

EFFECTS OF AMINOETHOXYVINYGLYCINE AND POSTHARVEST TREATMENT PACKAGE OF PLASTIC WRAPPING, FUNGICIDE PROCHLORAZ, AND LOW TEMPERATURE ON THE FRUIT SHELF-LIFE AND QUALITIES OF 'CALLINA' PAPAYA

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ABSTRACT

'Callina' papaya (*Carica papaya* L.) fruit is a recently released papaya fruit cultivar that dominates domestic markets in Indonesia. Its fruit has a very short shelf-life due to high respiration and transpiration rates. In our previous research, a postharvest treatment package consisting of one-layer plastic wrapping, fungicide Prochloraz 0.67 mL/L, and low temperature of 16-18 °C was able to prolong its shelf-life and maintain its high fruit qualities. By adding an anti-ethylene of aminoethoxyvinylglycine (AVG) to the postharvest package, longer fruit shelf-life can be expected. The purpose of this research was to study the combined effect of the fruit postharvest treatment package and AVG to the shelf-life and qualities of 'Callina' fruit. The study was laid out in a Completely Randomized Design of a 2 x 2 factorial. The first factor was the fruit postharvest treatment package (without and with the package consisting of a single layer plastic wrapping + Prochloraz fungicide 0.67 mL/L + low temperature 16-18 °C) and the second factor was the anti-ethylene AVG (without and with 5 mg/L AVG). The results showed that (1) the fruit postharvest treatment package had a significant effect on the fruit shelf-life of 'Callina' papaya by prolonging the shelf-life of 14 days longer than without the fruit postharvest treatment package, without affecting its fruit qualities, (2) the AVG had no effect on the shelf-life and fruit qualities, and (3) the combination of fruit postharvest treatment package and AVG gave the best result that prolonged its fruit shelf-life up to 16 days longer than the control.

Keywords: AVG, *Carica papaya*, postharvest, Prochloraz, wrapping

INTRODUCTION

Papaya (*Carica papaya* L.) is the original species from Mexico and northern South America, but now it has spread out around tropical and subtropical regions of the world. Currently the domestic market demand for 'Callina' papaya (formerly named 'California' papaya) in Indonesia is increasing. However, its high respiration and transpiration rates result in a quick decrease of its fruit quality and shortening its shelf-life. Therefore, proper storage technology is required in order to prolong its shelf-life and maintain its high fruit quality.

Fruit coating has become a commonly major postharvest technology in fruit industry. Its main effects are lowering O₂ supply to the fruits and transpiration rate, resulting in lengthening fruit shelf-life. However, as the coating time prolongs, temperature and relative humidity around the fruits are increased, favouring disease build-up, especially fungi. Therefore, applying fruit coating (Hai and Uthaibutra, 2015; Huyen and Pankasemsuk, 2018; Thu *et al.*, 2015) is usually accompanied with fun-

gicide and low temperature applications (Widodo *et al.*, 2017).

In our previous research (Widodo *et al.*, 2017), a postharvest treatment package consisting of one-layer plastic wrapping, fungicide Prochloraz 0.67 mL/L, and low temperature of 16-18 °C was able to prolong its fruit shelf-life and maintain its high fruit qualities. Widodo *et al.*, (2017) showed that Prochloraz 0.67 mL/L had no effect on shelf-life and fruit quality, but low storage temperature of 16-18°C and wrapping of fruit with 1 layer of plastic wrapping could extend the shelf-life of the fruit to 12.70 days, without affecting the quality of the fruit. The best effect was obtained when all three factors were applied together that could extend the shelf life of papaya fruit up to 11.20-23.40 days longer than control (Widodo *et al.*, 2017). Low temperature treatment slowed fruit softness, weight loss, color changes, and maintained the organoleptic score of fruit appearance and total sugar content (Bambang and Juniarti, 1998).

The ripening rate of fruit is inseparable from the role of ethylene gas, so it is necessary to inhibit the ethylene action. Aminoethoxyvinylglycine (AVG) is one of the ethylene inhibitors that blocks the production of ethylene released by the fruit. According to Çetinbaş and Koyuncu (2011), AVG can reduce ethylene production and respiration rate in fruit. By adding AVG to the postharvest package, more longer fruit shelf-life can be expected. The purpose of this research was to study the combined effect of the fruit postharvest treatment package and AVG to the shelf-life and qualities of 'Callina' fruit.

