



Please Note: While the National Mango Board has funded this research/literature review, it is not authorized to pursue changes to the Grade Standards.

The Big Picture:

Consumer research about mango preferences (flavors shoppers prefer, mango texture, aroma, etc.) is key to the future of mango marketing. Recent research by Professor Adel Kader of the University of California-Davis notes that few studies exist that track consumer opinions of mangos. More information is needed before additional marketing guidelines can be put into place.

The maturity of a mango at harvest is the No. 1 factor that determines how the fruit tastes when consumers get it home. Current USDA standards reveal that a mango is considered “mature” when it shows enough development to ripen correctly after harvest and postharvest handling, however, this ambiguous description leaves much room for interpretation. Unfortunately, 25% of the mangos coming into the U.S. currently are immature, Kader says. European and international standards currently outline more specific quality criteria for mangos than the U.S. grade standards.

U.S. standards for mangos should be updated to include some objective maturity indices, including notations about change in fruit shape (development of full shoulders), change in peel color in some varieties, change in flesh color, and minimal soluble solids content and/or total solids content measurements. Updating the standards would help ensure that mangos are of a more consistent quality at retail. Kader recommends the following:

More research can help determine how ripeness can be measured throughout the supply chain for each of the main varieties (Ataulfo, Haden, Kent, Keitt and Tommy Atkins).

By examining each variety separately, mango industry marketers can fine-tune their harvesting and marketing techniques so that optimal product is delivered every time.

- **At the consumer level:** Measure how consumers perceive mangos – what do they like about each of the varieties? What eating qualities are they looking for? This research would be done using a trained panel to discover what consumers think makes a good mango, including sweet taste (by measuring sugars and acids), aroma, juiciness and fiber content/texture.
- **In the field:** Evaluate which qualities mangos portray at harvest that will translate into an optimum product at retail. Studying flesh color and testing total solid content will need to be done using both objective measures (amount of sugars and acids present, level of aroma, etc.) and subjective measures (how the fruit appeals to the senses). Change in skin color from dark green to light green/yellow (in some varieties) can be a key indicator of ripeness.
- **Behind the scenes:** Study how each variety of mango can be optimally ripened throughout the supply chain so specific ripening practices can be developed according to each variety’s attributes. Along with this, test how consumers would respond to supermarkets offering ripe, ready-to-eat fruit.

Revising maturity indices for mangos is crucial.

There are several measures in place currently to help judge mango ripeness, however, no one technique seems to be the decisive measure. Current standards take into account firmness, lack of decay/defects, uniformity of size and shape, skin color, flesh color and flavor, but adding more descriptive detail to these categories, like the following, could benefit the industry:

- **Picking larger fruits may help quality and ripeness of the mangos down the line.** Large fruits are more mature on the tree, they ripen faster, and they have a higher soluble solids content than smaller fruits.
- **Shoulders should be full and above the stem-end.** Fruit shape needs to be taken into account at harvest. Full, well-shaped shoulders are a very good index of mango maturity, Kader says.
- **Specifying an acceptable peel color range for each variety would be helpful.** Exterior skin/peel color intensities at harvest are a good measure of ripeness for some varieties.
- **Within each production area, fruit should be sampled to test internal color; picking should be done when flesh color is at “stage 3” ripeness on the rating scale of 1 to 5.** Then the cold chain must be maintained at 55°F (13°C) so the mangos do not suffer heating or chilling injury in transit.



- **Establishing a size standard for mangos based on fruit weight would help prevent immature fruit from reaching the market and allow for optimal packaging.** Instead of packing a predetermined number of mangos per box (the current practice), shipping by weight would simplify the system.

The size standards could be broken down into five easily identifiable categories – small, medium, large, extra-large and maximum large – based on the following scale:

Small	Less than 200 g (less than 7.05 oz.)
Medium	201-400 g (7.09 oz. to 14.10 oz.)
Large	401-600 g (14.14 oz. to 1.32 lbs.)
Extra-large	601-800 g (1.32 lbs. to 1.76 lbs.)
Maximum large	More than 800 g (more than 1.76 lbs.)

Packing mangos by weight will allow shippers to choose shipping containers that provide maximum protection for mangos and allow for greater stability of pallets.

Developing a photographic guidebook that outlines defects and decay in mangos would strengthen the current U.S. grade standards and benefit the mango industry at all levels.

Photos and/or illustrations showcasing damage like peel discoloration, sapburn, heat damage, chilling injury, internal bruising and the like would help to ensure that only high quality mangos make it to supermarket shelves.

Reducing the maximum allowed length of the stem from 2.54 cm (1 in.) to 1 cm (.39 in.) could reduce puncture injuries.

Eliminating unnecessary puncture wounds would allow mango shippers to focus more on other injuries/damage to the fruit.

Promoting ripening programs will create a better eating fruit; mangos should be ripened at the wholesale, retail or consumer level.

While it's standard practice to pick mangos at the mature-green stage in the field (to withstand the rigors of postharvest handling) promoting ripening programs will help to ensure higher quality fruit in the end market.

- Controlled atmosphere treatments can delay ripening at the packing level.
- Ethylene treatments can speed up ripening at the retail level.

Developing marketing guidelines at retail, following consumer research on taste/flavor of mangos, would benefit the industry.

Currently consumers buy mangos primarily on the basis of color and firmness, which vary with each variety. Retailers need to focus on promoting flavor and educating consumers about the flavor factor, not just the appearance of mangos.

- Flavor and fiber content vary by variety, something a lot of consumers still don't know. For instance, Tommy Atkins variety mangos have a deep, red color that looks great on display, but, this variety is the most fibrous – something American consumers often don't like. One way to address this shift may be to market the nutritive benefits of the mangos. Displaying ready-to-eat mangos (preripened by the wholesaler or retailer) has been shown to increase sales.
- Surface coatings of carnuba wax help to reduce water loss and give the fruit a subtle shine, which may make it more appealing to consumers.