



Ripening Inhibition and Quality of Selected Tropical Fruits in Relation to 1-MCP Controlled Release Technology from Hazel Technologies

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Abstract: The use of in-package 1-MCP technology shows potential to extend distribution and broaden consumer availability of some tropical fruits, as well as reduce food waste by extending the shelf life of these ethylene-sensitive commodities. In this study, the Hazel Technologies 1-MCP slow-release sachet was evaluated for its effectiveness in extending the shelf life of six tropical fruits. These were mango (*Mangifera indica*), atemoya (*Annona × atemoya*), passionfruit (*Passiflora edulis*), Guatemalan-West Indian hybrid avocado (*Persea americana*), guava (climacteric and nonclimacteric types) (*Psidium guajava*), and Maridol type papaya (*Carica papaya*). The fruits were harvested from the University of Florida/IFAS (UF/IFAS) Tropical Research and Education Center in Homestead, FL and transported to the Postharvest Lab at UF/IFAS in Gainesville. Initial evaluations of ripeness and quality were performed before placing the fruit samples in the appropriate storage containers and conditions. Ripening parameters were monitored for control fruit and those treated with 1-MCP during storage until a significant percentage of the fruit were judged either to be overripe or unmarketable or when sufficient time had passed to accommodate any conceivable distribution marketing chain duration. Fruit quality was periodically assessed during storage. Based on the results of these experiments, the shelf life of these tropical fruits can be extended from 5 days up to 3 weeks with 1-MCP. Hazel Technology 1-MCP slow-release sachets resulted in slower ripening for 1-MCP-treated fruit compared to the control fruit, especially during the first week of storage. Irregular and non-uniform ripening was seen in some fruit, but the majority ripened normally if they did not become unmarketable due to decay.

1-Methylcyclopropene is a potent gaseous ethylene inhibitor that binds irreversibly to the ethylene receptors in plant tissues (Blankenship and Dole, 2003). Climacteric fruits serve as the predominant target for the investigation of 1-MCP, and the responses of these fruits confirm that the antagonist operates in opposition to ethylene (Huber, 2008). Ethylene management plays a pivotal role in maintaining postharvest life and the quality of horticultural commodities (Mahajan et al., 2014). For highly perishable and fast ripening crops like tropical fruits, ethylene management is key to slowing ripening and gaining flexibility during shipping. The use of in-package 1-MCP technology shows potential to extend distribution and broaden consumer availability of some tropical fruits, as well as reduce food waste by extending the shelf life of these ethylene-sensitive commodities (Hazel Technologies, 2021). In this study, the Hazel Technologies 1-MCP slow-release sachet was evaluated for its effectiveness in extending the shelf life of six tropical fruits. These fruits were mango (*Mangifera indica*), atemoya (*Annona × atemoya*), passionfruit (*Passiflora edulis*), Guatemalan-West Indian hybrid avocado (*Persea americana*), guava (climacteric and nonclimacteric types) (*Psidium guajava*), and Maridol type papaya (*Carica papaya*).

Materials and Methods

The fruits used in this study were harvested at different ripeness stages (chosen as appropriate for each fruit type) and transported from the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Tropical Research & Education Center in Homestead, FL to the Postharvest Laboratory at UF/IFAS in Gainesville. Initial evaluations of ripeness stage and quality were performed. The fruit samples were stored in controlled temperature and humidity storage rooms at the appropriate temperature for each type to avoid chilling injury (Gross et al., 2016), with 85 to 95% relative humidity (RH) maintained unless otherwise noted. In most cases, storage temperature was around 10–15 °C. The fruit in the air control and 1-MCP treatments were kept in separate rooms for the duration of storage. After different storage periods, the fruit were transferred to 20 °C for ripening. The fruit were maintained in their shipping cartons (corrugated, waxed fiberboard with no lid) if available.

Ripening parameters were monitored for control fruit and those treated with 1-MCP during storage until a significant percentage (typically > 25%) of the fruit were judged to be either overripe or unmarketable or when sufficient time had passed to accommodate any conceivable distribution marketing chain duration. Fruit quality was periodically assessed during storage (approximately 1 time per week) by evaluating or measuring appearance, weight changes, firmness, uniformity of external/internal color, soluble solids content (SSC), and total titratable

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Table 1. Effectiveness of Hazel Technology 1-MCP slow-release sachets in extending shelf life of several tropical fruits.

Fruit type	Effective in extending shelf life? (Yes/No)	Shelf life extension with 1-MCP (days or weeks)	Needs more research? (Yes/No)
Atemoya	No	n/a ²	Yes
Avocado	Yes	2–3 weeks	No
Guava (climacteric)	Yes	1–1.5 weeks	No
Guava (nonclimacteric)	No	n/a	No
Mango	Yes	2 weeks	No
Papaya	Yes	1–1.5 weeks	No
Passionfruit	Yes	5 days	Yes

²n/a = not applicable.

acidity (TTA). For visual evaluations and documentation, pictures and notes were taken on visual changes.

