

## Effects of Chitosan and Plastic Wrapping on Fruit Shelf-life and Qualities of ‘California’ Papaya

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**Abstract** – As a respiratory climacteric-typed fruit having a thin skin, ‘California’ papaya as other common papaya has a very short shelf-life with a quickly decrease of fruit qualities due to higher respiration and transpiration rates. Decreasing both respiration and transpiration rates are then expected to lengthen its shelf-life and maintain its high quality fruit up to its consumers. Chitosan is known as a potent fruit coating with biodegradable and biofungicidal functions and having the capabilities to lessen both transpiration and respiration. Therefore, lengthening fruit shelf-life and maintaining high fruit qualities of ‘California’ papaya are expected by combining chitosan with other treatments, such as plastic wrapping. This research objectives were to study the effects of chitosan and plastic wrapping in lengthening fruit shelf-life and maintaining high fruit qualities of ‘California’ papaya. The results 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 ‘California’ 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.

### 1. INTRODUCTION

As a respiratory climacteric-typed fruit having a thin skin, ‘California’ papaya as other common papaya (*Carica papaya* L.) has a very short shelf-life with a quickly decrease of fruit qualities due to high respiration and transpiration rates. Decreasing both respiration and transpiration rates are then expected to lengthen its shelf-life and maintain its high quality fruits up to its consumers.

Chitosan is known as an edible fruit coating with capable of controlling changes in several biochemical and biological aspects of food products [1-10]. It works to lessen both transpiration and respiration [11, 12] and has also biodegradable and biofungicidal functions [8, 13]. Our previous research confirmed that 2.5% chitosan could be used as a fruit coating [5, 6].

Plastic wrapping is a common practice in postharvest handling of horticultural products. It provides a physical barrier to respiratory gasses and water vapor, and therefore, to develop a modified atmospheric condition of low O<sub>2</sub> and high CO<sub>2</sub> which promotes low respiration and transpiration rates [14, 15]. Therefore, a longer shelf-life and maintaining high fruit qualities of ‘California’ papaya are expected by combining chitosan with plastic wrapping.

This research objectives were to study the effects of chitosan and plastic wrapping in lengthening fruit shelf-life and maintaining high fruit qualities of ‘California’ papaya.

### 2. METHODS

#### 2.1 Materials

This postharvest research was conducted on July-September 2015. ‘California’ papaya fruits of stage I (dark green with slightly yellow skin) were received directly from Nusantara Tropical Farm, Co. Ltd., Way Jepara,

East Lampung, Indonesia. Other materials were chitosan (cosmetic grade, Biotech Surindo, Cirebon, Indonesia) and LDPE plastic wrapping (Best Fresh®).

## 2.2 Procedures

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 chitosan [0 (C0, control), 1.25 (C1), and 2.5% (C2)], and plastic wrapping [without (W0) and with one-layer of plastic wrapping (W1)]. 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 accommodate five consecutive samplings up to the end of observation. In the second one, the observation on fruit stage development was conducted daily, while the others were conducted predeterminedly at 2-4 days increment and terminated if the fruits reached stage IV. The second experiment was conducted mainly to study changes in fruit stages and qualities during storage according to the treatments.

Chitosan was diluted in 0.5% acetic acid [5, 6, 10]. The fruits were quickly dipped in chitosan 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  $28 \pm 1$  °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, Co. Ltd., Japan), soluble solid as °Brix (with an Atago N-1E hand refractometer), titratable acidity (titrated with 0.1 N NaOH and phenolphthalein as an indicator), and sweetness level (°Brix/acidity ratio). All data were analyzed with ANOVA, further tested with Least Significantly Difference (LSD) at 5%, and presented graphically.

## 3. RESULTS AND DISCUSSION

The results showed that as a sole application, chitosan applications did not significantly affect papaya fruit shelf-life. Natural wax on the surface of papaya skin might lessen the effect of chitosan, as also occurred on other fruits [4, 5, 16]. The chitosan applications, however, were generally better than the control in maintaining high quality papaya fruits (Table 1). Chitosan applications developed a modified atmospheric condition of low O<sub>2</sub> and high CO<sub>2</sub> that were commonly believed to decrease respiration rate [17, 18], and therefore, to decrease carbohydrate degradation resulting in slower changes of fruit qualities. These responses agreed with our previous research [3-7, 9].

Similar to chitosan, due to natural wax around papaya skin, a sole application of one-layer of plastic wrapping did not significantly affect papaya fruit shelf-life, but it was generally capable in maintaining high quality papaya fruits (Table 1). Plastic wrapping worked by developing a modified atmospheric condition of low O<sub>2</sub> and high CO<sub>2</sub> that decreased respiration rate [17], and also provided a physical barrier to water vapor [19-21], resulted in lower fruit weight loss (Table 1). These results also agreed with our previous research [5, 6].

