

# Harvesting Carambola at Different Ripeness Stages Affects Postharvest Quality

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**Carambola (*Averrhoa carambola* L.) fruit grows well in southern Florida. The fruit is usually harvested commercially at the color break stage, while the fruit is still firm, to minimize mechanical injury. A study was conducted to determine the effect of carambola harvested at three ripeness stages (color break, half yellow, and full yellow) on postharvest quality. Treatments were  $\pm$  a commercial carnauba-based wax, three ripeness stages, and either holding for 7 days at 5 °C before transferring to 20 °C or holding constantly at 20 °C in four replications. At full-ripe stage (orange), the non-waxed fruit typically showed more shriveling at the stem end, had rib softening, and lost about twice as much weight as the waxed fruit; however, the waxed fruit held initially at 5 °C, then transferred to 20 °C, displayed non-uniform color development and internal tissue browning. Those fruit that were held constantly at 20 °C had non-uniform color and fermented flavor. Fruit harvested at the yellow color stage had a higher initial soluble solids content (7.9 °Brix) and lower total titratable acidity (0.25%) than the fruit harvested at the color break (6.7 °Brix, 0.28% acid) and half yellow stages (7.1 °Brix, 0.31% acid). Sugar : acid ratios for these respective harvest stages were: color break 23.3, half yellow 22.6, and full yellow 31.9.**

Carambola grows in subtropical areas and is a good fruit for fresh consumption. When sliced, it makes an attractive garnish because of its unique transverse shape. To avoid mechanical injury, fruits are harvested early while in the color break stage. While on the tree, sugar accumulation continues when the fruit change from green to yellow; however, the fruit in the full yellow and orange stages are fragile and susceptible to damage (Oslund and Davenport, 1983). Once harvested, sugar concentrations remain fairly constant but titratable acidity will slightly decrease at certain storage temperatures (Campbell et al., 1987; Siller-Cepeda et al., 2004).

Waxing carambola fruit can significantly lessen weight loss and slow fin browning, but can also lead to surface pitting (Miller and McDonald, 1993). Applying an edible wax coat to fruit has also been shown to limit CO<sub>2</sub> passage from the fruit to the surrounding atmosphere (Hagenmaier and Baker, 1993).

To determine the best postharvest handling practices for carambola, it is necessary to test many treatments. The objective of this research was to measure respiration, weight loss, appearance, soluble solids content, and total titratable acidity of carambola harvested at different ripeness stages, stored at different temperatures, and treated with an edible wax.

## Materials and Methods

Commercially harvested Carambola cv. Arkin at the color break, half yellow, and full yellow stages were obtained from Brooks Tropicals in Pine Island, FL (~260 miles from Gainesville). Once the fruit arrived at the lab, they were washed in 200 ppm chlorine solution and stored for 48 h at 7 °C. After cooling, the fruit were sorted and subjected to different treatments. Treatments were: 1)  $\pm$  a commercial carnauba-based wax (FMC

Food Tech Sta-Fresh® 819F, 50:50 solution with water); 2) three ripeness stages (color break, half yellow, full yellow); and 3) either holding for 7 d at 5 °C before transferring to 20 °C or holding constantly at 20 °C in four replications. Initial samples were evaluated for soluble solids content and total titratable acidity. Every 4 d the fruit were weighed and subjectively evaluated for decay, shriveling, and rib browning until they were orange. Once orange, the fruit were evaluated for soluble solids content and total titratable acidity.

To measure respiration rates and ethylene production, an additional set of fruit at the color break stage was held at 20 °C. Treatments were a control and the aforementioned wax coating.

## Results and Discussion

Respiration rates of control carambola treatments were about 18.7 mL CO<sub>2</sub> kg<sup>-1</sup>·h<sup>-1</sup> at 20 °C, whereas the waxed carambola were about 20.4 mL CO<sub>2</sub> kg<sup>-1</sup>·h<sup>-1</sup> (Fig. 1). The control treatment had only slightly higher respiration and ethylene production rates than the waxed treatment. The fruit in both treatments took about 21 d to turn orange and then started to display signs of senescence and decay. While the ground color of the waxed fruit turned orange, the outer ribs and stem end were persistently green until signs of senescence and decay were displayed (data not shown).

All stages of the waxed fruit that were held at 5 °C for 7 d had less stem end shriveling and the fins held their integrity; however, they showed signs of chilling injury and turned brown once transferred to 20 °C. The non-waxed fruit that were held at 5 °C for 7 d displayed surface pitting, shriveling, and fin browning. The fruit in the color break stage held at 5 °C showed internal flesh browning. Percent acid across all treatments was similar, but there were differences in °Brix. Generally, fruit harvested at the yellow color stage had higher °Brix and fruit harvested at the color break stage had the lowest (Table 1).

Fruit picked in the color break stage lost the most weight (Fig.

