

MANGO HANDLING AND RIPENING PROTOCOL

*Presented by the
National Mango Board*



Mango Handling and Ripening Protocol

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Mango Handling and Ripening Protocol

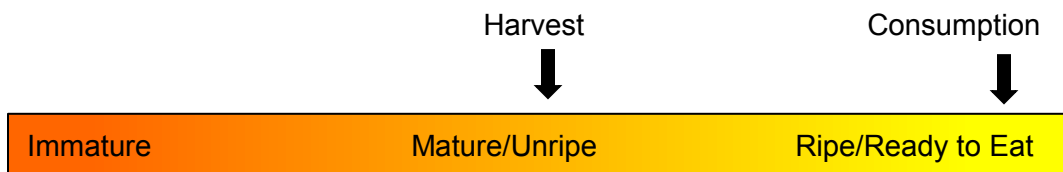
Objective and Overview

The Mango Handling and Ripening Protocol is designed to help improve mango handling practices in the United States, leading to better quality mangos, greater consumer acceptance and higher mango sales. This document provides best practices for the latter stages of the mango supply chain, and is meant for retailers, wholesalers, importers and anyone who handles mangos in the United States.

If you need information about the earlier stages of the supply chain, including postharvest practices at the farm and packing shed, please refer to the Mango Postharvest Best Management Practices Manual, which is available for download in both the industry and retailer sections of www.mango.org.

Understanding Mango Maturity and Ripeness

Mango maturity and ripeness levels exist along a spectrum. The fruit develops on the tree starting at the immature stage, and progressing to mature/unripe. This stage is often referred to as mature green. This can be confusing, as “green” in this instance refers to the ripeness stage, and has little to do with skin color. Mature/Unripe is the typical harvest point for mangos imported into the United States. During importation, transportation, distribution, and finally in the kitchen, mangos will continue along the spectrum to a ripe/ready to eat stage for the consumer.



Maturity at harvest is a critical factor for mango flavor at consumption. A mango harvested immature will not ripen normally to satisfy consumers. An immature mango will eventually become softer, but its flavor will not improve and neither will consumer acceptance. Thus, an immature mango is destined to disappoint the consumer, as there is no postharvest treatment that can salvage an immature mango and turn it into a flavorful piece of fruit.

Mangos produce ethylene, a naturally occurring ripening hormone. A mature piece of fruit will respond to the ethylene, and will ripen normally on its own. A ripening program, as discussed later in this document, may be used to move the mangos toward the ripe/ready to eat stage prior to store-level distribution.

At the mature/unripe stage at harvest, mangos are high in starches and acids, and low in soluble sugars and soluble solids. During ripening, mango firmness decreases, acidity and starch concentrations decrease, while fruit sugars increase. Internal flesh color will develop from pale yellow to deep golden yellow. External skin color changes will take place in some varieties. For example, the skin of the Ataulfo variety will progress from green to a deep, golden yellow at the ready to eat stage. Not all varieties show skin color changes during ripening.

Mango Receiving and Quality Assessment (QA)

The primary goal for a QA team receiving mangos should be to ensure that the fruit was harvested at the correct maturity and will ripen to a ready to eat state that will satisfy consumers. Beyond this, each receiving company may have their own specifications that further serve the needs of the company and their customers.



The Mango Maturity and Ripeness Guide (MMRG—see appendix) defines five maturity stages for the six most common commercial mango varieties sold in the United States. The MMRG includes internal flesh photos and color swatches, along with typical corresponding ranges for Soluble Solids Content (SSC) and Firmness.

The MMRG is available free of charge from the NMB. ***While it is included in the appendix of this document, it is strongly recommended that you order physical copies of the MMRG for your QA team.*** The colors shown in the internal flesh photos and color swatches will look quite different depending on the monitor or printer used to output the charts, so it's best to get the professionally printed and laminated version from the NMB.

The mango quality research team at the University of Florida and the University of California-Davis developed the MMRG. In it, they recommend that at least 90% of the mangos tested in a shipment should fall in stage 2 or higher in order to be accepted.

Mango Expectations at Receiving

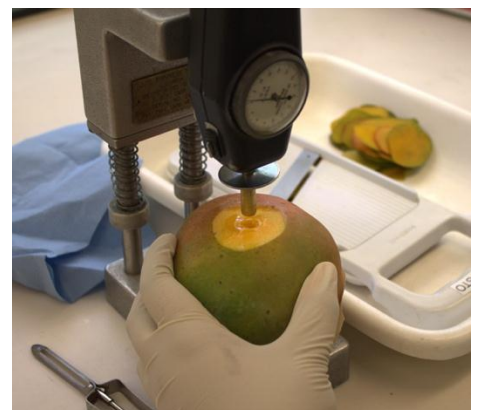
- Mangos are harvested when mature (firm), but not ripe or ready to eat (soft)
- A mature mango will ripen normally with increasing percentage of soluble solids concentration (SSC) and decreasing starch and firmness (pounds force) to become flavorful and ready to eat
- At receiving, you can expect the mangos to be mature, but not necessarily ripe
- Maturity at harvest can be judged by a combination of factors, including flesh color, firmness, SSC, dry matter and fruit shoulder shape

Maturity/Ripeness Indicators and Measurement

Fruit Firmness decreases as the fruit matures on the tree and continues to decrease during post-harvest ripening. Firmness should not be used as the only measure of maturity, but it can be a useful supplement to other indicators. See the MMRG for typical firmness ranges for each variety at each maturity stage.

