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Fruit Development and Ripening of the Star Apple (*Chrysophyllum cainito* L.)[1]

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Abstract: **The star apple is a nonclimacteric fruit and does not respond appreciably to treatment with ethylene, propylene, or ethephon. Its respiration rate at 20°C is 25 to 50 mg CO_2 per kg-hr, and ethylene production ranges from 10 to 100 nl per kg-hr. Both respiration rate and ethylene production increased with the onset of fruit decay caused by species of *Pestalotia* and *Diplodia*.**

The star apple or caimito (*Chrysophyllum cainito*; Sapotaceae) is a widely grown ornamental tree in the lowland tropics. In addition to attractive foliage, edible fruits are produced (2); in the Philippines ripe fruits of both green and purple types are on the markets March through May. While general horticultural knowledge is available (1, 4), nothing has been published on the physiology of developing and ripening fruits. Pantastico et al. (3) state only that ripe fruits should be stored at 3 to 6°C, with 90% relative humidity (RH); the storage life is then 3 weeks with a heat evolution of 1600 to 4400 BTU per ton-day (equivalent to a respiration rate at that temperature of 7 to 20 mg CO_2 per kg-hr). We have studied fruit development and ripening of this fruit.

As with many tropical fruits, star apples are relatively inaccessible in very large trees. Starting at the end of January (about 18 weeks after fruit set), we harvested fruits weekly. Tagging of blossoms to achieve fruits of known age was impracticable. Fruits were taken from a single branch of a large tree in the Department of Horticulture orchard for several weeks. When we changed to another branch, fruit behavior suggested that it came from a different physiological population; the fruits were significantly smaller and may have been younger.

All experiments were conducted at 20°C. Individual fruits were placed in small glass jars through which a continuous supply of air was passed at a measured rate (1 to 2 liter/hr). The respiration rate was determined by colorimetric measurement of the CO_2 content of the effluent air (5), and ethylene production was determined by flame ionization gas chromatography using an alumina column. When individual fruits were terminated, starch and soluble solids content were determined on the flesh by standard methods.

Fig. 1 Shows the growth of our experimental fruits during the period estimated to be 18 to 23 weeks after fruit set. During this period we found no consistent trend in soluble solids content; the observed range was 8 to 13%. The unripe fruits have a relatively high starch content (10 to 30%). A more comprehensive study of carbohydrate changes in fruits of precisely known age is needed. Soluble solids content may not relate directly to fruit age until final ripening when the starch is presumably hydrolyzed as in banana and kiwifruit. Better data on starch plus soluble solids as a function of age might provide a valid physiological measure of fruit development and quality.

Fig. 2 presents the postharvest patterns of carbon dioxide and ethylene production by a single representative fruit. Respiration rates for the fruits were typically between 25 and 50 mg CO_2 per kg-hr. Allowing for the higher experimental temperature, these values agree with the estimate of Pantastico et al. (3). No climacteric rise in respiration was observed, but respiration usually rose to a very high level at the end of the fruit's storage life due to decay. Ethylene production was typically in the range of 10 to 100 nl per kg-hr without the rise in rate that would be characteristic of a climacteric fruit. A rise in ethylene production accompanied the terminal rise in respiration as decay set in. We cannot say whether the ethylene increase came from the fungus or from the infected fruit tissue.

Some fruits of various ages were treated with ethylene or propylene by pipetting enough of the gas into the sealed fruit jar to give 1000 ppm. After 4 hr the jar was flushed with air, resealed, and regassed. After a third 4-hr treatment the jar was reconnected to the air supply overnight. The next

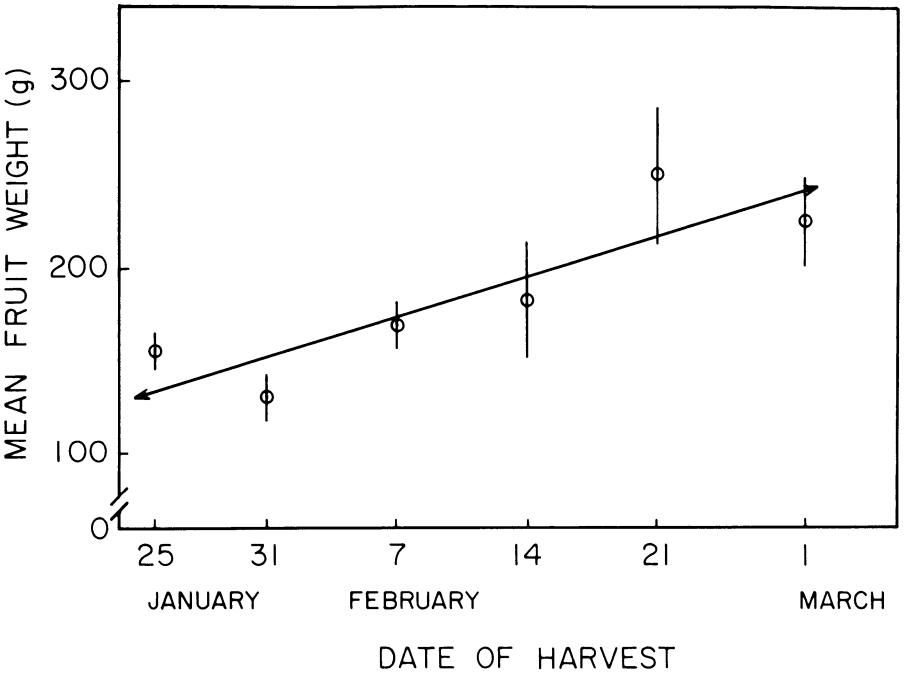

Fig. 1. Mean weights of fruits harvested from a single branch on the indicated dates. Vertical lines are SD (n = 6 to 10). The linear regression (r = 0.76) was calculated on all individual fruit readings.