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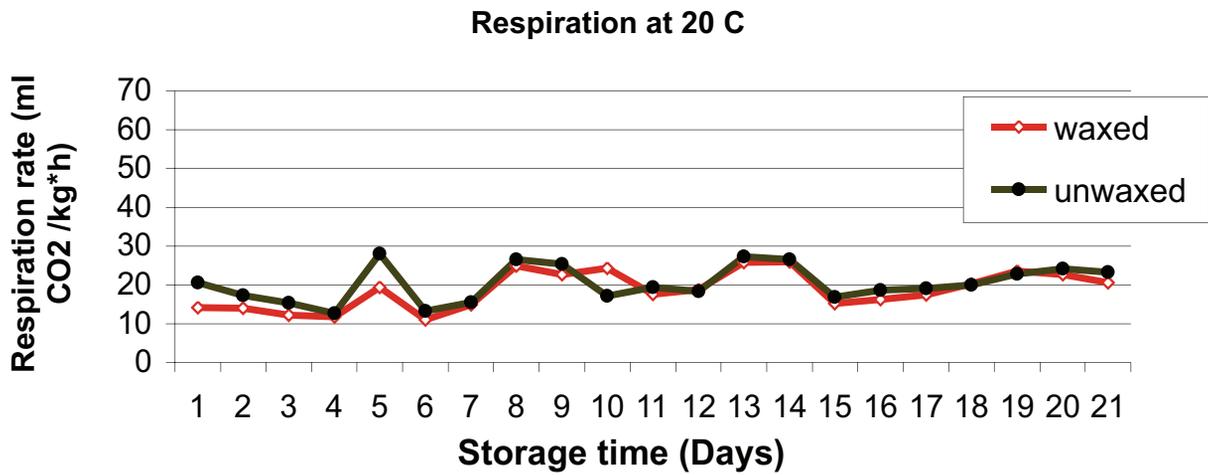


Fig. 1. Respiration rate of carambola initially at color break stage held at 20 °C.

Table 1.

Treatment <sup>a</sup>	°Brix	% Acid	Sugar: acid
CB nw 5 °C	4.70	0.24	19.58
CB w 5 °C	6.30	0.26	24.23
CB nw 20 °C	6.20	0.31	20.00
CB w 20 °C	5.90	0.26	22.69
H nw 5 °C	6.90	0.28	24.64
H w 5 °C	6.80	0.26	26.15
H nw 20 °C	7.60	0.24	31.67
H w 20 °C	7.30	0.25	29.20
Y nw 5 °C	7.70	0.24	32.08
Y w 5 °C	7.50	0.22	34.09
Y nw 20 °C	6.80	0.29	23.45
Y w 20 °C	7.20	0.22	32.73
Avg	6.74	0.26	26.71
sd	0.86	0.03	5.08

<sup>a</sup>CB, color break; H, half yellow; Y, full yellow; nw, non-waxed; w, waxed; 5, fruit held at 5 °C for 7 d; 20, fruit held constantly at 20 °C.

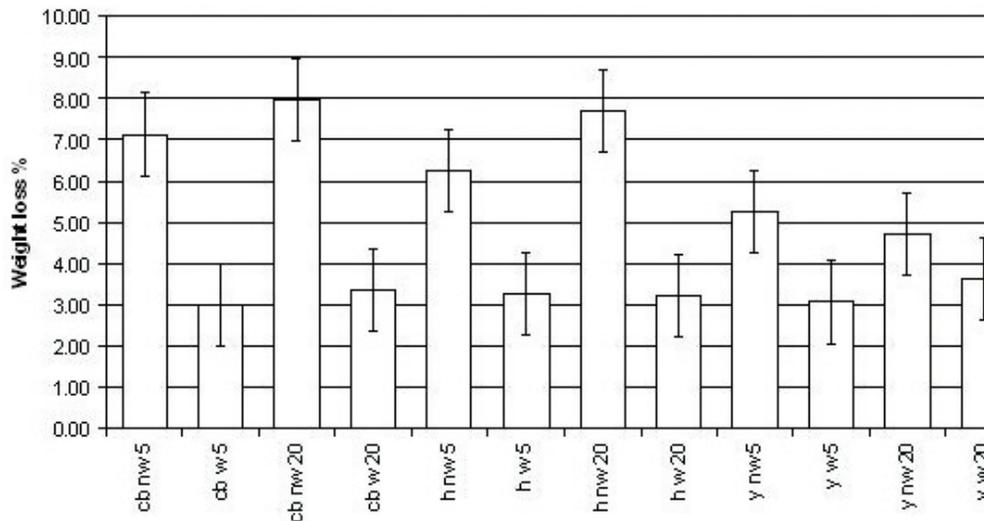


Fig. 2. Weight loss as percentage of initial weight. CB, color break; H, half yellow; Y full yellow; nw, non-waxed; w, waxed; 5, fruit held at 5 °C for 7 d; 20, fruit held constantly at 20 °C.

2), while fruit picked in the yellow stage lost the least amount of weight. The waxed fruit tended to lose less weight than the non-waxed fruit.

### Conclusions

Carambola cv. Arkin is popular because it is sweeter and less astringent than other varieties of carambola. The highest sugar levels observed in this experiment were from fruit harvested at the yellow color stage. To exploit the natural sweetness of 'Arkin', fruit should be picked later than the color break stage. Storing the carambola at 5 °C caused chilling injury, even after the fruit spent 48 h at 7 °C. The waxing treatment used was of no clear benefit to the fruit quality. Even though less weight was lost in the waxed fruit, the appearance of the fruit was poor, due to uneven ripening.

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