

Effects of 1-Methylcyclopropene, Plastic Wrapping, and Storage Temperature on Fruit Shelf-life and Qualities of 'Crystal' Guava

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Abstract – 'Crystal' guava fruit is economically important and freshly sold in Indonesian markets. It's very thin skin and climacteric-typed fruit make its shelf-life short and its fruit qualities quickly decreased due to high transpiration and respiration rates. 1-methylcyclopropene (1-MCP) is one of anti-ethylene that is believed to block responses to ethylene so that fruit ripening is hindered. By its applied combination with one-layer plastic wrapping and lower storage temperature, lengthened shelf-life and maintained high fruit quality are expected to be accomplished. The objectives of this research were to study the effects of application of 1-MCP, plastic wrapping, storage temperatures, and their interactions on the shelf-life and qualities of 'Crystal' guava fruits. The results showed that while the one-layer plastic wrapping significantly lengthened the fruit shelf-life of more than 11.75 days, decreased fruit weight loss, and maintained high fruit qualities, the applications of 1-MCP and lower storage temperature of 20 °C did not significantly affect the fruit shelf-life and qualities of 'Crystal' guava. No interaction was found among treatments applied. In fact, the significant effect of coating with one-layer plastic wrapping simply dominated over the other treatments.

1. INTRODUCTION

'Crystal' guava is one of many guava cultivars cultivated in Indonesia. Its fruits are economically important and freshly sold in Indonesian markets, and consumed as a fresh-salad fruit. With high respiration and transpiration rates, they are quickly deteriorated by developing brown spots and shrunked skin due to water loss. Therefore, they are usually sold in a one-layer plastic wrapping. Plastic wrapping is widely known to be a good fruit coating for many fruits [1-6].

A longer shelf-life is expected by combined applications of 1-methylcyclopropene (1-MCP) with other treatments, such as plastic wrapping and low storage temperature. 1-MCP is used to block tissue responses to ethylene so the fruit ripening process is delayed [7-11]. Plastic wrapping will function as a physical barrier to O₂, CO₂, and H₂O so that both respiration and transpiration rates are decreased. Consequently, fruit weight loss will be prevented, and internal and external fruit qualities are maintained longer [12, 13]. A low storage temperature usually causes longer fruit shelf-life by decreasing enzyme activities which are involved in respiration [14, 15].

The objectives of this research were to study the effects of application of 1-MCP, plastic wrapping, storage temperatures, and their interactions on the shelf-life and qualities of 'Crystal' guava fruits.

2. METHODS

2.1 Materials

This research was conducted on September-October 2014. 'Crystal' guava fruits of pale-green stage were received directly from Nusantara Tropical Farm, Co. Ltd., Way Jepara, East Lampung, Indonesia. Other materials were 1-methylcyclopropene (pure grade in white powder) and LDPE plastic wrapping (Cling-wrap®).

2.2 Procedures

Treatments were arranged in a completely randomized design with three replications and laid out in a 2 x 2 x 2 factorial design. The replications were applied to each experimental unit consisting of one fruit each. The first factor was 1-MCPs (without and with 1-MCP), the second factor was plastic wrapping (without and with one-

layer of plastic wrapping), and the third factor was storage temperatures (a room temperature of 28 °C and a lower one of 20 °C).

1-MCP gassing was developed by diluting 0.5 gram 1-MCP in 30 mL of water. Gassing was applied 24 hours to fruits in an 82 L of air-tight plastic chamber [16, 17]. 1-MCP-treated fruits were then individually wrapped, and placed in storage rooms of a room temperature of 28 ± 1 °C and a lower one of 20 ± 1 °C.

Observations were made on fruit shelf-life, weight loss, firmness (with a penetrometer typed FHM-5, with a cylindrical point of 5 mm in diameter of Takemura Electric Work, Ltd., Japan), °Brix (with an Atago N-1E hand refractometer), free acid content or acidity (titrated with 0.1 N NaOH and phenolphthalein as an indicator), and sweetness level (°Brix/acidity ratio). The observation were terminated if the fruits showed significantly decreasing qualities such as browning and/or shrunked-skin due to water loss. All data were analyzed with ANOVA, and further tested with Least Significantly Difference (LSD) at 5%,.

3. RESULTS AND DISCUSSION

The results (Table 1) showed that while both 1-MCP and lower temperature storage of 20 °C did not affect fruit shelf-life of ‘Crystal’ guava, coating with one-layer plastic wrapping significantly lengthened it by 11.75 days more than the control. The result that one-layer plastic wrapping significantly lengthened fruit shelf-life but did not significantly affect °Brix, acidity, sugar/acid ratio, and fruit firmness, said that plastic wrapping significantly lengthened fruit shelf-life and maintained fruit qualities. The guava fruit response to plastic wrapping was a common response in other fruits [1-6, 19, 20].

