POSTHARVEST PACKAGE OF SUGAR-ESTHER BLEND KD-112 AND PLASTIC WRAPPING APPLIED TO MANGOSTEEN FRUIT AT RIPENING STAGE 3 IN AFFECTING FRUIT SHELF-LIFE AND QUALITIES

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Abstract. For an export demand, mangosteen is commonly harvested when its rind color is reddish pink (stage 3). Having very thick rind, it is believed that mangosteen can survive from a high transpiration rate. Therefore, its fruit hardly receives any postharvest technology to lengthen its fruit shelf-life and maintain its high fruit qualities. This research was aimed at studying the effects of postharvest package of sugar-esther blend KD-112 and plastic wrapping applied to mangosteen fruit at ripening stage 3 in affecting fruit shelf-life and qualities. This study used a Completely Randomized Design, arranged in factorial 3 × 2. The first factor was KD-112 concentration (0, 7, and 14%), and the second one was plastic wrapping (without and with one-layer plastic wrapping). The results showed that (1) KD-112 prolonged significantly fruit shelf-life and slowed down softening, with the best result was shown by 14% KD-112 that significantly prolonged fruit shelf-life by 7.83 days longer; (2) plastic wrapping significantly prolonged fruit shelf-life by 4.83 days longer; (3) the two factors were significantly interacted with the best treatment combination was shown by 14% KD-112 and plastic wrapping which prolonged fruit shelf-life by 12.50 days longer than control with fruit qualities were mostly unaffected.

INTRODUCTION

Mangosteen (*Garcinia mangostana* Linn.) is one of the most popular tropical fruit commodities. Modern knowledge and technology are needed for the availability of mangosteen with a quality that suits the needs of its market. Packaging and storage technology becomes a must in maintaining the mangosteen so that it is not easily damaged and has a long shelf-life to meet consumer demand. Good packaging is an absolute requirement to reduce the extent of damage to the mangosteen fruit during transport and storage and make the product appears more attractive. Packaging materials used should be economical and easy to obtain.

Good quality is obtained by harvesting according to the appropriate fruit maturity level. Harvesting before reaching full maturity will result in poor quality fruits and an incomplete ripening process. Conversely delay of harvest time will increase the rate of damage to the fruit, so the quality and selling value decreases.

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Mangosteen is commonly harvested when its rind color changes to reddish pink (stage 3)[1]. Due to its very thick rind, it is believed that mangosteen can survive from a high transpiration rate that causes to fruit deterioration. Therefore, its fruit hardly receives any postharvest technology to lengthen its fruit shelf-life and maintain its high fruit qualities. This research was aimed at studying the effects of postharvest package of sugar-esther blend KD-112 and plastic wrapping applied to mangosteen fruit at ripening stage 3 in affecting fruit shelf-life and qualities.

MATERIALS AND METHODS

The research was conducted in the Laboratory of Horticultural Postharvest, Department of Agrotechnology, Faculty of Agriculture, University of Lampung from July to August 2017. Mangosteen fruits of ripening stage 3 were obtained from Mulang Maya village, Kota Agung, Tanggamus district, Lampung province, Indonesia.

The mangosteen fruits of stage 3 (reddish pink)[1] were harvested and immediately taken to the Laboratory of Horticultural Postharvest, Faculty

of Agriculture, Lampung University, Bandar Lampung, Lampung, Indonesia cleaned from sap by using a towel/napkin, sorted by size and uniform maturity level, and immediately treated in accordance to the treatment.

This study used a Completely Randomized Design with six replicates of one fruit each, arranged in a factorial 3 × 2. The first factor was sugar-esther blend of KD-112 concentration (0, 7, and 14%), and the second one was plastic wrapping (control/without and with one layer of plastic wrapping). A quick fruit dipping into the KD-112 solution was done for ± 10 seconds, until the fruit was completely coated, let them air-dried [2], and then packed with one-layer plastic wrapping (trademark Total' of 300 mm x 500 m x 11 μm). Samples of mangosteen fruit were put into a storage room with room temperature of 27-28 °C.

The variables used were fruit weight loss, days of storage (fruit stage changes, observed daily), fruit firmness, soluble solid contentt (°Brix), and free acid content. Observation was stopped if the skin color of mangosteen fruit has reached stage VI (purple black) [1]. Fruit firmness was measured with a penetrometer (type FHM-5, 5 mm diameter of cylindrical tip; Takemura Electric Work, Ltd., Japan), soluble solid content (°Brix) was be measured with an 'Atago' hand refractometer at room temperature, without dilution. Measurements of free acid content were carried out with a titration with 0.1 N NaOH and phenolphthalein as indicator. All data were analyzed with ANOVA, and further tested with Least Significant Difference at 5% (Statistix 9).

RESULTS AND DISCUSSION

The sugar-esther blend KD-112 of both 7 and 14% significantly increased mangosteen shelf-life by 6.67-7.83 days longer than the control and inhibited significantly fruit softening (Table 1). While the fruit firmness of the control decreased from 14.20 kg/cm^2 at 0 day storage to 8,87 during 9.75 days storage, the firmness of KD-112 treated fruits were almost unchanged during 16-18 days storage. These indicated that the sugar-esther blend KD-112 decreased respiration rate of the mangosteen fruits so that fruit shelf-life was lengthened and fruit softening was slowed down. [3] stated that the main effect of sugar esther application was decreasing respiration, transpiration, and ethylene production

Similar to KD-112, the use of one-layer plastic wrapping increased significantly fruit shelf-life by 4.83 days longer than the control, however, plastic wrapping did not significantly affect fruit weight loss and firmness compared to the control (Table 1). This indicated that the respiration rate was decreased due to decrease in O_2/CO_2 movement accross the coating [3, 4, 5]. [6] stated that coating fruit with sucrose polester was able to slow fruit ripening and to inhibit fruit softening by decreasing respiration rate and ethylene production.

