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Postharvest Handling of Mangos

Methodist University College, Ghana

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HORTICULTURE INNOVATION LAB

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Introduction and Purpose

Mangos are an economically important fruit and are a significant source of income for many farmers in tropical areas. However, harvested mangos are highly perishable and can spoil quickly if not harvested, stored, and transported correctly. Thus, the purpose of this manual is to aid in postharvest handling of mangos.

Many of the recommendations and photos in the manual come from the two sources below. These resources are recommended for more in depth information on mango harvest, handling, transport, packing, ripening, and processing.

Brecht, Jeffrey. *Mango Postharvest Best Management Practices Manual*. The National Mango Board, 2017. https://edis.ifas.ufl.edu/hs1185

Kitinoja, Lisa, and Adel A. Kader. *Small-scale postharvest handling practices: a manual for horticultural crops*. University of California, Davis, Postharvest Technology Research and Information Center, 2002.

This manual was produced as part of the 2017 project "Home-based processing and marketing of mango fruits in Wenchi Municipality" through the Methodist University College, Ghana, and the Horticulture Innovation Lab at the University of California, Davis. This manual is meant to be used as supplemental material for the above-mentioned project's workshop. To the best of the authors' knowledge, this manual contains popular and effective practices in for decreasing postharvest loss of mangos. However, the authors cannot guarantee the effectiveness of the following methods in every instance and cannot take responsibility for loss or injuries caused while following these recommendations. As conditions change from location to location, the most important and effective practice is to determine what practices are effective in each location. It is the authors' hope that this manual can provide a reliable and useful resource for popular best practices in mango harvest.

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Maturity at Harvest

Importance

Mangos harvested when mature will ripen by themselves during storage and shipping. Mangos harvested before they are mature will not be able to ripen properly and will not develop good flavor. Mangos harvested too late will bruise easily and may develop defects such as jelly seed. Below is a description of common maturity indicators. The methods section contains a recommended procedure for determining general maturity for a mango crop.

Indicators

Shape

Mango shape is the quickest, easiest, and most reliable way to gauge mango maturity. Determining mango maturity by shape is based mainly on the shoulder size and development. Mango shoulders should be full, with the shoulder connecting to the stem at less than a 90-degree angle. Rainfall and irrigation affect shoulder development such that higher amounts of rain or irrigation will cause fuller shoulders. The picture below shows an immature mango with sloping shoulders on the left and mature mango with full shoulders on the right.

Figure 1. Image credit: National Mango Board

Skin appearance

Skin color is not always an indicator of internal maturity or ripeness. Maturity and ripening are not related to red color and only somewhat related to green-yellow transition. Mango skin color will transition from green to yellow as the mango ripens. The following image shows a mature mango with green skin as an example of how skin color can be a misleading indicator of mango maturity.

Figure 2. Image credit: National Mango Board

Lenticel appearance

Kent mangos show prominent lenticels (light colored spots) in mature fruit. However, the appearance of lenticels is not the same for all varieties and should be used with other maturity indicators to predict maturity. The picture below shows a mature Kent mango with visible lenticels (white spots).

Figure 3. Image credit: National Mango Board

Flesh color

Flesh color is a good indicator of maturity. However, determining mango maturity through flesh color requires cutting and destroying the mango. Thus, flesh color should be used along with shape, lenticel appearance, and firmness to predict what maturity looks like in each specific crop. On the following page are internal flesh colors for Kent and Keitt mangos correlated with and brix data. Mango should be harvested at stage 2 of maturity or after.

Flesh firmness

Firmness is a useful indicator of mango development and decreases as mangos mature and ripen. The most accurate way of measuring mango flesh firmness is by testing with a penetrometer. A penetrometer is a small device that measures the force needed puncture the flesh with a probe. The methods section contains a detailed description of how to use a penetrometer. Flesh firmness can also be estimated by gently squeezing the mango in their hands, but training using a penetrometer is recommended. Flesh firmness should be use with other measures such as shape, flesh color, and BRIX to determine maturity and ripening.

BRIX

BRIX can be used with other measures as an indicator of maturity, but is more useful as a ripeness indicator. BRIX is mainly a measure of how much sugar is present in the mango, though other factors such as acid and pigment levels also affect BRIX readings. At harvest, mangos are recommended to be a minimum of 7-9% BRIX. However, external factors such as irrigation and rainfall can affect BRIX measurement and should be considered. BRIX can be measured using a refractometer and will increase as mangos mature and ripen. More information on refractometers can be found in the methods section.

