EFFECTS OF 1-METHYLCLOPROPENE AND POSTHARVEST TREATMENT PACKAGE OF PLASTIC WRAPPING, FUNGICIDE PROCHLORAZ, AND LOW TEMPERATURE ON THE FRUIT SHELF-LIFE AND QUALITIES OF 'CALINA' PAPAYA

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Abstract. 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 fruit shelf-life and mantain high fruit qualities of 'Calina' papaya. By adding an anti-ethylene of 1-methylclopropene (1-MCP) to the postharvest package, more longer fruit shelf-life can be expected. This research was aimed at studying the combined effect of the fruit postharvest treatment package and 1-MCP to the shelf-life and qualities of 'Calina' fruit. The study was laid out in a Completely Randomized Design in a factorial of 2 x 3. The first factor was a fruit postharvest treatment package (without and with the fruit postharvest treatment package), and the second one was 1-MCP (0, 2, and 4 grams/30 mL). The results showed that (1) postharvest treatment package applied was able to extend significantly the shelf-life of 'Calina' papaya fruit up to 15.33 days longer than the control, (2) the single application of 1-MCP did not significantly affect its fruit shelf-life and chemical qualities, but it tended to slow down fruit softening, and (3) there was no interaction between the two factors with the significant effect of the postharvest treatment package was dominating.

INTRODUCTION

The demand for the domestic 'Calina' (formerly named 'California') papaya market is increasing. Based on data from the Indonesian Central Bureau of Statistics [1], papaya production in 2015 was 851.532 tons, increased by1.36% compared to 2014 and papaya export reached 15.394 kg. The obstacle faced is to reach the consumers takes a long time and result in the quality of fruit gradually decreases, whereas the shelf life of papaya 'Callina' is very short and fruit quality changes are fast. Therefore, appropriate postharvest handling is needed to slow the quality change of the 'Calina' papaya fruit.

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In our previous research [2], 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 mantain its high fruit qualities. [2] 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 [2].

Plastic wrapping treatment is an economically easy-to-use technology of postharvest

handling that is common to horticultureal products. It is the most effective coating for minimizing storage losses, not only for inhibiting water loss, but also capable of decreasing respiration rate, so that the fruit shelf-life can be lengthened and fruit qualities can be maintained high. [3] showed that eventhough as a sole application 1.25% chitosan and one-layer plastic wrapping did not significantly affect papaya fruit shelf-life, they were generally best as a postharvest handling of 'Calina' papaya fruits to maintain high fruit qualities. Their combination lengthened its shelf-life up to about 21 days storage, or about 14 days longer than the control. Other fruit quality variables (fruit weight loss, °Brix, acidity, °Brix/acid ratio or sweetness level, and firmness) were significantly slowed down due to these treatment combination. Based on the research of [4], low temperature treatment slowed fruit softness, weight loss, color changes, and maintained the organoleptic score of fruit appearance and total sugar content. Fruit ripening can not be separated from the role of ethylene gases that affect the ripening rate. Inhibition of ethylene can be done using 1-MCP (1-methylclopropene). 1-methylchyclopropane is an anti-ethylene having a special mode of action to block responses of ethylene so that ripening signals cannot be generated [5, 6].

This research was aimed at studying the effect of combination of fruit treatment package consisting of 1 layer of plastic wrapping, Prochloraz fungicide 0.67 mL/L, and low temperature 16-18 °C with 1-MCP anti-ethylene compound on the shelf-life and quality of 'Calina' papaya fruit.

MATERIALS AND METHODS

This research was conducted in the Laboratory of Horticultural Postharvest, Faculty of Agriculture, University of Lampung, Bandar Lampung, Indonesia, from July to August 2017. The study was laid out in a Completely Randomized Design in a factorial of 2 x 3, 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 1-MCP (0, 2, and 4 grams MCP powder/30 mL).

1-MCP was given in solution by dissolving 1-MCP powder into water, as much as 2.0 g and 4.0 g of 1-MCP powder/30 ml of water. This solution released 1-MCP gas, which was based on the recommendation of the Hefei Chesen BioChem Co., Ltd. (No.470, Qianshan Road, Hefei city, China), was enough to treat the fruit samples used in the study. 1-MCP gassing was treated to the fruit samples for 24 hours in an 80 L air-tight container. The 1-MCP treated fruit samples were 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 storage room of room temperature 27-28 °C.

Observations were made before applying treatment and at the end of the observation. 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 color changes of papaya fruit reached full ripening stage (stage IV, fully reddish orange). ºBrix 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 phenolphthalene as an indicator. All data were analyzed with ANOVA, and further tested with Least Significant Difference at 5%.

RESULTS AND DISCUSSION

The results showed that the postharvest treatment package (consisted of one-layer plastic wrapping, fungicide Prochloraz 0.67 mL/L, and low temperature storage of 16-18 °C) had a significant effect on the 'Calina' papaya fruit shelf-life (Table 1). The postharvest treatment package increased the shelf life of the 'Calina' papaya 15.34 days longer than the control treatment, with its physical and chemical qualities unaffected (Table 2). This indicated that the treatment was able to decrease

respiration rate of the 'Calina' papaya fruit. This result reconfirmed our previous research [2] that the postharvest treatment package lengthened fruit shelf-life by 11.20-23.40 days longer.