To measure mango firmness:

- Remove a thin patch of skin along the cheek side of the mango
- Be consistent in the amount of skin removed for each tested sample
- Place the mango on a firm surface for testing pressure
- Using a penetrometer with an 8 mm (5/16") tip, measure the fruit firmness
- Repeat the process on the other cheek and record the average
- Avoid hitting the seed during the test
- A drill-press style penetrometer is more accurate and consistent than a hand-held version



Soluble Solids Content (SSC) increases as the fruit matures on the tree and continues to increase during post-harvest ripening. SSC (sometimes referred to as %Brix) should not be used as the only measure of maturity, but it can be a useful supplement to other indicators. See the MMRG for typical SSC ranges for each variety at each maturity stage.



To measure mango SSC:

- Collect two to three plugs of mango flesh, from just below the skin to the seed (a potato peeler works well for this task)
- Juice the plugs into a single sample (a lemon squeezer or garlic press is useful here)
- Ensure that the refractometer is clean and has been re-set
- Apply a drop of the mango juice to the prism of the refractometer and take a reading

Internal Flesh Color is one of the most reliable indicators of maturity/ripeness. Immature (stage 1 or below) mangos will have white or very pale yellow flesh. With increased maturity, the yellow flesh color begins to develop from the seed outward. After harvest, as the mango ripens, the depth of color increases, and covers more of the mango interior. The color range varies by cultivar.

To measure internal flesh color:

- Slice off both cheeks of the mango near the seed, but not exposing the seed
- Open the MMRG to the mango variety being received and find the closest match for the internal flesh color closest to the mango seed

KEITT		AVERAGE COLOR				
INTERNAL FLESH SAMPLES	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	
	16-19	12-15	7-8	2-4	1-2	
	8-10	9-10	10-10	12-14	14-17	
KENT		AVERAGE COLOR				
INTERNAL FLESH SAMPLES	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	
	19-22	14-18	11-12	5-8	2-4	
	6-10	9-11	12-13	12-14	14-16	
TOMMY ATKINS		AVERAGE COLOR				
INTERNAL FLESH SAMPLES	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	
	18-20	16-17	10-11	5-8	3-4	
	7-8	8-11	8-11	10-11	10-12	

External Skin Color is generally NOT a reliable indicator of maturity, quality or ripeness. Cultivars such as Keitt remain green on the outside, even when fully ripe. It is a common misperception amongst consumers and sometimes retailers, that red skin is an indicator of mango quality. In fact, the red color is a varietal trait that can be impacted by the position of the fruit on the tree. It is not related to eating quality. External flesh color should not be included in mango QA specs.

Suggested Steps for Receiving Mangos

Use the NMB Mango Evaluation and Ripening Log (see appendix) to capture the relevant arrival data for each shipment-lot. Randomly select at least 15 mangos of the same variety from the shipment lot. Collect the following data and take photos when problems are noted:

- Origin
- Harvest date
- Were the mangos hot water treated?
- Pulp temperature
- Firmness (lbs pressure using a penetrometer)
- SSC (%)
- Maturity stage (flesh color as compared to the photos in the MMRG, see appendix)
- External and internal defects (see appendix for references)

Temperature Management

Temperature management is extremely important, as chilling injury is one of the most common problems found in mangos at the retail level in the United States. Scald-like discoloration (graying) of the mango skin may indicate chilling injury. This condition may interfere with the ripening process, resulting in a flavorless and unappealing mango with a reduced postharvest life.



To avoid chilling injury, mangos should not be cooled below 50 or 54°F (10-12.2°C) depending on the variety (see below). Postharvest life potential at this temperature could be up to 2 to 4 weeks, depending on the variety, maturity and ripeness stage.

NMB research has identified the threshold for possible chilling injury for mangos for the four most common commercial varieties sold in the U.S. In general, the lowest safe temperature for long-term exposure (two weeks or more) of mature/unripe mangos is 50 to 54°F (10-12.2°C). Ataulfo and Kent varieties are more sensitive, and generally should not be cooled below 54°F (12.2°C). Tommy Atkins and Keitt can generally be cooled to 50°F (10°C).