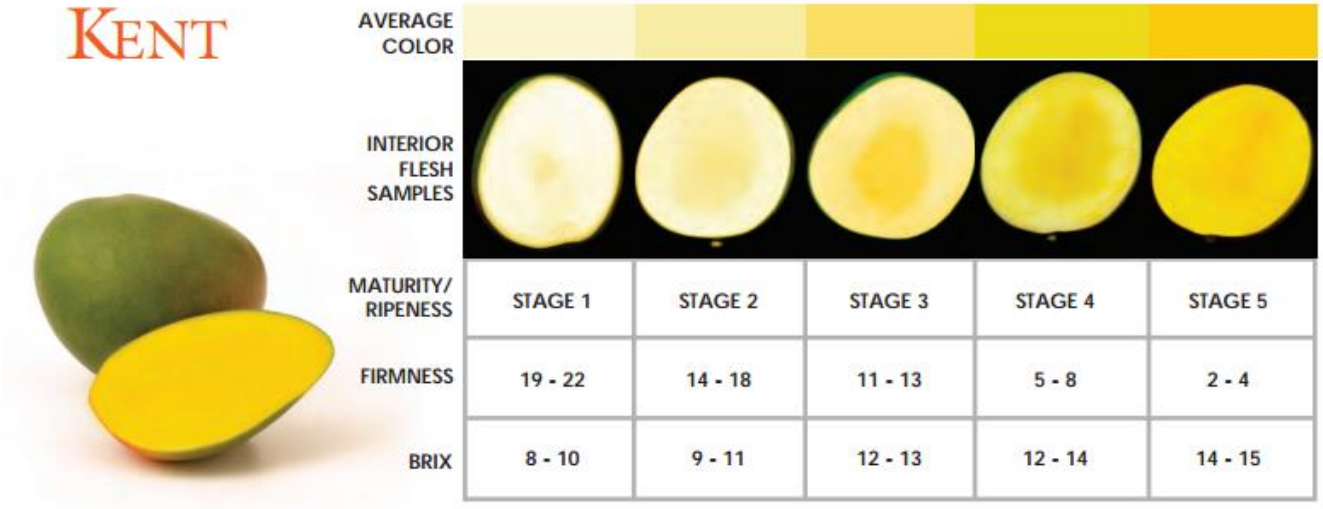


Figure 4. Image credit: National Mango Board

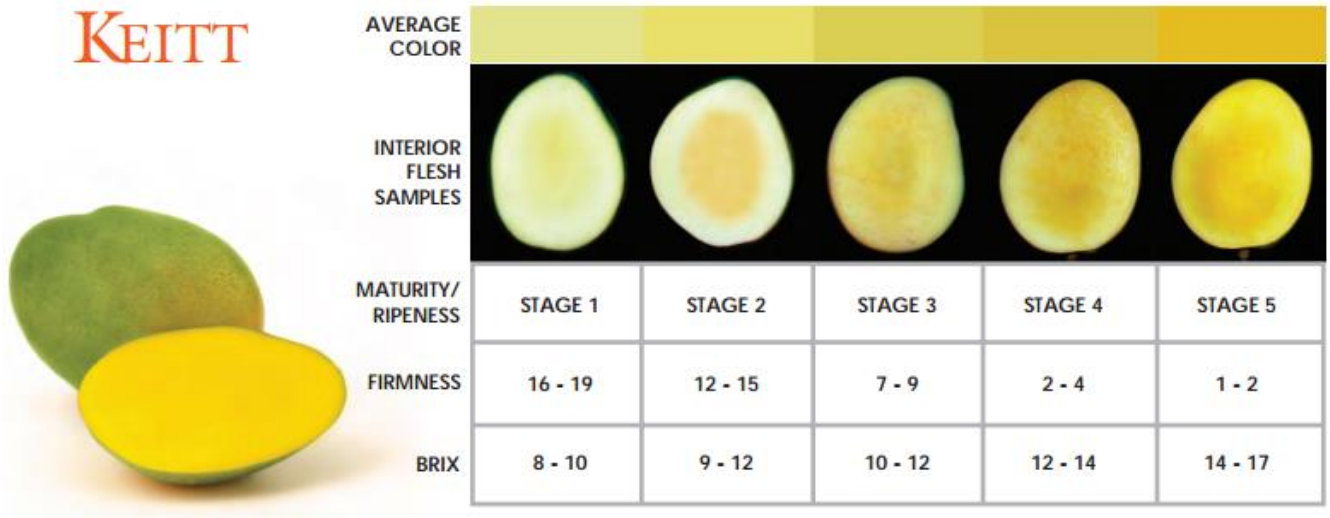


Figure 5. Image credit: National Mango Board

Harvest, Handling, and Storage

Importance

Harvest

Area preparation

Keeping the harvested area clear of decaying material will help reduce decay on mangos. Decaying material can be leaves, other plants, or fallen mangos. Having a plan for how the mangos will be stored and transported before picking can increase mango quality by having equipment in place to decrease mango exposure to direct sunlight and soil.

