cold storage area
- Inspect fruit in the cold storage area prior to placing the pallets on racks

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Importer/Distribution Center

Initial Inspection
- Immediately measure pulp temperature
- 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
- Photograph fruit, cartons, pallets

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Importer/Distribution Center

Re-working fruit
- Do this in a refrigerated area
- Follow BHPs for food safety (hygiene)
- Handle the fruit gently
- Return the fruit to the same boxes to maintain trace-back

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Importer/Distribution Center

Storage
- Store pallets on racks at 55 to 59°F (12.8 to 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) or FEFO (First expired, first out)

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Ripening Rooms
- Ripening rooms for bananas, avocados, kiwifruit, tomatoes, stone fruits and European pears can be used to ripen mature (but not already ripening initiated) fruits
- Ethylene gas applied to initiate ripening
- Pressurized or forced-air ripening rooms quickly reach and then maintain uniform fruit temperatures

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Best Conditions for Ripening Different Fruits

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

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

A. A. Kader
Importer/Distribution Center

Re-working Prior to Delivery Shipments
- Do this in the cold storage area, just as for inspections and re-working upon arrival.

Staging for Delivery Shipments
- Use a refrigerated staging area – 55 to 59°F (12.8 to 15°C)
- If the dock area cannot be properly refrigerated, stage loads in the cold storage area
- Protect the dock/staging area from the sun
- Load pallets/staging area from the sun

Loading Trailers
- Inspect each trailer for cleanliness; clean and sanitize if necessary
- Schedule routine trailer inspections for damage, water leaks, reefer unit operation
- Develop a loading plan to ensure best location for mixed loads with regard to temperature requirements

Retail Store

Unloading/Holding on Docks
- Educate personnel about produce temperature requirements and proper temperature management
- Minimize the time when trailer doors are open during unloading
- Designate someone to be responsible for product placement (back room or cooler?)
- Perform QC inspection upon delivery (provide prompt feedback of inspection results to the DC)

Storage in Walk-In Coolers?
- Store all produce at proper temperatures; don't hold mangos below 50°F (10°C)
- If no cooler space at 50°F or above, store mangos in the back room
Retail Store

Walk-In Coolers
- Produce manager 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

Stocking, Display Preparation, Rotation
- Avoid “storing” mangos at the store
  - Display mangos upon delivery
  - Order mangos more frequently
- Display at ambient temp.
  (by size, ripeness stage, and variety)
- Inspect display several times a day; remove out-of-grade fruit

A Note on Recordkeeping
Keeping records is an important part of a quality assurance program
- Assign an employee for the quality control (QC) program
- Prepare a list of all operations and procedures (refer to “Mango Best Handling Practices”)
- Develop a form to record all operations and procedures and when performed
- Include temperature records!

Conclusions
- Choose appropriate temperatures:
  - 55°F (12.8°C) to slow ripening and avoid chilling (55°F is always safe)
  - 68 to 72°F (20 to 22.2°C) to promote ripening (produces the best color and flavor)
- Maintain the cold chain — when mangos are allowed to warm, shelf life suffers and re-cooling can be slow or even impossible
- Finally, display mangos at room temperature in stores to allow their aroma to develop

Thanks for your attention!

Questions?

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UF Faulty
Florida Agriculture and Consumer Services