Table 1 Effects of 1-methylcyclopropene, plastic wrapping, and storage temperature on fruit shelf-life, weight loss, °Brix, acidity, sweetness level, and firmness of ‘Crystal’ guava*

Treatments	Shelf-life (days)	Weight loss (%)	°Brix (%)	Acidity (mg/100 g)	Sugar/acid ratio	Fruit firmness (kg/cm ²)
1-MCP (M):						
Without (M0)	11.75 a	24.64 a	9.88 a	0.72 a	14.41 a	17.46 a
With (M1)	11.33 a	25.47 a	10.75 a	0.73 a	15.31 a	16.42 a
Plastic wrapping (P):						
Without (P0)	5.67 a	33.41 a	10.97 a	0.73 a	16.13 a	18.03 a
With (P1)	17.42 b	16.69 b	9.67 a	0.72 a	13.59 a	15.85 a
Temperature (T):						
Room (T0)	10.75 a	21.44 b	9.98 a	0.74 a	13.73 a	16.91 a
Lower (T1)	12.33 a	28.67 a	10.65 a	0.70 a	15.99 a	16.97 a
M x P:						
M0P0	5.50 b	32.26 a	10.43 a	0.73 a	15.49 a	18.90 a
M0P1	18.00 a	17.02 b	9.33 a	0.70 a	13.33 a	16.02 b
M1P0	5.83 b	34.57 a	11.50 a	0.73 a	16.78 a	17.16 ab
M1P1	16.83 a	16.37 b	10.00 a	0.73 a	13.84 a	15.68 b
M x T:						
M0T0	10.33 a	20.10 a	9.10 a	0.76 a	12.53 a	17.16 a
M0T1	13.17 a	29.18 a	10.67 a	0.67 a	16.29 a	17.76 a
M1T0	11.17 a	22.78 a	10.87 a	0.73 a	14.92 a	16.65 a
M1T1	11.50 a	28.16 a	10.63 a	0.73 a	15.70 a	16.19 a
P x T:						

P0T0	6.17 c	28.65 b	9.73 ab	0.79 a	12.83 b	17.69 a
P0T1	5.17 c	38.17 a	12.20 a	0.67 b	19.44 a	18.41 a
P1T0	15.33 b	14.22 d	10.23ab	0.70 ab	14.62 b	16.16 a
P1T1	19.50 a	19.16 c	9.10 b	0.73 ab	12.55 b	15.54 a

*Values in the same column of each treatment or its combination followed with the same letters were not significantly different at LSD 5%. Values of °Brix, acidity, sweetness (sugar/acid ratio), and fruit firmness at 0 day-storage were 9.2%, 0.92 mg/100 g, 10.90, and 16.97 kg/cm², consecutively.

The data showed that 1-MCP did not significantly affect fruit shelf-life and qualities of ‘Crystal’ guava (Table 1). There might three possible causes responsible for the result. Firstly, 1-MCP was mainly used to block tissue responses to ethylene [7-11], but it did not directly affect respiration and transpiration, so that fruit deterioration was not significantly affected. Secondly, 1-MCP gas released by diluting 0.5 g pure 1-MCP-containing powder into 30 ml water might be still considerably low to hinder fruit ripening significantly if it was compared to [21] who applied 1 ppm 1-MCP gas. Thirdly, tissue sensitivity is one factor that should be considered during hormone applications [Davies, 1987] so that while ‘Crystal’ guava fruit tissues did not respond well, the same concentration of 1-MCP applied to ‘Mutiaru’ guava fruits significantly affected its shelf-life [17].

Low storage temperature of 20 °C (T1) applied to ‘Crystal’ guava fruits did not significantly affect fruit shelf-life (Table 1). The temperature of 20 ± 1 °C was the lowest possible temperature in the storage room of 5.8 x 2.8 x 3.15 m³ with two ACs, one humidifier, and one thermohygrometer. This relatively low storage temperature did not seem to be sufficiently low to suppress ‘Crystal’ guava fruit respiration because other researcher reported that 10 °C storage temperature lengthened guava fruit shelf-life of 15 days more compared to 27 °C [23].

While low storage temperature in this research did not affect fruit shelf-life and other fruit quality variables (Table 1), low storage temperature of 20 °C applied was turned out to increase fruit weight loss. This increase in fruit weight loss was merely due to unexpectedly lower relative humidity developed in the lower temperature room that might promote higher transpiration or water loss. Our data showed that relative humidity developed in the lower temperature room of 20 °C was 43% that was significantly lower than that in the other room of 28 °C that was recorded 56%. Other researcher reported that 80% relative humidity was needed for a room of 8 °C, and a minimum 60-70% relative humidity had to be maintained in the room of 25-28 °C to avoid excessive water loss [24].

Plastic wrapping is a common practice for coating horticultural products with the main objectives are to prolong shelf-life and to maintain high quality products during storage up to their consumers. It works by developing a modified atmospheric condition of low O₂ and high CO₂ that decreases respiration rate, and by providing a physical barrier to water loss [18]. With these functions, the fruit shelf-life of ‘Crystal’ guava was significantly lengthened of about 12 days more and its fruit qualities (°Brix, acidity, sugar/acid ratio, and fruit firmness) were maintained unchanged significantly compared to the control (Table 1). Similar results were reported by [19, 20].

No interaction was found among treatments applied. In fact, that significant effect of coating with one-layer plastic wrapping simply dominated the effects of two (Table 1) and three combination factors (not shown). Similar result was reported by [25] who got significant result when LDPE plastic wrapping was applied with atmospheric gases of 5% O₂ + 10% CO₂ and low storage temperature of 6 °C. Its significant result [25] was simply because of the effect of LDPE plastic wrapping that dominated over the other treatments.

4. CONCLUSION

The results showed that while the one-layer plastic wrapping significantly lengthened the fruit shelf-life of more than 11.75 days, decreased fruit weight loss, and maintained high fruit qualities, the applications of 1-MCP and lower storage temperature of 20 °C did not significantly affect the fruit shelf-life and qualities of ‘Crystal’ guava. No interaction was found among treatments applied. In fact, that significant effect of coating with one-layer plastic wrapping simply dominated over the other treatments.

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