Variety	Potential Chilling Injury Threshold
Ataulfo Kent	54°F (12.2°C)
Tommy Atkins Keitt	50°F (10°C)

The impact of temperatures will depend on the variety, stage of maturity and the particular time-temperature combination to which the mangos are exposed. Mangos harvested immature are more susceptible to chilling injury. **Damage from chilling injury is cumulative, getting worse with progressively lower temperatures or longer exposure times.**

Mango Storage

By properly managing mango inventory, you will not have a large backlog of fruit at any time. Mango postharvest shelf life will vary based variety, harvest maturity and temperature management. By moving the fruit through the warehouse quickly, you will help ensure a good eating experience for the customer.

After receiving, move fruit directly to cold storage at 54°F (12.2°C). Do not allow the fruit to sit out on the dock where it may become too cold or too warm. The same rule applies for outgoing fruit. See the Temperature Management section for more on ideal storage temperatures.

Maintain relative humidity at 90-95%. Scrub ethylene from cold room or do one fresh air exchange each day.

Mango Transportation

Trailers should be cleaned, sanitized, and precooled to the desired shipping temperature prior to backing up to the dock.

The purpose of precooling is to bring the interior surface of the trailer to the desired carrying temperature. If the interior of the reefer container is hot, the cargo can potentially be temperature

abused by contact with the hot sidewalls and floors. Failure to precool may result in heat transfer from the trailer body, which will warm the fruit.

Reefer units should be turned off during loading. Running the reefer unit while loading the cargo can cause icing of the evaporator coil, inferior cooling of the mangos, and/or the transfer of unwanted hot or cold ambient air and exhaust fumes into the cargo space.

Transportation to the stores has proven to be a critical step for mangos because of lack of proper control of temperature conditions and potential rough handling. Commodities are generally transported to the stores in a mixed load refrigerated truck cooled to the lowest temperature needed for an item in the load. Quite often, this is colder than mangos can stand without damaging quality.

Ripe mangos can tolerate temperatures below 50°F (10°C) during transportation better than unripe mangos. For long transportation time from facility to stores, transportation temperatures below 54°F (12.2°C) should be avoided if possible. Additional measures, such as wrapping the mango pallets in plastic and placing them in the warmest part of the truck can help to minimize, but may not totally eliminate chilling injury during transportation.

Mango Handling and Merchandising at the Store

Mangos should never be refrigerated at the store level. The typical backroom cooler in most stores is much too cold for mangos, as are the refrigerated display racks on the sales floor. Refrigerating mangos at the store level can cause chilling injury that may not appear until the fruit goes home with the customer. Therefore, mangos should always be held and displayed at ambient room temperature of 70°F (21.1°C) in the store.



Store-level personnel should be trained to recognize chilling injury, so they can remove this damaged fruit from the display and alert the QC team immediately. Mango chilling injury observed at the retail display was most likely caused by improper handling in the days or weeks from harvest to delivery at the stores.

Never display mangos in baskets, where the weave pattern can bruise the tender mango. Likewise, avoid stacking mangos too high or placing them below larger fruit such as pineapples or coconuts on an inclined display. While firm mangos may appear to be quite rugged, they can be bruised if handled too roughly. Ripe mangos are softer and are even more susceptible to damage at the retail display.

Best Mango Merchandising Practices

- Educate customers about selection, ripening, cutting, usage and nutrition by using point of sale materials from the NMB
- Group mangos by variety, size and ripeness level
- Keep displays well stocked, but to avoid bruising, do not stack too high
- Inspect displays regularly and rotate out shriveled or damaged fruit
- Never stack heavier fruit such as pineapple, papaya or coconuts above mangos on an inclined table
- Mangos provide 45% of tropical fruit category sales, so maintain high traffic shelf space year round so your customers can always find mangos
- Build secondary mango displays in the produce department or front of store, especially when mango volumes are highest and when mangos are on promotion
- Build sales by carrying multiple varieties and sizes of mangos

Mango Ripening

Why Ripen?

Ripening has revolutionized the world of bananas, avocados, pears, kiwifruit and other produce items. Ripening (sometimes called pre-conditioning) protocols have had a positive impact on consumer satisfaction and sales for ripened fruit.

In-store consumer tests conducted by UC-Davis on behalf of the NMB indicate that consumer acceptance doubles, increasing from approximately 39% for mature/unripe mangos to 87% for the same fruit ripe/ready to eat. The proper use of the mango ripening protocol, educational and promotion programs should increase consumption, increase sales and benefit consumer health.

Preparing for a Ripening Program

A very important step in a successful mango ripening program is to receive mangos that were harvested mature. The receiving process described in this document should help to ensure quality mangos that will react well to the ripening process. Fruit that was harvested immature will soften, but it will not develop a pleasing flavor. No ripening process will salvage a mango that was harvested immature.