Harvesting personnel preparation

Harvesting personnel should be well trained in proper harvesting methods. Harvesting personnel should clean their hands prior to picking and actively work to keep hands clean during harvesting. This can be done simply by periodically washing hands during harvest and avoiding hand contact with soil. If ladders are used, workers should carry the ladders by the sides rather than the rungs to avoid dirtying hands.

Timing

Harvesting mangos early in the day will keep mangos cool and reduce water loss. However, harvesting in the early morning will result in increased flow of latex from the mango stem after picking, so proper drainage procedures should be in place prior to early morning picking. Have a plan to transport mangos to a cool, shaded place, particularly before the hottest part of the day.

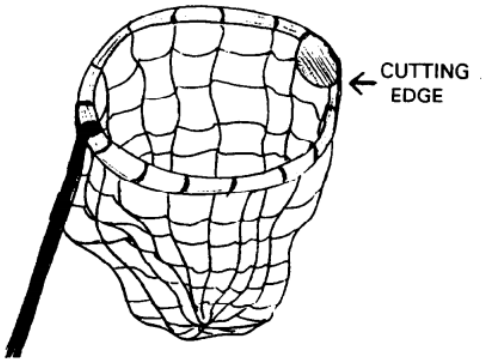
Effect of dropping or throwing mangos

During harvest, mangos can easily be damaged when dropped or thrown. Bruising caused by throwing or dropping mangos will decrease quality, increase occurrence of decay, and cause significant loss of mangos. One useful exercise is to imagine each mango is an egg. Removing eggs from a tree and transporting them to the ground would need to be done very gently to ensure the eggs do not break. Mangos should be picked and transported from the tree in a similar way to ensure bruising does not occur.

Harvesting tools

Many harvesting tools can be made or purchased to help protect mangos during harvest. One common harvesting tool is a basket on a long pole with a cutting tool attached (see following pictures). Another useful tool is a canvas tube extended at an angle from a container on the ground to a person picking in a tree. Mangos dropped though a correctly constructed and situated tube will slow to a safe speed before reaching the ground container. Simple harvesting aids such as collection nets in the tree can also be used to decrease mango damage (see following picture). Any blades used for harvesting should be sharpened regularly to minimize damage to the fruit and tree. Blades with rounded tips are recommended to decrease accidental damage to the fruit. Proper training before harvesting is key to using harvesting tool correctly.

Hand woven collection bag



Canvas collection sack

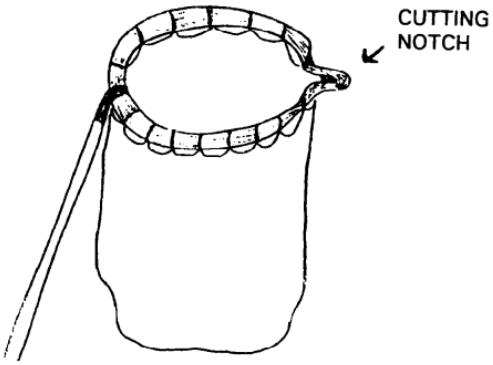


Figure 6. Image credit: National Mango Board

Containers

Containers used during harvest should be easy to clean, cleaned often, and have smooth insides to protect fruit from damage. Baskets used for harvest should be woven "inside out" so that the inside is smooth.

Reduction of latex burn

To reduce latex damage caused by latex leaking from the freshly cut stem, harvest mangos with a stem of 5 cm or longer still attached. No latex will leak from the stems if they are trimmed after 24 hours. Alternatively, stems can be trimmed to 1 cm after harvest and inverted on racks to safely drain latex from the stems.

Transport and Storage Conditions

Direct sunlight and soil contact

Whenever possible, avoid direct sunlight. Direct sunlight heats the fruit, causing damage and shortening mango shelf life. Direct sunlight can be avoided by placing picked mangos in the shade during harvest and covering mangos during storage and transportation. Contact with soil should also be minimized to avoid contamination that may cause decay or safety concerns.

Temperature

Keeping mangos cool is the most important and effective way of maintaining the quality of mangos. Mangos kept at lower temperatures will ripen more slowly and decay at a slower rate. Some easy ways of keeping mangos cool include shading when possible, using ventilated containers during storage and transport, transporting mangos during the coolest parts of the day when possible, and using refrigeration when possible. It is important to keep in mind that mangos are chill sensitive, with temperatures below 12°C causing significant quality loss. Thus cooling mangos below 12°C is not recommended.

