Effects of Sugar Ester Blend Coating of KD-112 and Plastic Wrapping on Fruit Shelf-Life and Qualities of 'California' Papaya

Soesiladi E. Widodo, Zulferiyenni, Suskandini R. Dirmawati, Rachmansyah A. Wardhana, Nurul Octavia, Lutfiana Cahyani

Abstract**—**'California' papaya (*Carica papaya* L.) is a newly released cultivar that is increasingly popular in Indonesia both as domestic and export markets. It has a very short shelf-life with quickly decreases of fruit qualities. Postharvest handlings to extend its fruit shelf-life and to maintain its high quality fruit are greatly needed.The objectives were to study the effects of sugar ester blend solution of KD-112 and plastic wrapping in extendingfruit shelf-life and maintaining high fruit qualities of 'California papaya.The results showed that as sole applications, fruit coatings of KD-112 and one-layer plastic wrapping extended significantly 'California' papaya fruit shelf-life and maintained high fruit qualities. The combined application of 7% KD-112 and one-layer plastic wrapping was recommended to be applied as a postharvest handling for 'California' papaya because it was capable of delaying fruit ripening and maintaining high fruit qualities up to 21 days storage, 13-16 days longer than control.

Keywords**—**papaya, KD-112, plastic wrapping, postharvest.

I. Introduction

'California' papaya (*Carica papaya* L.) is a newly released cultivar that is increasingly popular in Indonesia both as domestic and export markets. It has a very short shelf-life with a quickly decrease of fruit qualities due to high respiration and transpiration rates. Therefore, postharvest handlings to lengthen its fruit shelf-life and to maintain its high quality fruit up to its consumers are greatly needed.

KD-112 is mostly used in pineapple agroindustries as a fruit coating to delay pineapple ripening during its postharvest handlings. It is a sugar ester blend solution that is used as biosurfactant [1]. As with other sucrose polyester coatings, its main effects are to decrease respiration and transpiration rates, ethylene production, to delay fruit color development and softening [2]. Low fruit weight loss and softening rates are also expected by coating with sugar ester blend solution as it was also reported by another coating [3]. As far as our knowledge, KD-112 has never been studied and reported as a fruit coating to 'California' papaya in Indonesia.

Amongs fruit coating practices, plastic wrapping is known as a common practice in postharvest handling of horticultural products due to its simplicity, effectivity, and economical reasons. It works by developing a modified athmospheric condition of low O_2 and high CO_2 inside the coating and providing a physical barrier to water vapor which promotes low respiration and transpiration rates [4, 5] due to its lower permeabilities to athmospheric gases and water vapour [5]. Therefore, a longer shelf-life and maintaining high fruit qualities of 'California' papaya are expected by combining sugar ester blend solution of KD-112 with plastic wrapping.

This research objectives were to study the effects of sugar ester blend solution of KD-112 and plastic wrapping in extending fruit shelf-life and maintaining high fruit qualities of 'California papaya.

II. Materials and Methods

This research was conducted on July-September 2015. 'California' papaya at ripening stage I (green fruit with yellow line at peduncle side; [6]). was received directly from Nusantara Tropical Farm, Co. Ltd., Way Jepara, East Lampung, Indonesia. Other materials were sugar ester blend of KD-112, and plastic wrapping of LDPE (Best Fresh®).

Two parallel postharvest experiments with treatments arranged in a 3 x 2 factorial design were conducted. They were both laid out in a completely randomized design of KD-112 [0% (K_0, control), 7% (K_1), and 14% (K_2)] and plastic wrapping [without (W_0) and with one-layer of plastic wrapping (W_1)]. The first experiment used three replications with one fruit each and its observations were terminated once when the fruits reached stage IV (perfectly yellow/orange). The second one used three replications with five fruits each to accomodate five consecutive samplings up to the end of observation. In the second one, the observation on fruit stage development was conducted daily, while the other observations were conducted predeterminely at 2-4 days increment and terminated if the fruits reached stage IV. The