Before engaging in a ripening program, the intention to ripen and the required maturity level at harvest should be clearly communicated up the supply chain. Likewise, communication throughout the retail organization is critical. A ripe mango program will impact procurement and replenishment procedures. Stores should be made aware, so they can adjust merchandising and communication standards. Adjustments may be needed to “days on hand” inventories for mangos at the store and warehouse levels.

Temperature management, as described in this document, is extremely important for the success of a mango ripening program. Mangos that have sustained chilling injury may not ripen normally. Likewise, perfectly ripened mangos may be ruined if they are refrigerated at the store level.

Establishing the Transfer Point

The ideal transfer point must be determined before starting the ripening program. Transfer point refers to the ideal level of ripeness for delivery to the store. By setting a transfer point, the ripening team has a built in target that can guide their decisions about how to handle each incoming load.

Based on NMB research and the results of our consumer acceptance tests, the UC-Davis team is currently suggesting a firmness of 6 to 8 lbs force as the ideal transfer point. The transfer point will depend on the variety, transportation time, store rotation, display conditions and other factors. Each retailer must consider these variables and establish the ideal transfer point for their specific conditions.



Ripening Procedures

The appropriate ripening protocol will vary based on the ripeness level of the fruit at receiving, quarantine treatment (hot water treatment, see sidebar), and ripening center conditions. This is a general ripening protocol guideline to be used as a starting point for each ripening location. Protocol adjustments should be expected for each location in order to tailor the ripening program to their specific situation.

Ripening Center Conditions

Distribution centers may have high air flow (forced air) ripening rooms or low air flow (conventional) ripening rooms. Generally, banana ripening rooms are the forced air type

Force Air Ripening Room Capabilities

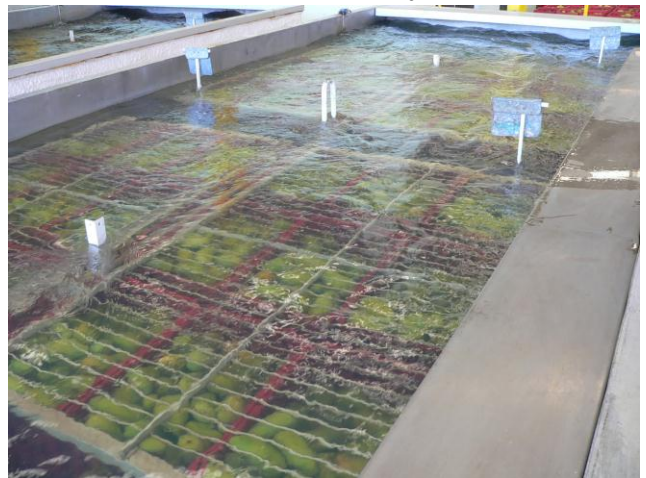
- Air flow of 1.0 cubic foot per minute (cfm) per lb (1 liter/sec-kg)
- Maintain uniform fruit temperature
- Remove heat
- Remove respiration
- Apply ethylene
- Proper air exchange
- It's possible that mangos kept in high velocity forced air conditions for long periods could experience dehydration

Conventional Ripening Room Capabilities

- Air flow of 0.05 to 0.10 cfm per lb (0.05 to 0.1 liter/sec-kg)
- Adequate air and ethylene contact to the fruit is possible if 4" to 6" of space is allowed in between the pallets

What is Hot Water Treatment?

Mangos are grown in tropical climates. Many mango production areas have populations of fruit flies that are not established in the United States. Importation of fruit from a fruit fly zone could carry the pest into the U.S. and threaten the domestic agricultural production. For this reason, many tropical fruits are required to go through some type of quarantine treatment to eliminate this risk. For mangos, the most common protocol is hot water treatment. The fruit is submerged in hot water for a sufficient time to control the risk of fruit fly importation.



A Note About Forced Air Rooms and Gaps

Some forced air ripening rooms operate in such a way that all gaps between the boxes must be eliminated. Otherwise, the air will take the path of least resistance, and will tend to travel in these gaps, rather than through the pallet-stacked boxes of mangos. Under some circumstances, the mango boxes may not totally fill the pallet, meaning that the pallets could be butted against each other, yet a gap still exists in between the box stacks. In this scenario, some creativity will be needed to fill the gaps. We suggest you experiment with air bags, cardboard, empty pallets or anything you may have on hand to fill the gaps.

Other forced air ripening rooms operate with greater air velocity, which will move into and through the mango box stacks, regardless of the gaps.

Keep this in mind and adjust your protocols accordingly.