Results and Discussion

For mangos, it was determined in preliminary research that one sachet was effective for 4.5 kg or one standard carton of mangos stored at 12 °C. This is a standard that was carried over to the other experiments. The 1-MCP resulted in less green to yellow color changes, less softening, and lower TTA than the control. Anthracnose decay affected the mangos in all treatments and the decay progressed with ripening. Nonuniform ripening was observed. The Hazel 1-MCP sachets were somewhat effective in extending the shelf life of ‘Tommy Atkins’ and ‘Keitt’ mangos by about 2 weeks.

For atemoya, due to their high sensitivity to chilling injury, a ripening temperature of 20°C was selected for this treatment. The treatments for this experiment consisted of 0, 1, or 3 sachets. After 4 days at 20 °C, both the control and 1-MCP-treated fruit showed surface browning and decay, which made them unmarketable. This change revealed that a lower temperature should have been used for the 1-MCP application to mimic shipping conditions. Whether 1 or 3 sachets were more effective could not be concluded. This experiment may be repeated with a larger quantity of fruit and an updated protocol for more accurate results.

For passionfruit, 0, 1, or 3 sachets were used on groups of 10 ‘Ruby Red’ fruit. The sachets showed potential for extending the shelf life. However, similar to the atemoya, this result is based on a small number of fruit and needs to be re-tested on more fruit with an improved experimental protocol. After 6 days of storage at 20 °C, the fruits were evaluated and each treatment (control, 1 sachet, and 3 sachets) developed approximately 20% decay (gram-negative grey mucoid bacteria). Pending availability, this fruit may be tested again.

For avocado, the 1-MCP sachets showed a significant impact in extending the shelf life of multiple varieties of avocado by approximately 2–3 weeks at 7 °C. ‘Choquette’, ‘Arue’, ‘Donnie’, and ‘Booth 8’ avocados were studied during the 2020 and 2021 seasons. From 2–4 sachets were used on each treatment group based on weight. After 14 days of storage, there was a noticeable difference between the control and 1-MCP-treated avocados. The control fruit developed browning and softening while the 1-MCP-treated fruit stayed green with little softening. By day 20, the control fruit were 80% brown and the 1-MCP-treated fruit were still green, though they were starting to soften. From this research, we can say that 1-MCP treatment of avocados can extend their shelf life by 12–20 days depending on the variety and the treated fruit still complete ripening in a normal manner.

For guava, climacteric ‘Para’ guavas stored at 7 °C were studied. The 1-MCP sachets (2 sachets per 24 fruit) were effective in extending the shelf life of these fruit by about 1–1.5 weeks, but were not effective in suppressing decay from Phoma leaf spot and gram-negative white mucoid bacteria. ‘Thai’ and ‘Watermelon’ nonclimacteric guava were also studied but the 1-MCP sachets had minimal effect in extending the shelf life of those fruit because ethylene is not involved in the ripening process. Minimal changes were observed through all methods of fruit quality analysis. After 2 weeks, *Pestalotia* spp. fungus that causes bitter rot was observed in >25% of the fruit.

For papaya, ‘Tainung’ Maridol type papayas were harvested at a range of ripeness stages from mature green to 3/4 color. Prochloraz and thiabendazole (TBZ) fungicides were applied according to label instructions to attempt to prevent anthracnose and other decays. The 1-MCP treatment was 3 sachets per 11–14 fruit (about 14 kg). The papayas were evaluated periodically during storage for 2 weeks at 12 °C. The 1-week evaluation showed 25% decay in 1-MCP-treated fruit while the control had 50% decay. The 2-week evaluation had 41% decay in the 1-MCP-treated papayas compared to 53% decay of the control fruit. Phoma leaf spot and gram-negative white mucoid bacteria were detected. Due to the incidence of decay, it was concluded that Hazel’s 1-MCP sachets were somewhat effective in extending the shelf life by 4–10 days, but without effectively controlling decay.

Conclusions

Overall, Hazel Technology 1-MCP slow-release sachets resulted in slower ripening for treated fruit compared to the control fruit, especially during the first week of storage (Table 1). Irregular and non-uniform ripening was seen in some fruit, but the majority ripened normally if they did not become unmarketable due to decay. No significant differences were measured in SSC, pH, or TTA at the fully ripe stage for any of the fruits tested. Overall, the results confirmed that 1-MCP-treated fruit were eventually able to resume and complete normal ripening. Decay was a significant factor in rendering many fruits unsuitable for further measurement. The 1-MCP sachets had a small effect in inhibiting decay. Anthracnose, Phoma leaf spot, and gram-negative white mucoid bacteria were the most common decay pathogens.

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