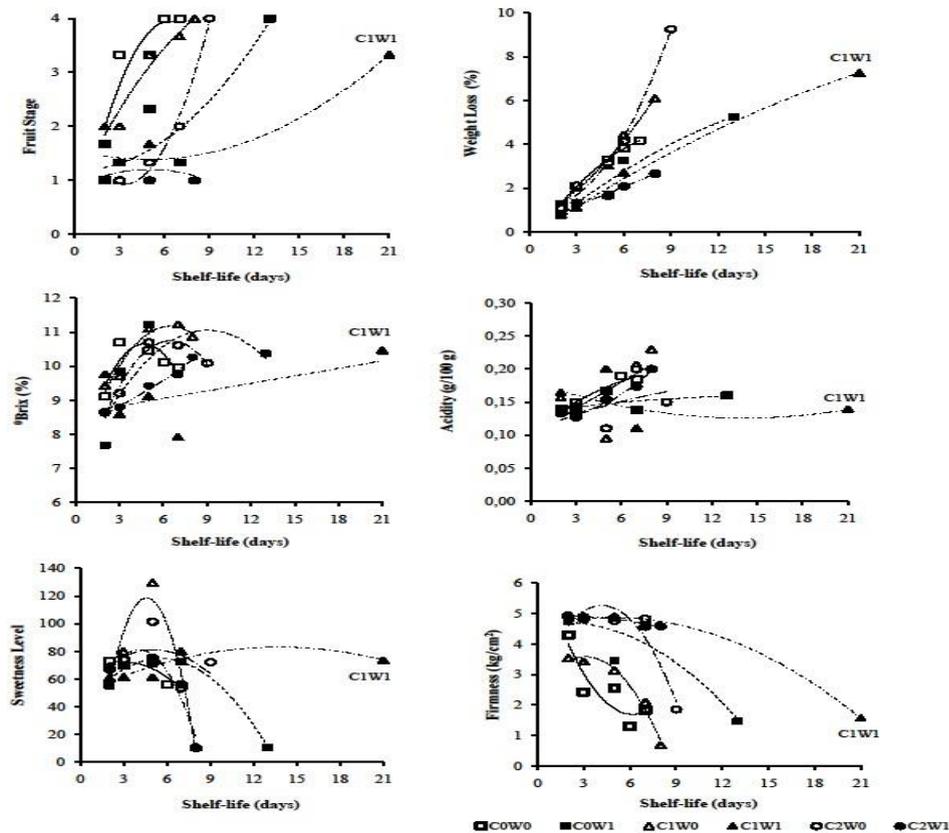
**Table 1 Effects of chitosan and plastic wrapping in the fruit shelf-life and qualities of ‘California’ papaya fruits\***

Treatments	Shelf-life (days)	Weight loss (%)	°Brix (%)	Acidity (g/100 g)	°Brix/acidity ratio	Fruit firmness (kg/cm <sup>2</sup> )
Chitosan (C):						
Chitosan 0% (C0)	11.67 a	7.57 a	10.05 ab	0.21 a	52.02 b	1.25 b
Chitosan 1.25% (C1)	14.50 a	8.74 a	10.73 a	0.17 b	63.51 ab	2.01 b
Chitosan 2.5% (C2)	15.03 a	11.08 a	9.18 b	0.14 b	64.42 a	3.47 a
Plastic wrapping (W):						
Without (W0)	12.11 a	11.50 a	10.63 a	0.19 a	60.51 a	2.12 a
With (W1)	15.36 a	6.75 b	9.35 b	0.16 b	59.46 a	2.37 a

\* Values in the same column of each treatment followed with the same letters were not significantly different at LSD 5%. Values of °Brix, acidity, sweetness (°Brix/acidity ratio), and fruit firmness at 0 day-storage were 9.20%, 0.15 g/100 g, 63.12, and 4.93 kg/cm<sup>2</sup>, consecutively.

The results showed that even though as a sole application, both 1.25% chitosan (C1) and one-layer plastic wrapping (W1) did not significantly affect papaya fruit shelf-life, they were generally best as a postharvest handling of 'California' papaya fruits to maintain high fruit qualities (Table 1). However, when they were applied as a combination, their combination was capable in lengthening its shelf-life up to about 21 days storage, or about 14 days longer than the control (Figure 1). That might be due to decreased respiration and transpiration rates [5, 6, 17], that decreased carbohydrate degradation and water loss, and resulted in slower changes of fruit qualities during storage.

Other fruit quality variables (fruit weight loss, °Brix, acidity, °Brix/acid ratio or sweetness level, and firmness) showed similar responses to the treatments of 1.25% chitosan (C1) and one-layer plastic wrapping (W1) (Table 1 and Figure 1). The treatment combination of 1.25% chitosan (C1) and one-layer plastic wrapping (W1) was not only capable in lengthening its shelf-life of about 14 days longer than the control (Figure 1), but also caused relatively lower fruit weight loss, °Brix, acidity, sweetness, and firmness. Considering that the treatment combination caused longer fruit shelf-life, the slower changes of fruit qualities (Figure 1) indicated that fruit respiration and water loss were hindered.



#### 4. CONCLUSION

The results showed that even though 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 'California' 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.

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