Ripening Protocol - *For Hot Water Treated Mangos*

- If fruit has ripened to or beyond the transfer point, it should be distributed to stores immediately
- As explained above, the recommended transfer point is fruit firmness of 6 to 8 lbs force, but each handler will need to determine their ideal transfer point
- For fruit that has not yet ripened to the ideal transfer point, follow these steps:
 - Fruit can be ripened using controlled temperature ONLY
 - Hold at 68-72°F (20-22.2°C)
 - No ethylene application is needed, although using ethylene on hot water treated mangos should not cause a problem
 - Exposure to ethylene will not significantly speed up the ripening process
 - Research indicates that hot water treated mangos kept at 68-72°F (20-22.2°C) will ripen in 2-6 days
 - Monitor progress and sample fruit for firmness until the ideal transfer point is reached

Ripening Protocol - *For Non Hot Water Treated Mangos*

- If fruit has ripened to or beyond the transfer point, it should be distributed to stores immediately
- As explained above, the recommended transfer point is fruit firmness of 6 to 8 lbs force, but each handler will need to determine their ideal transfer point
- For fruit that has not yet ripened to the ideal transfer point, follow these steps:
 - Fruit should be ripened using controlled temperature and ethylene
 - Hold at 68-72°F (20-22.2°C)
 - Apply ethylene at 100 ppm for 24 hours
 - After 24 hour ethylene exposure, hold mangos at the ripening temperature 68-72°F (20-22.2°C)
 - Research indicates that ethylene treated mangos kept at 68-72°F (20-22.2°C) will ripen in 3-9 days
 - Monitor progress and sample fruit for firmness until the ideal transfer point is reached

Ideal Mango Ripening Conditions

- 68-72°F (20-22.2°C) is ideal for ripening
- Above 80°F (26.7°C), mangos may develop mottled skin and off-flavor
- Above 86°F (30°C), mango ripening may be delayed
- Below 68°F (20°C), mangos may ripen too slowly
- Relative humidity of 90-95% will reduce potential water loss and mango shriveling
- Ethylene may or may not be necessary (see below for guidelines)

Ripening Mangos With Other Items

Mangos may be ripened with other items, such as bananas, which may require a lower ripening temperature. In these cases, testing will reveal if your particular combination of time, temperature and ethylene will have good results. Firmness and color variability during ripening and consumer reactions at the stores should be monitored, and adjustments made along the way.

- During ripening, with or without ethylene, carbon dioxide levels should always be kept below 1.0% by exchanging room air with outside air
- Monitor ethylene and carbon dioxide levels during ripening and vent as needed
- In some well-vented facilities, air exchange may not be needed
- Mangos may be ripened with other items, such as bananas (see sidebar)

Post Ripening Handling

After moving mangos out of the ripening room, randomly selected mangos should be pulled and data should be collected and recorded on the mango evaluation and ripening log (see appendix). This data log showing the quality conditions of the fruit before and after ripening will be your most valuable tool for fine-tuning your specific mango ripening protocol.

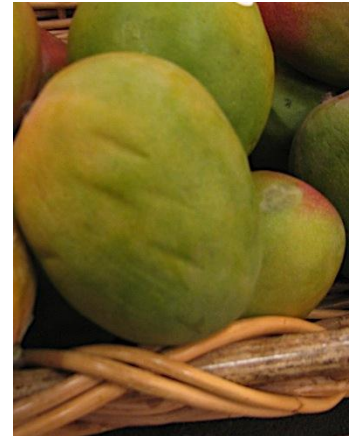
Once ripe, mangos will ideally be kept at 54-60°F (12-15.6°C) and 90-95% relative humidity for no longer than one week.

Merchandising Ripened Mangos

Produce department managers and associates should receive communication and training about the ripe/ready to eat mango program on an ongoing basis.

Stores may need to receive mangos more often to avoid having too many cartons stacked in the back room. Proper rotation and regular shipments will be very important to the success of your ripening program.

The ripe mangos will probably be softer than what the stores are accustomed to receiving. Extra care should be taken in handling and building the displays. Never display soft mangos in baskets, where the weave pattern can bruise the tender mango. Likewise, avoid stacking mangos too high or placing them below larger fruit such as pineapples or coconuts on an inclined display.



Consumer education will be critical. Store-level personnel should talk with consumers about the ripe/ready to eat mangos available for purchase and have a clear sign indicating that mangos are “Ready to Eat”. Point of Sale (POS) materials, available from the NMB, should be used to call attention to the ripe/ready to eat mangos and teach consumers about selection, cutting and usage.

For More Resources

The NMB’s website, www.mango.org, provides a wealth of resources for anyone in the business of handling and/or ripening mangos in the United States. Highlights include:

- Crop reporting
- Variety and availability information
- Historical volume and pricing queries
- Category development reports
- Consumer research reports
- Best practices for handling and merchandising
- Mango Postharvest Best Management Practices Manual in English, Spanish and Portuguese
- Mango University online training program for store level produce managers and associates
- Mango demo tips and training
- Mango Mania Display Contest details
- Mango nutrition info and other marketing messages

- Mango POS materials that teach selection, cutting, nutrition and usage ideas
- Mango recipes
- Images and logos
- Extensive research library covering everything mango-related, from post-harvest handling to human nutrition studies

Get monthly tips for handling, promoting and merchandising mangos. Sign up for the Mango Mover Retail E-Newsletter at <http://www.mango.org/retail>.