MATERIALS AND METHODS

This research was conducted in the Horticultural Postharvest Laboratory, Department of Agronomy and Horticulture, Faculty of Agriculture, University of Lampung, Bandar Lampung, Indonesia, from July to August 2017. Papaya 'Callina' fruit of stage I (green fruit with yellowing spot at peduncle side; Manenoi *et al.*, 2007) was obtained as a fresh harvest from Nusantara Tropical Farm, Co. Ltd., Labuhan Ratu, East Lampung, Indonesia. The fruits were then brought directly to the laboratory, sorted according to size, color and maturity level, and washed by using running water, wiped, and air-dried. After air-dried, the fruits were treated accordingly.

The study was laid out in a Completely Randomized Design in a factorial of 2 x 2, in five replications of one papaya each. The first factor was a fruit postharvest treatment package (without and with the package consisting of one-layered plastic wrapping + fungicide Prochloraz 0.67 mL/L + low temperature 16-18 °C, and the second one was AVG (0 and 5mg AVG/L; Aminoethoxyvinylglycine hydrochloride, PESTANAL®, analytical

standard, SIGMA-ALDRICH). The AVG treated fruit samples received 10 minutes dipping into a solution of 5 mg AVG/L, were air-dried, and then dipped into a fungicide solution of Prochloraz 0.67 mL/L for about 10 seconds, let them air-dried, and then coated with one-layered plastic wrapping (trademark Total' of 300 mm x 500 m x 11 µm). All fruit samples were stored in a cool storage room of 16-18°C, except those of the control treatment that were stored in a storage room of room temperature of 27-28 °C.

The observed variables were fruit weight loss, shelf-life or days of storage (fruit stage changes, observed daily), fruit firmness, soluble solid content (°Brix), free acid content, and sweetness level (°Brix/free acid content). Observations were discontinued when the papaya fruit color reached full ripening stage (stage IV, fully reddish orange). The °Brix value was measured with an Atago 'N-1E hand-refractometer, firmness was analyzed with a penetrometer (FHM-5 type penetrometer, 5 mm in diameter, Takemura Electric Work, Co. Ltd., Japan), and free acid was titrated with 0.1 N NaOH and phenolphthalein as an indicator. All data were analyzed with ANOVA, and further tested with Least Significant Difference at 5%.

RESULTS AND DISCUSSION

The fruit package treatment was able to extend the fruit shelf-life of 'Callina' papaya by 14 days longer than the control (Table 1). This result was similar to Widodo *et al.*, (2017). The use of plastic wrapping could suppress fruit respiration rate due to decreased concentration of O₂ and increased CO₂ concentration around the fruit so that it slowed the ripening process of the fruit.

Table 1: Effects of a combination of fruit postharvest treatment package and aminoethoxyvinylglycine (AVG) on fruit shelf-life, weight loss, firmness, soluble solid content (°Brix), free acid content, and sweetness level of 'Callina' papaya fruit

Treatments	Shelf-life (days)*	Weight loss (%)*	Firmness (kg/cm ²)*	°Brix (%)*	Free acid (g/100 g)*	Sweetness level*
Package (P):						
Control (P0)	6.60±2.41 b	5.04±3.21 a	5.29±1.50 b	9.46±1.62 a	0.14±0.04 a	75.04±25.28 a
Package (P1)	20.20±3.91 a	4.81±0.72 a	10.38±4.80 a	9.14±1.35 a	0.11±0.04 a	97.54±37.36 a
AVG (A):						
Control (A0)	12.20±6.71 a	5.14±3.16 a	7.48±3.49 a	9.17±1.62 a	0.12±0.04 a	82.97±33.79 a
5 mg AVG/L (A1)	14.60±8.69 a	4.71±0.90 a	8.19±5.22 a	9.43±1.36 a	0.12±0.05 a	89.61±33.92 a
Package x AVG:	**P = 0.0376	**P = 0.3985	**P = 0.1375	**P = 0.3800	**P = 0.4717	**P = 0.3300
P0A0	6.80±3.92 c	5.73±4.54 a	6.16±1.55 b	9.02±2.26 a	0.14±0.04 a	64.40±19.29 a
P0A1	6.40±0.94 c	4.36±1.21 a	4.43±0.88 b	9.90±0.56 a	0.13±0.05 a	85.68±27.99 a
P1A0	17.60±4.04 b	4.56±0.99 a	8.80±4.54 ab	9.32±0.84 a	0.10±0.03 a	101.55±36.52 a
P1A1	22.80±1.10 a	5.06±0.18 a	11.96±5.01 a	8.96±1.81 a	0.11±0.06 a	93.53±42.04 a