Soesiladi E. Widodo, Department of Agrotechnology, Faculty of Agriculture, University of Lampung, Bandar Lampung35145, Indonesia
E-mail: sestiwidodo@gmail.com
Zulferiyenni, Department of Agricultural Product Technology, Faculty of Agriculture, University of Lampung, Bandar Lampung35145, Indonesia
E-mail: zulferiyenni@gmail.com
Suskandini R. Dirmawati, Department of Plant Protection, Faculty of Agriculture, University of Lampung, Bandar Lampung35145, Indonesia
E-mail: ratih_hasanudin@yahoo.com
Rachmansyah A. Wardhana, Great Giant Food, Co. Ltd., Terbanggi Besar, Central Lampung, Indonesia
E-mail: ra.wardhana@ntf.co.id
Nurul Octavia, Department of Agrotechnology, Faculty of Agriculture, University of Lampung, Bandar Lampung35145, Indonesia
E-mail: octavianurul20@yahoo.com
Lutfiana Cahyani, Department of Agrotechnology, Faculty of Agriculture, University of Lampung, Bandar Lampung35145, Indonesia
E-mail: lutfianac@gmail.com

second experiment was conducted mainly to study changes in fruit stages and qualities during storage according to the treatments.

KD-112 solutions were prepared by adding destilled water to KD-112 stock solution according to their concentrations.The fruits were quickly dipped in KD-112 solutions (or water in the control), air-dried, and then wrapped in one-layer of plastic wrapping. Treated fruits were then placed in a storage room of a room temperature of 28 ± 1 °C.

Observations were made on fruit shelf-life, weight loss, firmnness (with a penetrometer typed FHM-5, with a cylindrical point of 5 mm in diameter ofTakemura Electric Work, Co. Ltd., Japan), soluble solid as ^{o}Brix (with an AtagoN-1E hand refractometer), titratable acidity (titrated with 0.1 N NaOH and phenolphthalein as an indicator), and sweetness level (^{o}Brix/acidity ratio). All data were analyzed with ANOVA, and then further tested with Least Significantly Difference (LSD) at 5%, and presented graphically.

III. Results and Discussion

The results showed that as sole applications, both KD-112 and plastic wrapping applications extended significantly papaya fruit shelf-life (Table 1). While 7% KD-112 did not significantly extend fruit shelf-life compared to the control, the higher concentration of 14% KD-112 extended significantly papaya fruit shelf-life by 3.66 days longer. This results were different than our other result of chitosan [7], in which chitosan applications did not affect papaya fruit shelf-life. This current result showed that, as a fruit coating, 14% KD-112 was better than 1.25-2.50% chitosan [7]. KD-112 aplication seemed to develop a better modified athmospheric condition of lower O_2 and higher CO_2 so that respiration rate and ethylene production decreased [2, 8, 9]. Higher fruit weight loss (Table 1) might be a consequency of a longer shelf-life, as was also noted in our previous research [10].

Similar to KD-112, a sole application of one-layer of plastic wrapping extended significantly 'California' papaya fruit shelf-life by 8.44 days longer (Table 1), and it was generally capable of mantaining high fruitqualities. These agreed with the results reported by [7, 10]. Plastic wrapping developed a modified athmospheric condition of low O_2 and high CO_2 inside the coating and also provided a physical barrier to water vapor [5, 11-13] which promoted low respiration and transpiration rates [4, 5,14]. As a result, not only fruit color development was delayed, as also shown by [15], but also fruit weight loss was decreased (Table 1).

Significant effects of 14% KD-112 and plastic wrapping as sole applications over other treatments (Table 1) were observed in their combined applications (Fig. 1). While fruits coated with KD-112 but without plastic wrapping had very short shelf-lifes of around 5-7 days (Fig. 1), those coated with KD-112 and plastic wrapping had longer shelf-lifes up to 21 days storage with fruit stages had not reached full ripe (Table 1 and Fig. 1).