Acknowledgements

This document is the culmination of seven years of research into mango production, harvest, handling and merchandising. The mango industry is firmly committed to this ongoing research, and there is much more to learn.

The National Mango Board would like to thank the following individuals and institutions for their contributions to mango research that were drawn upon in the creation of this document. Without them, the Mango Handling and Ripening Protocol would not exist.

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Mango

MATURITY & RIPENESS GUIDE



HOW TO USE THIS TOOL

- These charts are intended for use at the retail receiving point in the United States.
- You should expect at least 90% of the mangos tested to fall in stage 2 or higher.
- Experience and good judgment are still your best tools. Actual results may vary from these findings.
- These charts are meant to be educational and to provide a guideline for understanding mango maturity and ripeness. They do not represent U.S. Federal Grade Standards and should not serve as the basis for a contract or for an inspection.

These guidelines were developed by the mango quality research team at the University of Florida and the University of California-Davis.

MANGO EXPECTATIONS AT RECEIVING

- Mangos are harvested when mature, but not ripe.
- A mature mango will ripen normally with increasing soluble solids content (degrees Brix) and decreasing firmness (lbs. force) to become ready to eat.
- At receiving, you can expect the mangos to be mature, but not necessarily ripe.
- Maturity can be judged by a combination of factors, including internal color, firmness, degrees Brix and fruit shape.
- Red skin is not an indicator of maturity, quality or ripeness and should not be used to evaluate mangos at receiving.
- It is very typical to find mangos of differing maturity and ripeness in the same load and in the same box.

MEASURING MANGO MATURITY & RIPENESS

- Internal flesh color, which develops near the seed and will progress outward as shown in these photos, is generally the best indicator of maturity and ripeness. Firmness and degrees Brix ranges are provided as an additional reference.
- To measure firmness with a fruit penetrometer, use a 5/16" (8mm) tip and test the mango flesh with the skin removed.
- To measure degrees Brix with a refractometer, collect the flesh from an entire mango cheek OR a plug taken down to the seed and juice the entire flesh sample.
- Full shoulders at the stem end may be an indicator that the mango was harvested mature and will ripen normally.

Store whole mangos at 54-60° F (12-15.5° C)

ATAULFO



AVERAGE COLOR					
INTERIOR FLESH SAMPLES					
MATURITY/RIPENESS	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5
FIRMNESS	18 - 22	11 - 13	6 - 8	2 - 3	1 - 3
BRIX	7 - 8	9 - 10	11 - 12	12 - 15	14 - 18

FRANCIS



AVERAGE COLOR					
INTERIOR FLESH SAMPLES					
MATURITY/RIPENESS	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5
FIRMNESS	18 - 23	12 - 16	8 - 10	5 - 7	3 - 5
BRIX	6 - 7	10 - 13	12 - 15	13 - 16	14 - 17

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HADEN



AVERAGE COLOR					
INTERIOR FLESH SAMPLES					
MATURITY/RIPENESS	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5
FIRMNESS	12 - 15	12 - 14	5 - 8	4 - 5	2 - 3
BRIX	6 - 8	9 - 11	12 - 15	14 - 16	14 - 17

KEITT



AVERAGE COLOR					
INTERIOR FLESH SAMPLES					
MATURITY/RIPENESS	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5
FIRMNESS	16 - 19	12 - 15	7 - 9	2 - 4	1 - 2
BRIX	8 - 10	9 - 12	10 - 12	12 - 14	14 - 17

KENT



AVERAGE COLOR					
INTERIOR FLESH SAMPLES					
MATURITY/RIPENESS	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5
FIRMNESS	19 - 22	14 - 18	11 - 13	5 - 8	2 - 4
BRIX	8 - 10	9 - 11	12 - 13	12 - 14	14 - 15

TOMMY ATKINS



AVERAGE COLOR					
INTERIOR FLESH SAMPLES					
MATURITY/RIPENESS	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5
FIRMNESS	18 - 20	15 - 17	10 - 13	6 - 8	3 - 6
BRIX	7 - 9	8 - 11	9 - 11	10 - 13	12 - 15

Version 1, Spring 2010

These charts are meant to be educational and to provide a guideline for understanding mango maturity and ripeness. They do not represent U.S. Federal Grade Standards and should not serve as the basis for a contract or for an inspection.