The sugar-esther blend of KD-112 did not interacted with one-layer plastic wrapping in effecting fruit shelf-life and other variables measured (Tables 1 and 2). Their combination effects were just combination effects of their individually significant effects with the best effects were shown by combinations of both KD-112 concentrations with one-layer plastic wrapping (K1W1 and K2W1). Their combinations were able to lengthen the mangosteen fruit shelf-life by 11.00-12.50 days longer than the control (Table 1). By considering lower fruit weight loss and slower fruit softening caused by K2W1 compared to K1W1 and higher soluble solid content (°Brix) caused by 14% KD-112 (K2) compared to 14% KD-112 (K1), therefore, it was better to use a combination of 14% KD-112 coating and one-layer plastic wrapping as it increased the shelf life by 12.50 days longer compared to the control. This was similar with a recomendation by [2] for coating 'California' papaya. However, because KD-112 does not possess any biopesticide function, even in *in-vitro* condition [7], its application should be accompanied with a biopesticide, such as Perchloraz (imidazole carboxamide) [8], that is a common practice in the fruit producing horticultural industries.

CONCLUSION

The results showed that (1) KD-112 prolonged significantly fruit shelf-life and slowed down softening, with the best result was shown by 14% KD-112 that significantly prolonged fruit shelf-life by 7.83 days longer than control, with most other fruit qualities unaffected; (2) one-layer

plastic wrapping significantly prolonged fruit shelf-life by 4.83 days longer than control with most fruit qualities unaffected; (3) The two factors were not significantly interacted in effecting fruit shelf-life and other variables measured. Their combination effects were just combination effects of their individually significant effects with the best effects were shown by combinations of 14% KD-112 coating and one-layer plastic wrapping as it increased the fruit shelf life by 12.50 days longer compared to the control.

TABEL 1

EFFECTS OF SUGAR-ESTHER BLEND KD-112 AND PLASTIC WRAPPING APPLIED TO MANGOSTEEN FRUITS HARVESTED AT RIPENING STAGE 3 ON FRUIT SHELF-LIFE, WEIGHT LOSS, AND FIRMNESS

Treatment	Shelf-life (days)*	Weight loss (%)*	Firmness (kg/cm^2)*
KD-112 (K):			
KD-112 0% (K0)	9.75 b	11.06 a	8.87 b
KD-112 7% (K1)	16.42 a	12.61 a	15.41 a
KD-112 14% (K2)	17.58 a	13.91 a	14.45 a
Plastic Wrapping (W):			
Without (W0)	12.17 b	13.25 a	13.00 a
1 Layer (W1)	17.00 a	11.81 a	12.82 a
KD-112 x Plastic Wrapping:	P = 0.7047**	P = 0.3685**	P = 0.4209**
K0W0	8.00 c	11.64 ab	9.92 ab
K0W1	11.50 bc	10.48 b	7.82 b
K1W0	13.83 b	12.17 ab	16.47 a
K1W1	19.00 a	13.05 ab	14.36 ab
K2W0	14.67 b	15.92 a	12.62 ab
K2W1	20.50 a	11.89 ab	16.28 ab

*The values in the same columns followed by the same letter were not significantly different according to 5% LSD test; **Probability values generated with ANOVA test; Fruit firmness at 0 day storage was 14.20 kg/cm^2.

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TABEL 2

EFFECTS OF SUGAR-ESTHER BLEND KD-112 AND PLASTIC WRAPPING APPLIED TO MANGOSTEEN FRUITS HARVESTED AT RIPENING STAGE 3 ON SOLUBLE SOLID CONTENT (°BRIX), FREE ACID CONTENT, AND SWEETNESS LEVEL

Treatment	°Brix (%)*	Free acid (g/100 g)*	Sweetness level*
KD-112 (K):			
KD-112 0% (K0)	15.75 a	0.56 a	32.12 a
KD-112 7% (K1)	13. 92 a	0.47 a	36.62 a
KD-112 14% (K2)	15.67 b	0.54 a	34.78 a
Plastic Wrapping (W):			
Without (W0)	15.22 a	0.59 a	28.13 a
1 Layer (W1)	15.00 a	0.45 b	40.88 a
KD-112 x Plastic Wrapping:	P = 0.5472**	P = 0.3802**	P = 0.2633**
K0W0	16.33 a	0.62 a	32.01 ab
K0W1	15.17 ab	0.50 ab	32.22 ab
K1W0	13.67 b	0.59 a	23.51 b
K1W1	14.17 ab	0.34 b	49.74 a
K2W0	15.67 ab	0.56 a	28.87 ab
K2W1	15.67 ab	0.51 ab	40.69 ab

*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; Brix, free acid content, and sweetness level at 0 day storage were 16.52, 0.48 g/100 g, and 34.11, consecutively.

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