



## Carambola: Postharvest Quality-Maintenance Guidelines

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This star-shaped fruit has a waxy skin with several smooth brown seeds, and its flesh and skin are juicy and crisp (Paull and Duarte 2012). It is also referred to as star fruit; however, this name is not preferred, as there is another tropical fruit also called “star fruit.” Carambola is grown widely in the tropics and the warmer areas of the subtropics.

### Quality Characteristics and Criteria

Fruit should be firm and crisp with shiny golden-yellow, orange, or yellow skin when ripe, with no brown discoloration on the skin or wings (ribs). Browning on the wing edges is due to mechanical injury and should not be seen in the best grades. The shape is oval or elliptic in outline, 10 to 13 cm (4 to 5 in) long and 5 to 8 cm (2 to 3 in) in diameter. The absence of fiber is desirable. Cultivars vary greatly in sweetness and acidity, from tart ‘Golden Star’ and sweeter ‘Arkin’ to the low-acid, very sweet cultivars derived from Malay varieties. Fruit showing wind, insect, or bird damage and poor shape are culled.

### Horticultural Maturity Indices

Harvesting is based on physiological and horticultural maturity as indicated by skin color change from green



Carambola  
*Averrhoa carambola* L.

to yellowish-green, then to full yellow or yellowish-orange (Campbell 1989). Optimum sugars are achieved at the full yellow color; however, ripe fruit are more fragile and easily damaged. Hence, fruit are frequently harvested at the color-break stage (O'Hare 1993). Fruit that are 50 to 75% yellow are firmer than full-color fruit and are therefore regarded as commercially mature. Fruit continue to develop color after harvest, although there is little other change in quality.

### Grades, Sizes, and Packaging

There are no U.S. or International grades. Carambola are sold in 3.5 kg (7 lb) flats, 10 kg (22 lb) single layers, 9 kg (20 lb) suitcases, and clamshells (16 fruit in 1 layer or 32 fruit in 2 layers). Fruit require careful packing to reduce damage; use a plastic or foam sleeve or waxed paper wrap.

### Pre-Cooling Conditions

Cool to 4 to 10°C (39 to 50°F) by forced-air or room-cooling as soon as possible.

### Optimum Storage Conditions

Though a tropical crop, fruit can be stored at 4 to 5°C (39 to 41°F) with 90 to 95% relative humidity for 21 to

35 days (Kader 1999). The length of storage varies with ripeness when placed in storage. Lower relative humidity results in more severe rib edge browning; if held at 20°C (68°F) and 60% relative humidity, fruit have a storage life of 3 to 4 days.

### Controlled Atmospheres (CA) Consideration

Fruit held at 7°C (45°F) in 2.2 to 4.2% O<sub>2</sub> with 8 to 8.2% CO<sub>2</sub> retained color and firmness more than fruit held in air (Revel and Thompson 1994). Sealed polyethylene film bags delay degreening and have no effect on flavor after 1 week at 20°C (68°F) on either green or full-colored fruit (Wan and Lam 1984) when the final CO<sub>2</sub> content in the bag is 2.5 to 4.5% and O<sub>2</sub> is about 15%. Waxing also delays water loss and degreening (Vines and Grierson 1966).

### Retail Outlet Display Considerations

Do not display green fruit, and do not stack more than two or three fruit high to avoid mechanical injury to the fragile wings (ribs). Misting is acceptable.

### Chilling Sensitivity

Carambola are not especially sensitive to chilling. However, during low-temperature storage at 0°C (32°F) or 5°C (41°F) for 2 and 6 weeks, respectively, some small surface pitting and rib edge browning can occur. The severity of injury increases with storage time (Wan and Lam 1984).

Greener fruit are more susceptible to injury (Wan and Lam 1984, Kenney and Hull 1986). This symptom can also be seen with desiccation and may not be true chilling injury.

### Ethylene Production and Sensitivity

These non-climacteric fruit have a low production rate of less than 3 μL C<sub>2</sub>H<sub>4</sub> kg<sup>-1</sup> h<sup>-1</sup> at 20°C (68°F) depending on maturity (Oslund and Davenport 1983). Ethylene treatment (100 μL L<sup>-1</sup> for 24 h) slightly hastens degreening but has little effect on flavor. Higher rates of ethylene production have been recorded after 12 days at 20°C (68°F) (Shiesh et al. 1987) and may be associated with decay.

### Respiration Rate

See Table 1 for respiration rates at specific temperatures. To get mL kg<sup>-1</sup> h<sup>-1</sup>, divide the mg kg<sup>-1</sup> h<sup>-1</sup> rate by 2.0 at 0°C (32°F), 1.9 at 10°C (50°F), and 1.8 at 20°C (68°F). To calculate heat production, multiply mg kg<sup>-1</sup> h<sup>-1</sup> by 220 to get BTU per ton per day or by 61 to get kcal per metric ton per day. Respiration rate and pattern depend on cultivar and maturity at harvest (Shiesh et al. 1987).

### Physiological Disorders

The major problem is physical injury, especially on the rib edges, that leads to browning. Injury due to abrasion and impact can be avoided by careful handling. Browning



Boxed carambola



Bird and mechanical damage

due to mechanical injury can intensify with water loss. Fruit that have lost about 5% of their weight due to water loss show visible symptoms of dehydration.

### Postharvest Pathology

Anthraxnose (*Colletotrichum gloeosporioides*) is most common, and the symptoms are thin, light brown patches on fruit edges (Watson et al. 1988). Diseases due to *Alternaria alternata*, *Cladosporium cladosporioides*, and *Botryodiplodia theobroma* have been reported. These disease mainly occur at physical injury sites with prolonged storage.

### Quarantine Issues

Carambola is a fruit fly host. Irradiation and a cold treatment (14 days at 1°C) have been recommended.

### Suitability as Fresh-Cut Product

Slices and pieces have been developed (Matthews 1989). Vacuum-packed slices held at 4°C retained color, texture, and flavor for 6 weeks if dipped in citrate.

### 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)*

**Table 1. Respiration Rates for Carambola**

Respiration Rate	
Temperature	mg CO <sub>2</sub> /kg <sup>-1</sup> h <sup>-1</sup>
5°C	10 to 19
10°C	15 to 29
15°C	19 to 34
20°C	37 to 92

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