Mango Evaluation and Ripening Log

Date Received	Supplier	Pack Date	Origin	Variety	Size	Hot Water Treated?
						Y N
Overall Quality Notes						
Condition At Receiving						
	Flesh Temp	Firmness	SSC	Maturity	Flesh Temp	Firmness
1				1 2 3 4 5 9		
2				1 2 3 4 5 10		
3				1 2 3 4 5 11		
4				1 2 3 4 5 12		
5				1 2 3 4 5 13		
6				1 2 3 4 5 14		
7				1 2 3 4 5 15		
8				1 2 3 4 5 16		
Ripen or Ship?	Room #	Ethylene PPM	Ripening Temp	Other Items in Room	Time In	Time Out
Overall Quality Notes						
Condition Post Ripening						
	Flesh Temp	Firmness	SSC	Maturity	Flesh Temp	Firmness
1				1 2 3 4 5 9		
2				1 2 3 4 5 10		
3				1 2 3 4 5 11		
4				1 2 3 4 5 12		
5				1 2 3 4 5 13		
6				1 2 3 4 5 14		
7				1 2 3 4 5 15		
8				1 2 3 4 5 16		

Notes:

Mango Defects

Latex Staining

- Naturally occurring substance produced by the tree
- Does not impact eating quality - cosmetic only



Chilling Injury

- Surface pitting
- Grayish scalding
- Flesh browning in severe cases
- Uneven ripening
- Poor color and flavor development



Hot Water Injury

- May cause black or brown scalding
- Severe cases may cause pockets in the flesh



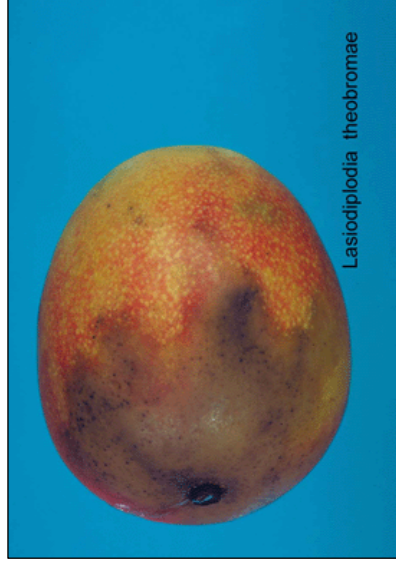
Anthraxnose Decay

- Black lesions
- Caused by a field fungus
- Generally well-controlled by hot water treatment



Stem End Rot Decay

- Brown, grey or black lesions and decay starting at the stem end of the fruit
- Caused by a number of different fungi



Lasiodiplodia theobromae



Information provided by Dr. Elizabeth Mitcham,
Pomologist, UC-Davis Postharvest Technology
Research & Information Center



Brought to you by the
National Mango Board
www.mango.org

Mango PLU Codes

PLU Code	Varieties	Size
4051	Tommy Atkins, Haden and Kent	Size 12 and smaller
4959	Tommy Atkins, Haden and Kent	Size 10 and larger
4312	Ataulfo and Manila	Size 18 and smaller
4961	Ataulfo and Manila	Size 16 and larger
4311	Keitt	Size 12 and smaller
4584	Keitt	Size 8 to 10
3114	Keitt	Size 7 and larger
3621	Francis	All sizes

Four retailer-assigned mango PLU codes are also available to allow retailers and their suppliers to manage unique situations that do not fit into the chart above. These are 4313, 4314, 4315 and 4316.

Codes for organic mangos are the same as those listed above, with the addition of a leading “9”. For example, the code for an organic small Keitt would be 94311.



Mango VARIETIES & AVAILABILITY



ATAULFO

FLAVOR: Sweet and creamy

TEXTURE: Smooth, firm flesh with no fibers

COLOR: Vibrant yellow

SHAPE: Small, flattened oval shape

RIPENING CUES: Skin turns to a deep golden color and small wrinkles appear when fully ripe. Squeeze gently to judge ripeness.

PRIMARY SOURCE COUNTRY:
Mexico



FRANCIS

FLAVOR: Rich, spicy and sweet

TEXTURE: Soft, juicy flesh with fibers

COLOR: Bright yellow skin with green overtones

SHAPE: Oblong and sigmoid S-shape

RIPENING CUES: Green overtones diminish and the yellow becomes more golden as the Francis ripens. Squeeze gently to judge ripeness.

PRIMARY SOURCE COUNTRY:
Haiti



HADEN

FLAVOR: Rich, with aromatic overtones

TEXTURE: Firm flesh due to fine fibers

COLOR: Bright red with green and yellow overtones and small white dots

SHAPE: Medium to large with an oval to round shape

RIPENING CUES: Green areas of the mango turn to yellow as it ripens. Squeeze gently to judge ripeness.

PRIMARY SOURCE COUNTRY:
Mexico



KEITT

FLAVOR: Sweet and fruity

TEXTURE: Firm, juicy flesh with limited fibers

COLOR: Dark to medium green, sometimes with a pink blush over a small portion of the mango

SHAPE: Large oval shape

RIPENING CUES: Skin stays green even when ripe. Squeeze gently to judge ripeness.

