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EFFECT OF CHITOSAN'S COATING AND HARVESTING TIME TO THE QUALITY AND SHELF-LIFE OF MELON (*CUCUMIS MELO* L.)

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Abstract. Melon is one of high demands fruit in Indonesia, but the research about the fruit coating to fresh melon is still rare. This research is about application of fruit coating (chitosan) in different harvesting times to keep the quality and shelf-life of melon in room storage. The study was aimed to study the effect of chitosan and harvesting time on fruit quality and shelf-life melon in normal room storage. The research was conducted using a completely randomized design in two factors. The first consisted of 2 treatments; without coating (control) and with the coating (chitosan). The second consisted of 3 treatments of harvesting time; 60, 65, and 70 days after planting. Each treatment is repeated 4 times. The data is then analyzed in variance with F-test, then proceeded with the separation of the middle value with LSD at the 5% level. The results showed that fruits shelf-life can be extended until 20 days storage based on visual observation, but for fruits that were applied chitosan and harvested on 60 and 70 days can be extended 10 days and 15 days only. Application of chitosan didn't significantly affect the quality of the melon such as on weight loss, soluble solids, and level of preferences (color, sweetness, texture, and aroma), but as additional information the level of preferences test showed that fruits applied with chitosan which were harvested on 65 and 70 days after planting experienced off-flavor on the 5th days of storage.

1. INTRODUCTION

Melon is one of the horticultural commodities that contributes to the supply of fruit in Indonesia. Melons contributed 0,76% on the availability of fruit in Indonesia. The area of melon harvest in Indonesia in 2013 was 7,068 ha and increased to 8,185 ha in 2014. The increase in the melon harvest area was followed by an increase in melon production in Indonesia, which was 125,207 tons in 2013, and to be 150,347 tons in 2014 [5,9]. The increase in harvested area and melon production are believed to occur due to the increasing demand for melons in the market.

In fruit cultivation, harvesting time is one of the important things that must be paid attention to produce a high-quality product. Melon fruits mostly can be harvested 65 days after planting. The early harvesting time will produce small and reduced flavor of the fruits with unattractive color, and some unidentifiable characterizes that could have a bad effect on fruit quality after storage such as non-uniform ripening [10]. Therefore, it is important to study about harvesting time to get the best harvesting time, so a high-quality product could be produced.

One of the superior traits of melon that is sought by agribusiness entrepreneurs is melon which has a long shelf-life. One postharvest treatment that is known to prolong the shelf-life of fruits and is safe for health is a coating (coating fruit using chitosan). Chitosan is one of the natural cationic polysaccharides obtained by the process of chitin deacetylation from the exoskeleton of many organisms of which is considered as wastes by a worldwide seafood company. Chitin is a form of basic polysaccharide which is the most abundant marine polymers in the world [4].

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Preliminary research showed that the shelf-life of netted skin melon is shorter than the shelf-life of the smooth skin one. The shelf-life of melon with netted skin without postharvest treatment ranges from 7-14 days, but this still depends on its harvesting time. The use of chitosan as a coating on melons is mostly done on peeled / processed fruit, not on fresh fruits.

Therefore, it is necessary to do research on the application of chitosan as a coating on fresh melon fruit in several harvesting times in order to increase the shelf-life of melons so it will be useful for the distribution of melons. The success of this research will be very useful in post-harvest melons as the technology produced is easy, inexpensive, and applicative for agribusiness entrepreneurs of melons.

2. MATERIALS AND METHODS

This research was conducted in April – September 2019 in the screen house and post-harvest laboratory of Lampung State Polytechnic.

2.1 Materials

The material was used in this research are chitosan (food grade), and acetic acid.

2.2 Method

Action 434 melons are harvested on 60, 65, and 70 days after planting (DAP) from the screen house and then sorted based on physical appearances. Furthermore, chitosan was diluted in 0.5% of acetic acid [15]. Melons are washed and then dipped in chitosan solution after that fruit was dried [12]. Then the treated fruits are placed in room temperate storage.

Observations were made to the shelf-life of fruits, weight loss, soluble solid as ◦Brix and the level of delights as organoleptic test that was taken from 10 volunteers who have to fill the organoleptic form (Table 1). It was done at 0, 5, 10, 15, and 20 days of storage.