TABLE I
EFFECTS OF KD-112 AND PLASTIC WRAPPING ON THE SHELF-LIFE, WEIGHT LOSS, AND FIRMNESS OF 'CALIFORNIA' PAPAYA FRUITS*

Treatments	Shelf-life (days)*	Weight loss (%)*	Fruit firmness (kg/cm²)*
KD-112(K):			
0% (K_0)	10.50 b	5.85 b	5.91 a
7% (K_1)	10.33 b	7.56 ab	9.27 a
14% (K_2)	14.16 a	10.46a	5.86 a
Plastic Wrapping(W):			
Without (W0)	7.44 b	9.32 a	4.63 b
One-layer (W1)	15.88 a	6.57 b	9.37 a

* Values in the same column of each treatment followed with the same letters were not significantly different at LSD 5%. Values of fruit firmness at 0 day-storage was 25.10 kg/cm^2.

TABLE II
EFFECTS OF KD-112 AND PLASTIC WRAPPING ON THE SOLUBLE SOLID CONTENT, ACIDITY, AND SWEETNESS OF 'CALIFORNIA' PAPAYA FRUITS*

Treatments	^{o}Brix (%)*	Acidity (g/100 g)*	Sweetness**
KD-112(K):			
0% (K_0)	11.46 a	0.19 a	64.5 a
7% (K_1)	11.20 a	0.15 a	75.5 a
14% (K_2)	11.18 a	0.16 a	70.7 a
Plastic Wrapping(W):			
Without (W0)	11.51 a	0.19 a	63.03 a
One-layer (W1)	11.08 a	0.14 b	77.47 a

* Values in the same column of each treatment followed with the same letters were not significantly different at LSD 5%. Values of solulbe solid content (°Brix), acidity, and **sweetness (°Brix/acid ratio) at 0 day-storage were 9.20%, 0.15 g/100 g, and 63.12, consecutively.

Eventhough KD-112 did not affect fruit quality parameters, (Tables 1 and 2), and because plastic wrapping was capable of maintaining high fruit qualities by lower fruit weight loss and higher fruit firmness (Table 1), and lower acidity (Table 2), their combinations (K1W1 and K2W1) were capable of maintaining high fruit qualities (Fig. 1). While other fruit parameter observations were terminated at around 5-8 days storage, combinations of KD-112 and plastic wrapping maintained high fruit qualities up to 21 days storage (Fig. 1). Those might be due to decreased respiration and transpiration rates [8, 10, 16], that decreased carbohydrate degradation and water loss, and resulted in slower changes of fruit qualities up to 21 days storage.

Due to a more economical value of 7% KD-112 over 14% KD-112, the best postharvest handling for 'California' papaya, therefore, should be the combined application of 7% KD-112 and plastic wrapping. It delayed fruit ripening and maintained high fruit qualities up to 21 days storage.

IV. Conclusion

The results showed that as sole applications, fruit coatings of KD-112 and one-layer plastic wrapping extended significantly 'California' papaya fruit shelf-life and maintained high fruit qualities. The combined application of 7% KD-112 and one-layer plastic wrapping was recommended to be applied as a postharvest handling for 'California' papaya because it was capable of delaying fruit ripening and maintaining high fruit qualities up to 21 days storage, 13-16 days longer than control.