TABEL 1

EFFECT OF A COMBINATION OF 1-METHYLCLOPROPENE (1-MCP) AND A FRUIT POSTHARVEST TREATMENT PACKAGE ON THE FRUIT SHELF-LIFE, WEIGHT LOSS, AND FIRMNESS OF 'CALLINA' PAPAYA

Treatment	Shelf-life (days)*	Weight loss (%)*	Firmness (kg/cm^2)*
Package (P)**:			
Without (P0)	7.13 b	6.23 a	20.94 a
With package (P1)	22.47 a	6.02 a	19.39 a
1-MCP:			
Control (M0)	14.70 a	6.13 a	14.11 a
MCP 2 grams/30 mL (M1)	14.20 a	5.26 a	19.01 a
MCP 4 grams/30 mL (M2)	15.50 a	6.99 a	27.37 a
Package x MCP:			
P0M0	6.20 b	5.96 ab	10.25 b
P0M1	6.00 b	4.73 b	17.75 ab
P0M2	9.20 b	8.00 a	34.82 a
P1M0	23.20 a	6.30 ab	17.96 ab
P1M1	22.40 a	5.79 ab	20.27 ab
P1M2	21.80 a	5.97 ab	19.92 ab

*Values in the same column of each treatment followed with the same letters were not significantly different at LSD 5%; *The fruit postharvest treatment package consisted of one-layer of plastic wrapping, Prochloraz fungicide 0.67 mL/L, and low temperature storage of 16-18 °C; Fruit firmness at 0 day storage was 20.10 kg/cm^2.

Amongs fruit coating practices, plastic wrapping is known as a common practice in postharvest handling of horticultural products. It functions as a physical barrier to O_2, CO_2, and water vapour by developing a modified athmospheric condition which promotes low respiration and transpiration rates [7, 8, 9]. Fungicide Prochloraz is still needed when longer fruit shelf-life is demanded. [10] reported that as ripening progresses, lengthening fruit shelf-life might increase the risk of pathogen buildup. It needs 6-12 days incubation periods for pathogen buildup [11, 12]. Among coating materials, unfortunately, chitosan and sugar-esther blend of KD-112 failed to act as biofungicides to antraknosa [*Colletotrichum gloeosporioides* (Penz.) Sacc] [13, 14]. Lower temperature storage during postharvest handling might extended fruit shelf-life due to decreased metabolic processes such as respiration and ethylene production [8, 9].

Single treatments of 1-MCP did not affect fruit shelf-life, and most fruit physical and chemical qualties (Tables 1 and 2). The 1-MCP treatment showed a tendency to lengthen fruit shelf-life and to decrease fruit softening, especially the 1-MCP of 4 gram/30 mL (M2). Difficulties in receiving papaya fruits of homogenous maturity might caused these unsignificant results.

1-MCP application inhibits ripening by deactivating the ethylene receptor [15]. In this study, the ineffectiveness of 1-MCP application might because ethylene receptors that had been bound by 1-MCP might be replaced by new receptor synthesis and the receptor may be bound by ethylene back

[16]. This was also the case in the research by [17] which caused the roses remained withered. [18] also said that 1-MCP concentrations should be appropriate to meet the receptor and treatment must be in a long enough time so that the gas could penetrates the plant tissue. In addition, [6] reported that the efficacy of 1-MCP in delaying ripening of partially ripened bananas is too inconsistent for commercial application. The treatments influenced differently in different stages [19]. [20] reported that 1-MCP significantly retarded the softening process of fruit when administered early before ethylene treatment.

TABEL 2

EFFECT OF A COMBINATION OF 1-METHYLCLOPROPENE (1-MCP) AND A FRUIT POSTHARVEST TREATMENT PACKAGE ON THE FRUIT SOLUBLE SOLID CONTENT, FREE ACID CONTENT, AND SWEETNESS LEVEL OF 'CALLINA' PAPAYA

Treatment	Soluble solid content (°Brix, %)*	Free acid content (g/100 g)*	Sweetness level*
Package (P)**:			
Without (P0)	8.75 a	0.11 a	86.41 a
With package (P1)	8.73 a	0.13 a	88.51 a
1-MCP:			
Control (M0)	9.56 a	0.15 a	75.66 a
MCP 2 gram/30 mL (M1)	8.98 ab	0.12 ab	89.02 a
MCP 4 gram/30 mL (M2)	7.67 b	0.09 b	97.69 a
Package x MCP:			
P0M0	8.92 ab	0.12 b	78.51 ab
P0M1	9.76 ab	0.11 b	97.52 ab
P0M2	7.56 b	0.10 b	83.21 ab
P1M0	10.20 a	0.19 a	72.81 b
P1M1	8.20 ab	0.13 ab	80.53 ab
P1M2	7.78 b	0.08 b	112.18 a

*Values in the same column of each treatment followed with the same letters were not significantly different at LSD 5%; **The fruit postharvest treatment package consisted of one-layer of plastic wrapping, Prochloraz fungicide 0.67 mL/L, and low temperature 16-18 °C; Sweetness level = °Brix/free acid ratio; Fruit soluble solid content, free acid content, and sweetness level at 0 day storage were 6.82%, 0.09 g/100 g, and 85.81, consecutively.

The combined postharvest treatment package with 1-MCPs did not affect significantly the variables measured. The significant effect of postharvest treatment package determined significantly the combined treatments, with the fruit physical and chemical qualties were mostly unaffected (Tables 1 and 2).

CONCLUSION

The results showed that (1) postharvest treatment package applied was able to extend significantly the shelf-life of 'Callina' papaya fruit up to 15,33 days longer than the control, but did not significantly affect its fruit qualities, (2) the single application of 1-MCP did not significantly affect its fruit shelf-life and chemical qualities, but it tended to slow down fruit softening, and (3) there was no interaction between the two factors with the significant effect of the postharvest treatment package was dominating.

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