The research was conducted using a completely randomized design in two factors. The first consisted of 2 treatments; without coating (T) and with a coating (C). The second consisted of 3 treatments of harvesting time; 60, 65, and 70 days after planting. Each treatment is repeated 4 times. The data was then analyzed in variance with F-test, then proceeded with the separation of the middle value with LSD at the 5% level.

Table 1. Organoleptic form.

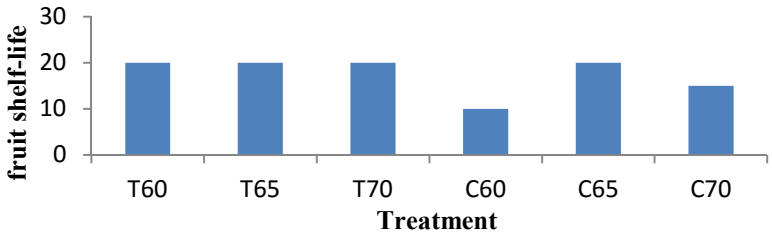
Organoleptic test								
Color		Sweetness			Texture		Aroma	
Unattractive	Attractive	Less	Medium	Sweet	Soft	Firm	No smells	Smells good
1	2	1	2	3	1	2	1	2

1, 2, 3 : the score of delights level

3. RESULT AND DISCUSSION

The observations about the effect of coating application and harvesting time to melon fruit which was stored in room-temperate treatment to shelf-life fruit in all treatments are shown in Figure 1.

3.1 Shelf-life



Remarks : T60 = without coating, harvested on 60 DAP; T65 = without coating, harvested on 65 DAP; T70 = without coating, harvested on 60 DAP; C60 = chitosan coating, harvested on 60 DAP; C65 = chitosan coating, harvested on 65 DAP; C70 = chitosan coating, harvested on 70 DAP

Figure 1. Effect of chitosan coating and harvesting time of melon to the shelf life of melon fruit.

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Figure 1. showed that the shelf-life of melon fruits can be extended until 20 days of storage, but for fruits that were applied chitosan which were harvested on 60 and 70 DAP can be extended only 10 and 15 days of storage, and as additional information based on organoleptic observations, some of the fruits that were harvested on 65 and 70 DAP have experienced off-flavors in the 5th days of storage, of which the fruits showed that they were beginning to ferment with the smell and taste of alcohol and flesh of the fruit experience softening.

Melon is one of the most consumed tropical fruits. According to [14], tropical fruits are very sensitive to cold temperatures so they cannot be stored at temperatures near 0 ◦C. Therefore a combination of storage temperature and application of fruit coatings is needed. In addition, melon fruit is also a climacteric fruit that continues to experience a respiration burst when the fruit has been harvested [8]. Respiration rate is strongly influenced by environmental temperature, the higher the storage temperature, the higher the respiration rate, the faster the quality of the fruit will decrease [14]. It means that we should find the best combination of temperature and fruit coating for melon fruits.

The decrease of O_2 levels will inhibit respiration and prevent changes in the aroma and taste of the fruit. The application of fruit coatings can prevent the diffusion of O_2 and CO_2 through the fruit skin. When the supply of O_2 and the release of CO_2 are inhibited, the fruit will quickly rot and unedible eating. This kind of inhibition can cause the fruit to get off-flavor due to anaerobic fermentation. Therefore, the selection of types and formulations of fruit coating materials must be considered [13]. In this study, the shelf-life fruits were stored in room-temperate storage and were applied chitosan. The result showed that the fruits which were harvested on 65 and 70 DAP can be extended their storage time only 10 and 15 days. It happened due to the storage temperature of the fruit and the formulation of fruit coatings that were not suitable for the fruit.

According to [3], melons can be harvested at several maturity levels. The higher the level of maturity, the lower the temperature recommended to use, in order to extend the shelf life fruits. The storage temperature of melons ranges from 5 - 10 ◦C. Melons that are stored above 10 ◦C will experience softening of the flesh and have an unpleasant odor. Because the temperature used in this study was room temperature ranging from 27 - 28 ◦C, the results obtained as shown in Figure 1, mostly fruit shelf-life can be extended until 20 days of storage by visual observation but fruits that were harvested on 65 and 70 DAP experience off-flavor on their 5th days of storage. Therefore, it is better not to store melons at room temperature in order to maintain the fruit's quality.