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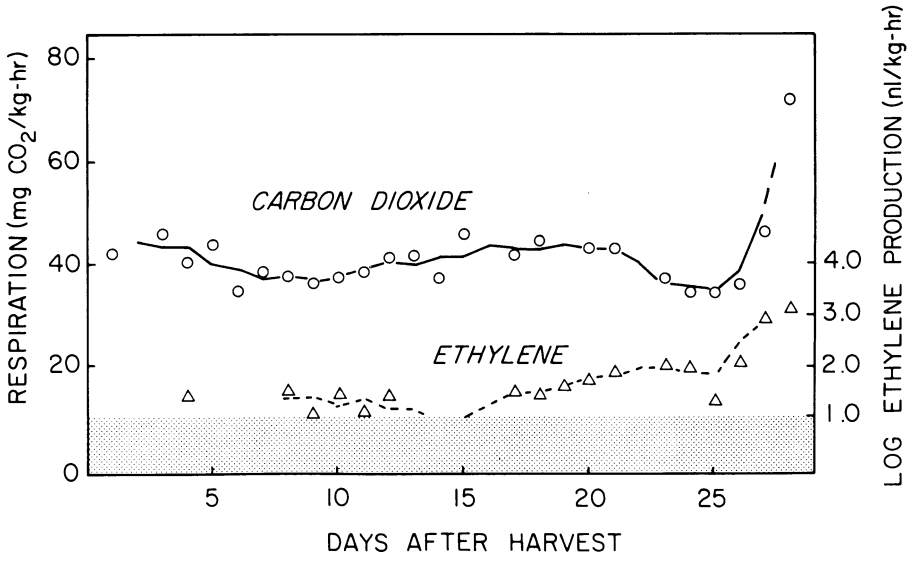

Fig. 2. Respiration and ethylene production from an individual fruit. For carbon dioxide production, the solid line is a 3-day moving average. For ethylene production, the dashed line is the logarithm of the 3-day moving average. The stippled area represents trace concentrations of ethylene – an identifiable gas chromatography peak too small for accurate measurement. This specimen was terminated with *Pestalotia* stem and decay.

morning the respiration and ethylene production rates were measured and the gas treatment was resumed. Some fruits were treated with a 10 min dip in 1000 ppm of (2-chloroethyl) phosphonic acid (ethephon). None of these treatments, even repeated gassing for 3 days, induced an appreciable rise in respiration or in ethylene production by the fruit.

From our evidence we conclude that the star apple is a nonclimacteric fruit. This may explain the apparent confusion in the meager literature. Popenoe (4) says, "The fruits are not good unless allowed to remain on the tree until fully ripe; if picked when immature they are astringent and contain a sticky white latex." On the other hand, Kennard and Winters (2) say, "The fruits do not normally drop and, therefore, must be picked and allowed to ripen off the tree." Wilcox and Hunn (6) imply that the fruit should be picked half-ripe and ripened off the tree. The best indication of horticultural fruit maturity, especially in the green type, is attainment of a highly glossy skin.

The principal research problem we encountered was the lack of a firm basis for actual individual fruit age. Stem end decay, leading to serious internal decay, was very common. With the help of Prof. Lina L. Ilag the most frequent pathogens were identified as species of *Pestalotia* and *Diplodia*. Occasionally fruits were infested with small larvae, usually only 1 per fruit, which was almost indetectable until frass appeared in the fruit jar.

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Guava Fruit Firm Rot Induced by Bruising[1]

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Abstract. **Firm rot of guava (*Psidium guajava* L.) fruit usually started at the blossom end where affected tissue became water soaked but remained firm. The disorder, which advanced 7 to 40 mm in 24 hours, enhanced the development of fruit spot associated with *Guignardia musae* Racib. Guava fruit inoculated with diseased tissues did not develop firm rot, nor did hot water treatment prevent further development of the disorder. Healthy fruit struck against a bench in the laboratory or guava branches in the field developed firm rot at the blossom end but not at the stem end. Guava fruit firm rot, which is not caused by an infectious agent, appears to be triggered by wounding resulting from striking against hard objects.**

Guava fruit are used mainly for processing into puree and beverage juice in the state of Hawaii. The guava industry has expanded rapidly in recent years due to the greater market demand for these products. A new guava fruit rot was noticed on the island of Hawaii in 1974. Subsequently, the disorder was found in guava orchards every year, although the severity varied from year to year and seemed to be more severe during the dry seasons. The present study was initiated to determine the nature of this new disorder.

The disease usually started at the blossom end of the mature guava fruit on trees or on the ground. The affected area became water-soaked and expanded rapidly but tissue remained firm. Flesh of affected tissue also appeared water-soaked. This firm rot was different from mucor rot of guava fruit incited by *Mucor hiemalis* Wehmer (3) in that it did not give off a yeasty odor and diseased fruit were not covered with a yellowish fuzzy mass of fungal fruiting bodies and mycelia. The blackish fruit spot associated with *Guignardia musae* always developed within the affected area in the later stage of firm rot development.

Perimeters of advancing margins on recently diseased fruit on trees were marked with a felt marker to determine the expansion rate of firm rot. Distances between the marked margin and the new advancing marign were measured at 5 random points on each of 6 fruit after 24 hr. The expansion of guava firm rot was unusually fast at the beginning, about 23 mm in the first 24 hr, with

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