*The values in the same columns followed by the same letter were not significantly different according to 5% LSD test; Sweetness level was °Brix/free acid content ratio; **Probability values generated with ANOVA test; Fruit firmness, °Brix, free acid content, and sweetness level at 0 day storage were 20.10 kg/cm², 6.82%, 0.09 g/100 g, and 85.81, consecutively.

According to Maniwaru *et al.*, (2015), low density polyethylene plastic (LDPE) suppressed the respiration rate after 1 day of application. Maniwaru *et al.*, (2015), also mentioned that the application of LDPE with low temperature consistently lowered the rate of respiration along with the decreasing temperature. Research by Hamaisa *et al.*, (2007) showed that the average rates of CO₂ production of papaya stored at low temperatures of 10 and 15 °C were lower than at room temperature by 4.46, 10.68 ml of CO₂/kg/hour, compared to 22.62 ml of CO₂/kg.hour at room temperature. Low temperature 16-18 °C of the fruit treatment package might not only lowering the rate of fruit respiration (Hamaisa *et al.*, 2007; Maniwaru *et al.*, 2015) but also inhibiting fungus growth (Baloch *et al.*, 2018).

The fruit treatment package significantly affected the fruit firmness by 5.11 kg/cm² harder than the control. This suggested that the use of plastic wrapping and low temperature storage suppressed the respiration rate of the fruit so as to prolong the shelf-life of the fruit. According to Johansyah *et al.*, (2014), packaging using plastic wrapping resulted in higher CO₂ concentrations than O₂ that resulted in low fruit respiration. Low fruit respiration slowed the fruit ripening so that the softening of the fruit was inhibited.

A single AVG treatment of 5 ppm did not significantly affect the shelf-life of the 'Callina' papaya (Table 1). This might because the concentration of AVG used was too low. Tarabih (2014) study showed that the use of AVG 200 ppm in 'Le Conte' pears stored in cold temperatures reduced ethylene production, thus delaying ripening and prolonging the shelf-life of the fruit. Similarly, Candir (2016) studied with 1000 mg/L AVG application at 20 °C, resulted in a decreased ethylene production and extending tomatoes 6 to 8 days to ripe.

Table 1 shows that AVG single treatment did not affect the fruit weight loss, firmness and other fruit quality variables of 'Callina' papaya fruit. According to Widodo *et al.* (2016), it was suspected that AVG affected only the ethylene biosynthesis and did not affect transpiration. This low AVG concentration (Tarabih, 2014; Candir, 2016) might also result in the insignificant effects on fruit quality variables (Table 1).

Table 1 shows that treatment combinations with fruit treatment packages, both fruit treatment packages with AVG (P1A1) and without AVG (P1A0), increased significantly the shelf-life of the 'Callina' papaya. This was due to a single factor of the treatment package that was able to extend the shelf-life of the 'Callina' papaya. The best result was found in the combination treatment between

the fruit treatment package and AVG (P1A1) which could extend the shelf-life 16 days longer than the control.

The fruit treatment package and its combination with AVG generally did not affect the quality of the papaya fruit (Table 1). These results were similar to those reported by Widodo *et al.* (2017).

CONCLUSION: The results showed that (1) the fruit postharvest treatment package had a significant effect on the fruit shelf-life of 'Callina' papaya by prolonging the shelf-life of 14 days longer than without the fruit postharvest treatment package, without affecting its fruit qualities, (2) the AVG had no effect on the shelf-life and fruit qualities, and (3) the combination of fruit postharvest treatment package and AVG gave the best result that prolonged its fruit shelf-life up to 16 days longer than the control.

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