3.2 Weight loss

Table 2. Effect of chitosan coating and harvesting time of melon to a weight loss of fruits at 5, 10, 15, and 20 days of storage

No	Treatment	Weight loss (days of storage)			
		5	10	15	20
1	T 60	0,08a	0,09a	0,14a	0,22a
2	T 65	5,04a	0,70a	1,01a	0,34a
3	T 70	0,03a	0,07a	0,09a	0,07a
4	C 60	0,09a	0,09a	-	-
5	C 65	0,07a	0,11a	0,14a	0,08a
6	C 70	0,04a	0,08a	0,10a	-

Remarks : T60 = without coating, harvested on 60 DAP; T65 = without coating, harvested on 65 DAP; T70 = without coating, harvested on 60 DAP; C60 = chitosan coating, harvested on 60 DAP; C65 = chitosan coating, harvested on 65 DAP; C70 = chitosan coating, harvested on 70 DAP; *Values in the same column of each treatment followed by the same letters were not significantly different at LSD 5%.

Fruits that were treated with fruit coating and stored at low temperatures will maintain eating quality and fruit weight because fruit coating will cover the pores of the fruit and inhibit the process of respiration and transpiration in the fruit. So, the fruits that are stored at room temperature and without

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the fruit coating will experience a high loss of weight and rapid damage [16]. The results of weight loss observations in this study showed that there were no significant differences in melon coated with chitosan and stored at room temperature (Table 2). Based on the results of [16] research, the comparison of melons stored at room temperature with melons stored at low temperatures shows a high loss of weight on fruits that stored at room temperature. Melons stored at room temperature only last for one day. This is due to the high transpiration and evaporation of the fruit. In addition, the high storage temperature will also cause a high rate of respiration, because the respiration process is an enzymatic process that is sensitive to high temperatures [14].

In the process of respiration, there is an overhaul of carbohydrates that will produce CO_2, water, and energy [16]. Water, gas, and energy produced during respiration will trigger evaporation, so that the fruit will experience weight loss [6]. It is suspected that because of the high storage temperature, the fruit weight loss was not significantly different in this study. In addition, chitosan coatings used are also less effective to inhibit weight loss in melon fruit. According to [11], chitosan-based polysaccharides are very good in inhibiting oxygen exchange, but due to its hydrophilic nature, chitosan is less effective as a barrier to water evaporation. Storage fruits at low temperatures will inhibit the process of respiration, this eventually can extend the shelf-life of the fruits [16]. Therefore, melons should be stored at lower temperatures.

3.2 Soluble solids (◦Brix)

The result of observations to soluble solid showed that there is no significant effect of coating melon with chitosan that stored in ambient storage (Table 3).

Table 3. Effect of chitosan coating and harvesting time of melon to ◦Brix of fruits at 5, 10, 15, and 20 days of storage

No	Treatment	◦Brix (days of storage)			
		5	10	15	20
1	T 60	8,12a	9,67a	8,12a	8,25a
2	T 65	8,57a	8,33a	8,67a	9,83a
3	T 70	11,37a	10,87a	9,33a	11,37a
4	C 60	9,50a	9,37a	-	-
5	C 65	9,62a	10,25a	9,00a	10,00a
6	C 70	11,00a	9,12a	10,00a	-

Remarks : T60 = without coating, harvested on 60 DAP; T65 = without coating, harvested on 65 DAP; T70 = without coating, harvested on 60 DAP; C60 = chitosan coating, harvested on 60 DAP; C65 = chitosan coating, harvested on 65 DAP; C70 = chitosan coating, harvested on 70 DAP; *Values in the same column of each treatment followed by the same letters were not significantly different at LSD 5%.

The results of observations in Table 3 show that the application of chitosan coating at several harvesting times did not give any significant difference in the content of soluble solid in melon. According to [1], at higher temperatures, the reduction of solutes will also be higher and increase the rate of respiration in fruit. Increased content of solutes in fruit correlates with the hydrolysis activity of starch, increased activity of enzymes that are responsible for the hydrolysis of starch to dissolve sugar, and conversion of starch to sugar indicates that the fruit is in the maturity process [7]. This shows that the coating of melons with chitosan stored at room temperature cannot inhibit the rate of fruit respiration.