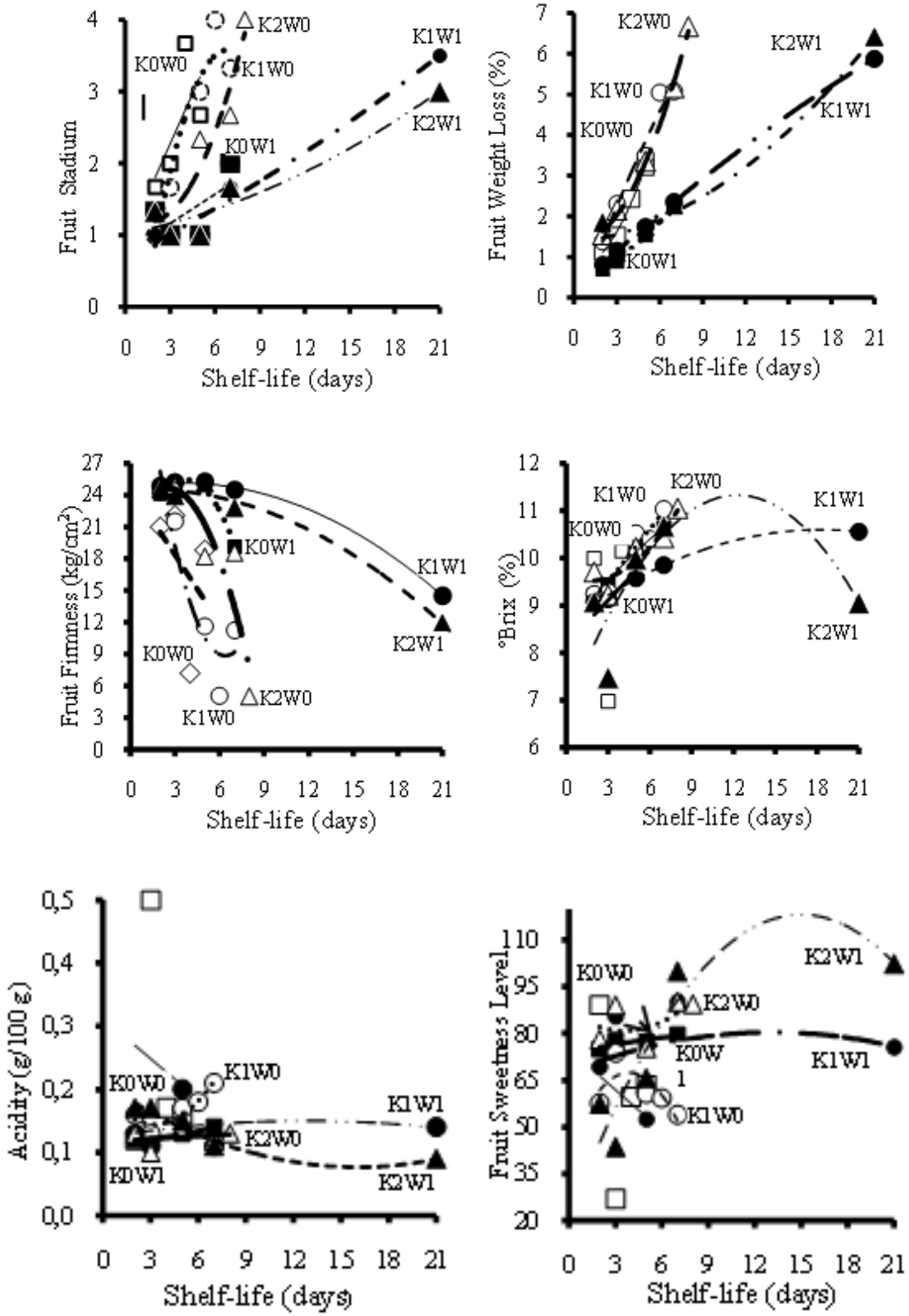

Fig. 1. Effects KD-112 and plastic wrapping on the fruit quality changes of 'California' papaya

ACKNOWLEDGMENT

A special thank was directed to the General Directorate of Research Empower and Development, the Ministry of Research, Technology, and Higher Education, the Republic of Indonesia for funding this research through the National Research Grand of The Research for Science and Technology Development 2015. Thanks to Nusantara Tropical Farm, Co. Ltd., Way Jepara, East Lampung, Indonesia for providing fruit

samples and Drs. Agus Karyanto and Kuswanta P. Hidayat for discussion during the preparations of research report and manuscript.

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