Carambola

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Scientific Name and Introduction: This star shaped fruit *(Averrhoa carambola* L.), has a waxy skin with a several smooth brown seeds, the flesh and skin are juicy and crisp (Nakasone and Paull, 1998). This fruit is also referred to as star fruit, however, the name is not preferred, as there is another tropical fruit called "star fruit." Carambola is grown widely in the tropics and the warmer areas of the subtropics.

Quality Characteristics and Criteria: 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. Shape 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, 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, 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 hence are 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 clam shells (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 ºC (39 to 50 ºF) 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 ºC (39 to 41 ºF) with 90 to 95% RH for 21 to 35 days (Kader, 1999). The length of storage varies with ripeness when placed in storage. Lower RH results in more severe rib edge browning; if held at 20 ºC (68 ºF) and 60% RH, fruit have a storage-life of 3 to 4 days.

Controlled Atmospheres (CA) Consideration: Fruit held at 7 ºC (45 ºF) in 2.2 to 4.2% O_2 with 8 to 8.2% CO_2 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 ºC (68 ºF) on either green- or full-colored fruit (Wan and Lam, 1984) when the final CO_2 content in the bag is 2.5 to 4.5% and O_2 about 15%. Waxing also delays water loss and degreening (Vines and Grierson, 1966).

Retail Outlet Display Considerations: Do not display green fruit, 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 chilling sensitive. However, during low temperature storage at 0 ºC (32 ºF) or 5 ºC (41 ºF) 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 dessication and may not be true chilling injury.

Ethylene Production and Sensitivity: These non-climacteric fruit have a low production rate of < 3 µl C_2H_4 kg^{-1} h^{-1} at 20 ºC (68 ºF) depending on maturity (Oslund and Davenport, 1983). Ethylene treatment (100 µL L^{-1} 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 ºC (68 ºF) (Shiesh et al., 1987) and may be associated with decay.

Respiration Rate:

Temperature	mg CO_2 kg^{-1} h^{-1}
5 ºC	10 to 19
10 ºC	15 to 29
15 ºC	19 to 34
20 ºC	37 to 92

To get mL kg^{-1} h^{-1}, divide the mg kg^{-1} h^{-1} 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^{-1} h^{-1} by 220 to get BTU per ton per day or by 61 to get kcal per metric ton per day. Data are from Lam and Wan (1983; 1987). 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: Anthracnose (*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 ºC) have been recommended.

Suitability as Fresh-cut Product: Slices and pieces have been developed (Matthews, 1989). Vacuum-packed slices held at 4 ºC retained color, texture and flavor for 6 weeks if dipped in citrate.
Special Considerations: None.

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