According to [2], the level of fruit maturity and storage temperature will affect the total conversion rate of sugar in the fruit. When the process breaking down of polysaccharides into simple sugars is complete, the process of respiration will proceed to produce energy and continue the metabolic process. Moreover, fruits that are harvested in higher maturity will contain more soluble solid [12]. It means that fruits that are harvested in higher maturity will contain more soluble solid when they are

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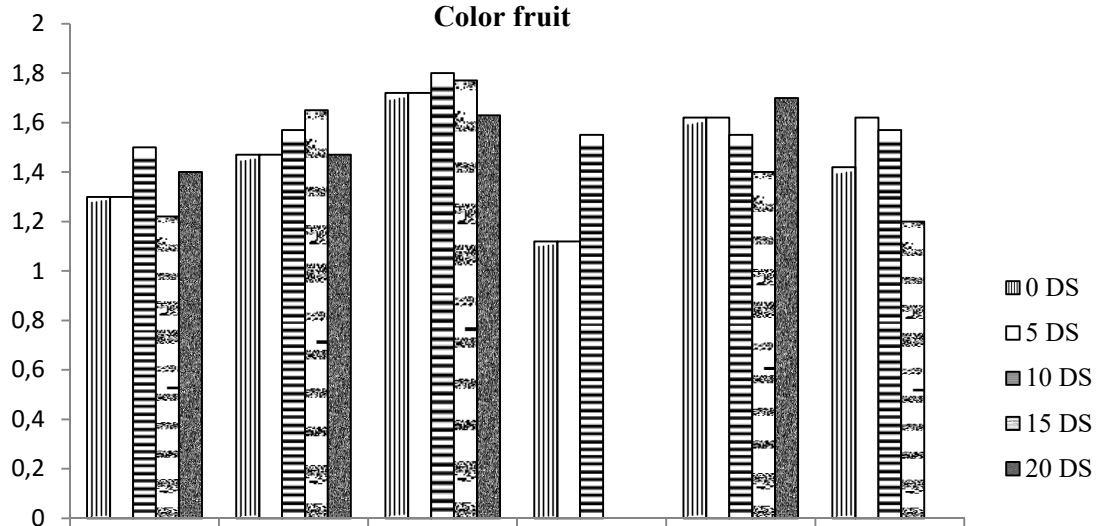
just harvested, but in the storage, the contents of the soluble solid shows no difference whether the fruits are applied with chitosan or not (Table 3).

The research of [13] showed that melon fruit treated with fruit coatings and stored at 13 ◦C had had a decreased fruit quality on the 6th days of storage. Treatment of fruit coatings made from cellulose and synthetic coatings did not significantly affect fruit hardness, solute content, and weight loss of fruit. In line with these studies, the results of this study on the fruits which were stored at room temperature and with chitosan coating also did not show significant differences.

3.3 The level of preference

Observation to the level of preference was done to 10 volunteers that had filled an organoleptic form about the preference of color, sweetness, texture, and aroma of melon. The result shows in Figures 2, 3, 4, and 5.



	T 60	T 65	T 70	C 60	C 65	C 70
0 DS	1,3	1,47	1,72	1,12	1,62	1,42
5 DS	1,3	1,47	1,72	1,12	1,62	1,62
10 DS	1,5	1,57	1,8	1,55	1,55	1,57
15 DS	1,22	1,65	1,77	0	1,4	1,2
20 DS	1,4	1,47	1,63	0	1,7	0

Remarks : T60 = without coating, harvested on 60 DAP; T65 = without coating, harvested on 65 DAP; T70 = without coating, harvested on 60 DAP; C60 = chitosan coating, harvested on 60 DAP; C65 = chitosan coating, harvested on 65 DAP; C70 = chitosan coating, harvested on 70 DAP

Figure 2. Effect of chitosan coating and harvesting time of melon to color fruits at 5, 10, 15, and 20 days of storage (DS)