Reduction of handling

Mangos have a waxy protective outer layer called a cuticle. Any time a mango is touched, rolled, or in any other way handled, the cuticle is damaged. Thus reducing the number of times a mango is handled can reduce cuticle damage, resulting in decreased waterloss and decay. One simple way to reduce the amount a mango is touched is to have an established plan known by all pickers for how the mangos will be harvested, stored, and transported. Less confusion almost always results in less handling and damage of mangos.

Bruising during handling and transport

Bruising during transport and handling can cause significant losses to mangos. One common cause of bruising is dumping or emptying containers of mangos with too much force. Mangos should be gently transferred from container to container to protect against bruising. During transport, mangos should be protected as much as possible from vibration and bumps. Improvements in the road between the harvesting location and the packing location can result in a reduction of damage to mangos during transportation.

Ripening

Most mangos will ripen within 10 days at room temperature. Separating unripe mangos from ripe mangos and other ripe fruits may slow ripening by reducing exposure to ethylene. Ripening can be monitored through firmness, BRIX measurement, or flesh color.

Methods

Determining mango crop maturity

When mangos are thought to be mature, select approximately 10 mangos from different trees and locations in the field. Take note of the outside appearance of the mangos with emphasis on the shoulder shape and lenticel appearance. Next judge the firmness of the mangos by ether gently squeezing in your hands or using a penetrometer if one is available. Then cut the mango in half near to the seed to observe the flesh color. If available, measure the Brix from two slices of mango using a refractometer. These two slices should be cut from the stem to the bottom of the mango and should be from opposite sides of the mango. Finally compare these observations to the recommendations in the "Maturity at harvest" section of this manual. Using this process, select a few mangos determined to be mature to use as references. Compare the outside appearance of these reference mangos to the outside appearance of unpicked mangos to determine which mangos should be picked and which mangos should be left to continue development.

Using a penetrometer

Penetrometers are very useful tools in determining mango maturity and ripening when used correctly. First, remove a small portion of the mango skin near on the center on the side of the mango. Place the mango on a flat surface, such as a table. Stabilize the mango with one hand and place the penetrometer probe on the area where the skin was removed. The probe is the circular metal rod that will penetrate the mango. Holding the end opposite the probe and using a steady, downward force, push the penetrometer into the mango. Repeat on the other side of the mango. Using an inconsistent force, angle, or support surface will result in different penetrometer readings. Thus, consistency between samples is very important.

Using a refractometer

Refractometers are used to measure the BRIX of a juice and can be used with other indicators to determine maturity and ripening. To measuring BRIX using a refractometer, start by cutting two slices on opposite sides of the mango running from the stem to the bottom. Squeeze one slice to produce a few drops of juice and place this juice on the prism area of the refractometer. For manual refractometers, this will usually be an exposed square of glass with a cover opposite the eyepiece. For digital refractometers, the prism area will usually be a circular area of exposed glass near the digital readout. To make a reading, either look into the eyepiece in the case of a manual refractometer, or press the button which starts analysis for a digital refractometer. The photos below show two different types of refractomters and how to look through a manual refractometer.

Figure 7. Image credit: National Mango Board

Figure 8. Image credit: National Mango Board

Terms

Brix: A measure of the total amount of sugars in a juice. BRIX is often called total soluble solids and can be measured using a refractometer.

Penetrometer: A device using to measure the force needed to penetrate a fruit. Penetrometers almost always consist of a probe (metal cylinder that penetrates the fruit) and a gauge used for measuring the force applied.

Refractometer: A device used to measure the BRIX or total soluble solids of a juice. A refractometer almost always consists of a prism (glass area where the juice is placed) and an eye piece or digital readout to for reading measurements. A refractometer measures the BRIX by determining how light bends as it moves through a juice. This is then correlated with the density of the juice and the total amount of dissolved solids, the majority of which are often sugars.

Decay: Microbial spoilage of mangos. This can be caused by visible spoilage organisms, such as molds, or invisible organisms such as bacteria.

Latex: Liquid running from the stem of the mango after harvest. If not wash off or drained properly, latex can cause significant damage to the fruit surface.

Bruising: Damage caused by dropping, throwing, pressure, or other physical impacts to the fruit.

Mature mango: A mango that, if picked, will ripen properly and develop good flavors.

Immature mango: A mango that, if picked, will not ripen properly or develop good flavors.

Ripe mango: A fruit that has softened and developed flavors ideal for heating.

Lenticel: Light colored spots on the peel of the mango. Lenticels are a sign on maturity in the Kent variety and are used by the mango for breathing.