PRIMARY SOURCE COUNTRIES:
Mexico, United States



KENT

FLAVOR: Sweet and rich

TEXTURE: Juicy, tender flesh with limited fibers

COLOR: Dark green and often has a dark red blush over a small portion of the mango

SHAPE: Large oval shape

RIPENING CUES: Kents have yellow undertones or dots that cover more of the mango as it ripens. Squeeze gently to judge ripeness.

PRIMARY SOURCE COUNTRIES:
Mexico, Ecuador, Peru



TOMMY ATKINS

FLAVOR: Mild and sweet

TEXTURE: Firm flesh due to fibers throughout

COLOR: A dark red blush often covers much of the fruit with green and orange-yellow accents

SHAPE: Medium to large with oval or oblong shape

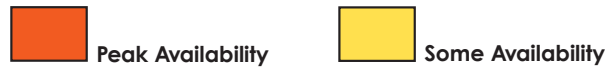
RIPENING CUES: This mango may not provide any visual cues. Squeeze gently to judge ripeness.

PRIMARY SOURCE COUNTRIES:
Mexico, Guatemala, Brazil, Ecuador, Peru



AVAILABILITY BY VARIETY

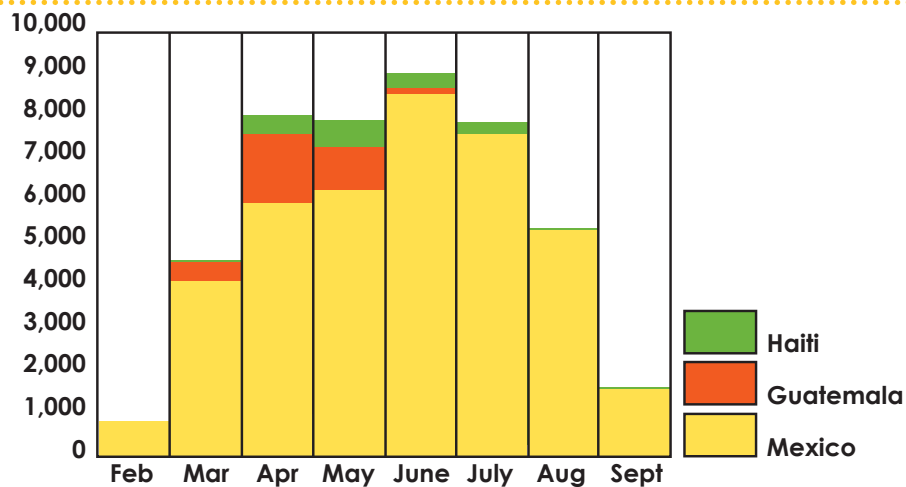
Variety	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Ataulfo			Some	Peak	Peak	Peak	Peak	Some				
Francis				Some	Peak	Peak	Peak	Some				
Haden		Some	Some	Peak	Peak	Some	Some					
Keitt							Some	Peak	Peak	Some		
Kent	Some	Peak	Peak	Some		Some	Peak	Peak	Some			
Tommy Atkins	Peak	Some	Some	Peak	Peak	Peak	Peak	Some		Peak	Peak	Peak



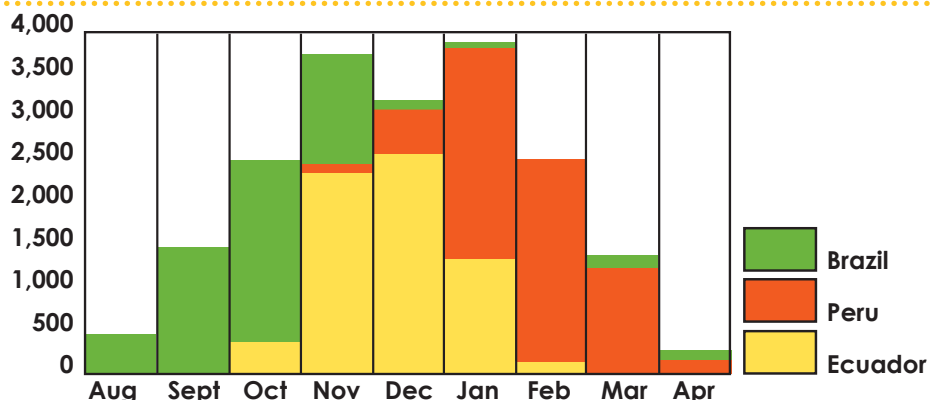
AVAILABILITY BY COUNTRY

The mango year has two seasons, one in the spring/summer and one in the fall/winter. The two seasons overlap to provide a year-round supply. Although close to 70% of the of the total mango volume is sent to the United States in the spring and summer there is a distinct peak in both seasons. For more information please visit www.mango.org/crop.

SPRING/SUMMER



FALL/WINTER



Stated in 10,000 lb units
 Source: Foreign Agricultural Service & National Mango Board
 Volume represents a 3-year average, 2007-2009