



## Mangosteen: Postharvest Quality-Maintenance Guidelines

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**M**angosteen is one of the most praised of tropical fruit. It is also known as mangostanier, mangoustanier, mangouste, mangostier (French), mangostan (Spanish), manggis, mesetor, semetah, sementah (Malaysian), manggustan, mangis, mangostan (the Philippines), mongkhut (Cambodian), mangkhut (Thai), cay mang cut (Vietnamese), manggis, manggistan (Dutch), and mangostao, mangosta, mangusta (Portuguese) (Ketsa and Paull 2011, Paull and Duarte 2012). The smooth, globe-shaped berry is 4 to 7 cm (1.6 to 2.8 in) across, with a persistent calyx. The pericarp is 6 to 10 mm (0.24 to 0.4 in) thick and turns purple during ripening. It contains a bitter, yellowish latex and purple-staining juice. The edible white aril has 4 to 8 segments, including 1 or 2 larger segments containing apomictic seeds; there is no true seed.

### Quality Characteristics and Criteria

Fruit have pinkish-red skin when mature, turning to a dark purple when ripe. The red color is due to anthocyanins, which are important antioxidants. The skin should be thick and soft, but firm, when ripe. Fruit have



**Mangosteen**  
*Garcinia mangostana* L.

a soft, sweet, slightly acid flesh with a pleasant flavor. Misshapen and damaged fruit should be removed. Burst latex vessels leave a dried yellow latex on the fruit skin that should be scraped off, after which the fruit should be washed with a soft brush. Fruit are graded to remove damaged fruit and for size. Some Thai growers/exporters coat cleaned fruit with lacquer, giving fruit skin that has been damaged by thrips prior to harvest a more attractive appearance.

### Horticultural Maturity Indices

Skin color is the major criterion used to judge maturity. Immature fruit, which have a light greenish-yellow skin with scattered pinkish spots, do not ripen to full flavor if harvested. The earliest harvest stage for high-quality fruit occurs when the skin has distinct irregular, pink-red spots over the entire surface of the fruit. Fruit are at the edible, ripe stage when the skin has darkened to a reddish-purple, no latex remains in the skin, and the flesh segments separate easily from the skin (Tongdee and Suwanagal 1989). Careful handling is essential for the ripe fruit in order to avoid mechanical injury.

### Grades, Sizes, and Packaging

A Codex standard is available for Mangosteen (FAO/WHO 2007), though no U.S. standard has been developed. Fruit are graded by size and color. They are normally sold in single-layer fiberboard cartons of 2.25 kg (5 lb) with padding, or sometimes in trays of 20 to 24 fruit with fruit individually wrapped to prevent injury. In Southeast Asia, fruit are sold in baskets or strung in bundles of between 10 and 25 fruit.

### Pre-Cooling Conditions

Room-cooling is normally used (Augustin and Azudin 1986).

### Optimum Storage Conditions

Recommendations vary from 3.9 to 5.6°C (39 to 42°F) with 85 to 90% relative humidity for 7 weeks (Pantastico 1975) to 13.3°C (56°F) with 85 to 90% relative humidity for 14 to 25 days. Storage at 4°C (39.2°F) or 8°C (46.4°F) can lead to significant hardening of the skin (Augustin and Azudin 1986), although the flesh may still be acceptable after 44 days. Current practice is to store fruit at 12 to 14°C (54 to 57°F), giving storage-life of about 20 days without chilling injury. Application of surface coatings reduces weight loss and prevents calyx wilting (Choehom 1997).

### Controlled Atmospheres (CA) Considerations

An atmosphere of 5% O<sub>2</sub> + 5% CO<sub>2</sub> has been used for 1 mo (Yahia 1998) and resulted in best overall retention of peel appearance and internal quality (Rattanachinnakorn et al. 1996). Waxing also reduces weight loss, softening, and pericarp color change. Holding fruit in polyethylene film bags reduces weight loss and disease (Daryono and Sabari 1986). However, it is not clear if the effects are due to the prevention of water loss or to the modified atmospheres in the bags.

### Retail Outlet Display Considerations

Display in over-wrapped trays or in closed styrene clam-shell containers with no perforations at 10 to 14°C (50 to 57°F). Do not mist.

### Chilling Sensitivity

Storage at less than 10°C (50°F) for more than 15 days leads to rapid hardening and darkening of pericarp when fruit are returned to ambient temperature

(Uthairatanakij and Ketsa 1996, Choehom 1997). At 5°C (41°F), injury appears in 5 days.

### Ethylene Production and Sensitivity

Mangosteen is a climacteric fruit. Ethylene production is about 29 nL kg<sup>-1</sup> h<sup>-1</sup>. The respiratory peak occurs sooner when fruit are treated with ethylene. Ethylene treatment triggers autocatalytic ethylene production (Noichinda 1992). A methylcyclopropene (1-MCP) treatment delays pericarp color development and aril softening (Ketsa and Paull 2011, Piriyaivinit et al. 2011). High doses of 1-MCP lead to pericarp hardening.

### Respiration Rate

21 mg (12 μL) CO<sub>2</sub> kg<sup>-1</sup> h<sup>-1</sup> at 25°C. Heat production is 4,620 BTU ton<sup>-1</sup> day<sup>-1</sup> (1,281 kcal tonne<sup>-1</sup> day<sup>-1</sup>).

### Physiological Disorders

Fruit damage during harvesting and marketing can affect more than 20% of fruit. The “gamboges” disorder occurs where latex seeps into the flesh (aril), turning it yellow and giving it a bitter taste. The “gamboges” also moves onto the outer surface of the fruit. This is a pre-harvest disorder of unknown cause that makes it difficult to separate the aril from the surrounding tissue, even in ripe fruit; it also causes hardening of the pericarp.

This disease should not be confused with impact injury, which leads to hardening of the pericarp at the point of impact and to aril collapse, dehydration, pink color development, or browning (Tongdee and Suwanagul 1989). A drop of 10 cm can cause slight pericarp damage, indicated as hardening at the point of impact within 24 h. Higher drops causing significantly greater damage can often lead to downgrading of the fruit (Tongdee and Suwanagul 1989, Ketsa and Atantee 1998).

Another disorder of mangosteen fruit is translucent aril (*nue-kaew*) believed to be induced by heavy rain during fruit growth and development, even if just before harvest (Laywisakul 1994). The specific gravity of fruit with translucent aril is more than 1.0, while that of those with normal arils is less than 1.0. This allows separation of fruit by floating them in water (Poddee 1998). Fruit with translucent aril have lower soluble solids content (SSC) and titratable acidity (TA) than normal fruit (Pankasemsuk et al. 1996).

## Postharvest Pathology

*Botryodiplodia theobromae*, *Diplodia* spp., *Pestalotia flagisettula*, *Phomopsis* spp., and *Rhizopus* spp. have been reported; they harden the skin and decay the aril.

## Quarantine Issues

Mangosteen is a fruit fly host. Irradiation at 150 Grays is approved in the US if the sepals are removed and the fruit has undergone a postharvest dip or the orchard has had a broad-spectrum insecticide treatment. If mealybugs or thrips are present a 400-Gray dose is required. Alternatively, harvested fruit are carefully cut open and the arils inspected; fruit are then frozen whole and shipped.

## Suitability as Fresh-Cut Product

Some potential.

## Special Considerations

None.

*An earlier version of this article was originally published at the USDA website: [www.ba.ars.usda.gov/hb66/contents.html](http://www.ba.ars.usda.gov/hb66/contents.html)*

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