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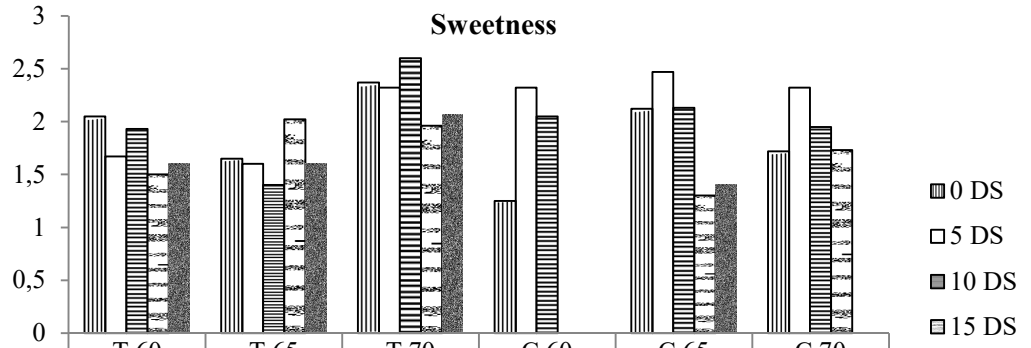
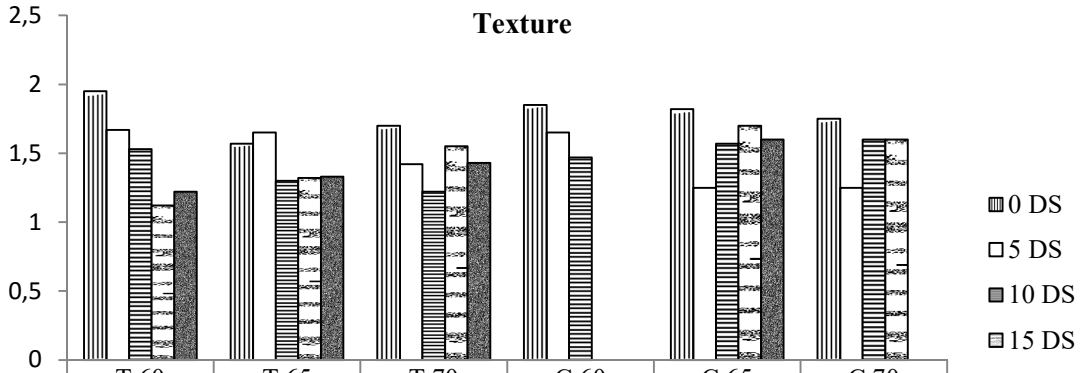


	T 60	T 65	T 70	C 60	C 65	C 70
0 DS	2,05	1,65	2,37	1,25	2,12	1,72
5 DS	1,67	1,6	2,32	2,32	2,47	2,32
10 DS	1,93	1,4	2,6	2,05	2,13	1,95
15 DS	1,5	2,02	1,96	0	1,3	1,73
20 DS	1,6	1,6	2,07	0	1,4	0

Remarks : T60 = without coating, harvested on 60 DAP; T65 = without coating, harvested on 65 DAP; T70 = without coating, harvested on 60 DAP; C60 = chitosan coating, harvested on 60 DAP; C65 = chitosan coating, harvested on 65 DAP; C70 = chitosan coating, harvested on 70 DAP

Figure 3. Effect of chitosan coating and harvesting time of melon to sweetness fruits at 5, 10, 15, and 20 days of storage (DS)



	T 60	T 65	T 70	C 60	C 65	C 70
0 DS	1,95	1,57	1,7	1,85	1,82	1,75
5 DS	1,67	1,65	1,42	1,65	1,25	1,25
10 DS	1,53	1,3	1,22	1,47	1,57	1,6
15 DS	1,12	1,32	1,55	0	1,7	1,6
20 DS	1,22	1,33	1,43	0	1,6	0

Remarks : T60 = without coating, harvested on 60 DAP; T65 = without coating, harvested on 65 DAP; T70 = without coating, harvested on 60 DAP; C60 = chitosan coating, harvested on 60 DAP; C65 = chitosan coating, harvested on 65 DAP; C70 = chitosan coating, harvested on 70 DAP

Figure 4. Effect of chitosan coating and harvesting time of melon to fruits texture at 5, 10, 15, and 20 days of storage (DS)

