

# **Carambola**

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## **Scientific Name and Introduction**

The carambola (*Averrhoa carambola* L.) is a star-shaped fruit that has a waxy skin with several smooth brown seeds. The flesh and skin are crisp and juicy (Nakasone and Paull 1998). The carambola is also referred to as “star fruit.” However, the name is not preferred, because there is another tropical fruit called star fruit. Carambola is grown widely in the tropics and in the warmer areas of the subtropics.

## **Quality Characteristics and Criteria**

The carambola is a firm, crisp fruit 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 included in the best grades. The shape is oval or elliptical 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 the tart ‘Golden Star’ and the sweeter ‘Arkin’ to the low-acid, sweet cultivars derived from Malay varieties (Nakasone and Paull 1998). Fruit showing wind, insect, or bird damage and poor shape are culled (Campbell 1989).

## **Horticultural Maturity Indices**

Harvesting is based on physiological and horticultural maturity as indicated by skin color change from green 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. Thus, 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 thus are regarded as commercially mature. Fruit continue to develop color after harvest, though there is little other change in quality.

## **Grades, Sizes, and Packaging**

There are no U.S. or international grades. Carambola fruit are sold in 3.5-kg (7-lb) flats, 10-kg (22-lb) single layers, 9-kg (20-lb) suitcases, and clam shells (16 fruit in 1 layer or 32 fruit in 2 layers). Fruit require careful packing to reduce damage. A plastic or foam sleeve or wax paper should be used.

## **Precooling Conditions**

Cool at 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% RH for 21 to 35 days (Kader 1999). Length of storage varies with the ripeness when fruit are placed in storage. Lower RH results in more severe rib-edge browning. If held at 20 °C (68 °F) and 60% RH, fruit have a storage life of 3 to 4 days.

### **Controlled Atmosphere (CA) Considerations**

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% with 15% O<sub>2</sub> content. 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**

During low-temperature storage at 0 °C (32 °F) and 5 °C (41 °F) for 2 and 6 weeks, respectively, some small surface pitting and rib-edge browning occurred, with severity of injury increasing with storage time (Wan and Lam 1984). Greener fruit are more susceptible to chilling injury (Wan and Lam 1984, Kenney and Hull 1986). Surface pitting and rib-edge browning can also be seen with desiccation, which may not be true chilling injury.

### **Ethylene Production and Sensitivity**

These nonclimacteric fruit have a low production rate, under 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 Rates**

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

Data from Lam and Wan (1983, 1987).

To get mL CO<sub>2</sub> 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 tonne 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 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 caused by *Alternaria alternata*, *Cladosporium cladosporioides*, and *Botryodiplodia theobroma* have been reported. These diseases mainly occur at physical injury sites with prolonged storage.

### **Quarantine Issues**

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

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