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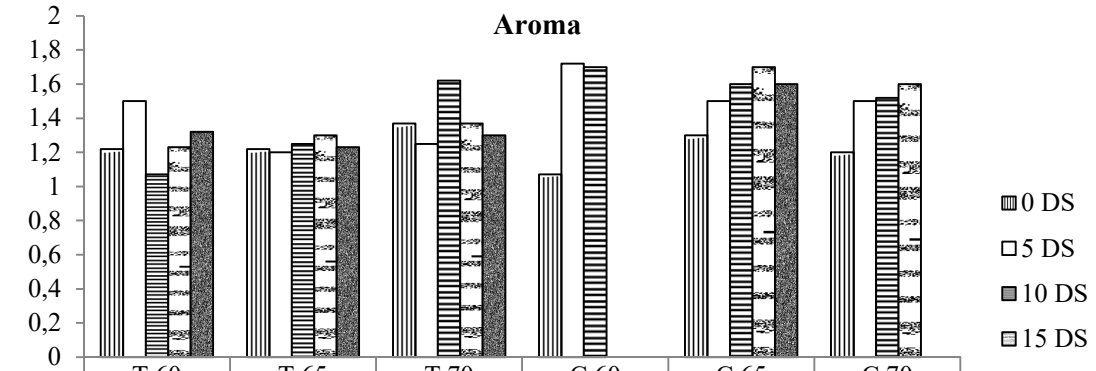

	T 60	T 65	T 70	C 60	C 65	C 70
0 DS	1,22	1,22	1,37	1,07	1,3	1,2
5 DS	1,5	1,2	1,25	1,72	1,5	1,5
10 DS	1,07	1,25	1,62	1,7	1,6	1,52
15 DS	1,23	1,3	1,37	0	1,7	1,6
20 DS	1,32	1,23	1,3	0	1,6	0

Remarks : T60 = without coating, harvested on 60 DAP; T65 = without coating, harvested on 65 DAP; T70 = without coating, harvested on 60 DAP; C60 = chitosan coating, harvested on 60 DAP; C65 = chitosan coating, harvested on 65 DAP; C70 = chitosan coating, harvested on 70 DAP

Figure 5. Effect of chitosan coating and harvesting time of melon to fruits aroma at 5, 10, 15, and 20 days of storage (DS)

Based on the data, all of the variables test were not significantly different. In the test of fruit color with the criteria of "attractive" and "unattractive", the highest data is in the melons that were harvested on 70 DAP without fruit coatings and 10 days of storage, i.e. 1,8 (Figure 2). In addition, the tests on the sweetness level with the criteria of "sweet", "medium", and "less" the highest data is shown in the fruits without fruit coatings that were harvested on 70 DAP and 10 days of storage, i.e. 2,6 (Figure 3). In the test of fruit texture with the criteria of "firm" and "soft", the highest data is shown in the fruit without fruit coatings that were harvested on 60 DAP and 0 days of storage, i.e. 1,95 (Figure 4). Whereas the test of fruit aroma with the criteria of “no smells” and “smells good”, the highest data is shown in the fruits with chitosan that harvested on 60 DAP and 5 days of storage, i.e. 1,72 (Figure 5). The observation also traced flavor change. The results indicate that the fruits harvested on 65 and 70 DAP and applied with chitosan had experienced off-flavor in the 5th days of storage even though they looked normal as visuals.

Table 4. Effect of chitosan coating and harvesting time of melon to off-flavor fruits at 5, 10, 15, and 20 days of storage (DS)

No	Treatment	Flavor				
		0 DS	5 DS	10 DS	15 DS	20 DS
1	T 60	-	-	-	-	-
2	T 65	-	-	-	-	-
3	T 70	-	-	-	-	-
4	C 60	-	-	-	-	-
5	C 65	-	x	x	x	x
6	C 70	-	x	x	x	x

x: off-flavor in fruits

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4. CONCLUSION

The research has revealed that the application of chitosan and harvesting time of melon in room storage do not significantly affect the quality of the melons. In addition, layering melons with chitosan can extend the fruit's shelf life for 10 to 15 days for the fruits which are harvested on 60 and 70 days after planting. For the rest of other fruits batch can be prolonged up to 20 days of storage. The application of chitosan on melons did not significantly affect the quality of the fruits in terms of weight loss, soluble solids, and the level of preference on colors, sweetness, texture, and aroma. Hence, the organoleptic test traced that the fruits that were harvested 65 and 70 days after planting then layered with chitosan had experienced off-flavor in the 5th days of storage.

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