

Development Of Edible Coating Products Based On Palm Oil Derivative To Extend The Arumanis Mangoes Graduation

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ABSTRACT

Mangoes are considered as climatic fruits, which are commonly harvested directly after the minimum pre-climacteric conditions are reached. This means the fruit is ripe but not ripe enough for consumption, then the fruit undergoes a ripening process during postharvest to the full climatological rise stage. If the fruit is harvested too late, it will cause a reduction in shelf life and quality of taste. One of the postharvest activities is to extend the freshness of mangoes by coating technology.

The purpose of extending the shelf life of horticultural products is through suppressing the rate of respiration (the rate of O₂ intake and the rate of CO₂ removal) so that it slows the fruit's metabolic process, prevents too much water loss (transpiration) and inhibits the rate of formation of Ethylene. The general requirements for this fruit coating are: does not affect the odor and taste, easy to dry, not sticky, not easily broken, does not produce a thick surface, not toxic, easy to obtain, and has a low price. The mangoes used in this coating process are Arumanis mangoes from East Java with a maturity level of 80-85%. The varieties that are known and dominating there include Arumanis varieties (40%), Golek (20%), and the rest are other varieties of mangoes.

The purpose of this research is to make a prototype of edible coating products on a 1000 mL lab scale by utilizing palm oil derivative products to be applied to the Arumanis mangoes so that the fruit's freshness becomes longer. When applied to these Arumanis mangoes, the edible coating products based on palm oil derivatives have been able to suppress weight losses of up to <5% for approximately 4 (four) weeks, the hardness level is 22.33N, Total Dissolved Solids (Brix) is 9.27, O₂ and CO₂ respiration rate of 10.91 and 15.24 ml / kg / hour.

Keywords : Mango, Postharvest, Coating Technology, Palm Oil Derivatives, and Edible Coating

INTRODUCTION

Coating technology is one of the post-harvest activities to extend the freshness of mangoes so that they can be enjoyed by the wider community even though the harvest period has not yet arrived and also to maintain the price of mangoes during peak season (harvest time) so that they do not fall too much. Naturally, the fruit is coated with a waxy layer which functions to maintain the exchange of CO₂ and O₂, as well as to prevent excessive water loss. The transpiration process causes the fruit to lose a lot of water, causing the fruit to shrivel / wrinkle with an appearance that is not good / fresh and also to reduce weight. The waxy layer on the fruit is reduced / lost due to washing in the post-harvest handling process. The reduced waxy layer on the fruit surface can accelerate the fruit metabolism process, especially in the ripening process, the respiration rate increases rapidly. To restore the waxy layer, a coating is applied using a wax emulsion.

Coating is an attempt to slow down the ripening process which aims to extend the life of the product. This saves horticultural products by suppressing the rate of respiration (rate of intake of O₂ and rate of removal of CO₂) so that it slows down the metabolic process of fruit, prevents excessive water loss (transpiration) and inhibits the rate of formation of Ethylene. General requirements for this fruit coating include not affecting the smell and taste, easy to dry, not sticky, not easily broken, does not produce a thick surface, non-toxic, easy to obtain, cheap price and is expected to give a more attractive appearance due to its shiny impression and make the product to be more acceptable at a longer period of time to the customers.

The critical factor for fruit coating is the thickness of the waxy layer. If the coating layer is too thin, it will cause the coating to be ineffective, but if the coating layer is too thick it will cause fruit rot, since almost all the pores of the commodity will be closed. In the manufacture of fruit edible coatings, edible coating materials are needed according to what fruit they are intended for, because each fruit has its own characteristics. The edible coating material in this invention, which is based on palm oil derivatives, is used as a coating wax on mangoes which can extend the freshness life of mangoes for a long time so that the mangoes can be exported to other countries.

Previously, types of edible coating that have been used are sugarcane wax (Sugarcane Wax), carnauba wax (Carnauba Wax), resin, thermoplastic terpene resin, shellac, honey beeswax (beeswax), conventional wax, hydrocolloids (proteins, polysaccharides), lipids and composites (a mixture of hydrocolloids and lipids). Meanwhile, the raw materials that have received considerable attention to be developed are those from palm oil and its derivatives.

The raw material as the basic component of edible coating in this invention is palm oil, because Indonesia has abundant natural resources of palm oil with an area of palm oil plantations of around 14 million hectares and palm oil production of around 37.8 million tons in 2017. Palm oil-based edible coating is made from Stearin derived from palm oil, which is non-toxic, easy to obtain, cheap, biodegradable and environmentally friendly.

Bambang S. Purwoko et al, 1999 conducted a study entitled Effect of Post-Harvest Treatment and Storage Temperature on the Shelf Life and Quality of Mango (*Mangifera indica* L.) Arumanis variety using CaCl₂, spermidine, wax and plastic packaging at two storage temperatures (24 -25°C and 18-19°C). The results showed that post-harvest treatment gave an appearance value of 6 days after the treatment, except for waxing treatment until 9 days after the treatment. The temperature treatment of 18-19°C was effective in inhibiting the increase in softness, the increase in PTT, and the decrease in fruit acid content but could not inhibit the attack of post-harvest diseases at 15 days after harvest.

Khotimatus Sa'adah et al., 2015 conducted a study entitled The Effect of Beeswax Coating and Packaging on the Characteristics of Apple Mango Fruit (*Mangifera indica* L.) during Storage at Room Temperature. The result is that the effect of wax coating and packaging has a very significant effect on the characteristics: weight loss, total dissolved solids, fruit moisture content, texture and organoleptic (color, aroma, taste, texture) of mango apple fruit for 12 days of storage with an interval of 2 days and the best treatment used is obtained by using the effectiveness index method, namely the combination treatment of 6% wax layer with plastic wrap packaging.

Fardiana Eka Sari et al., 2004 conducted a study entitled The Effect of CaCl_2 Levels and Soaking Time on the Shelf Life and Ripening of the Arumanis Mango Fruit. The result was that the shelf life of mangoes soaked in a 4% CaCl_2 solution had increased linearly with increasing immersion time. On the other hand, mangoes soaked in an 8% solution of CaCl_2 ripen faster.

METHODS

Materials and Equipment

The materials needed in this research include Palm Stearin, polyalcohol, base catalyst, polymer polysaccharide, antifungal, palm-based emulsifier, Aquades, and Arumanis mangoes from the plantation owned by PT. Trigatra Rajasa (Situbondo) with a maturity level of 80 – 85% (floats).

The equipment used in this study include a hotplate, homogenizer, stirred reactor, 1 L beaker glass, thermometer, analytical balance, measuring cup, and measuring flask.

Research methods

The first step is the manufacture of palm oil ester is consisted of Palm Stearin and polyalcohol with a mole ratio of 2:3. The esterification process was carried out at a temperature of 90 – 100°C for 6 hours. After the process is complete, the resulting product is put into a mould. The next step is the manufacture of edible coating based on palm oil derivatives such as 2% (w/v) palm oil esters, 0.03% (w/v) polymer polysaccharides, 0.7% (w/v) emulsifiers, and antifungals. by 0.2% (w/v). This process is carried out in 30 - 60 minutes at a temperature of 70 - 80°C. After the process is complete, the resulting product is put into a covered container. The flow chart of the process of making edible coatings based on palm oil derivatives can be seen in Figure 1. While the stages of testing edible coating products based on palm oil derivatives on Arumanis mangoes can be seen in Figure 3.

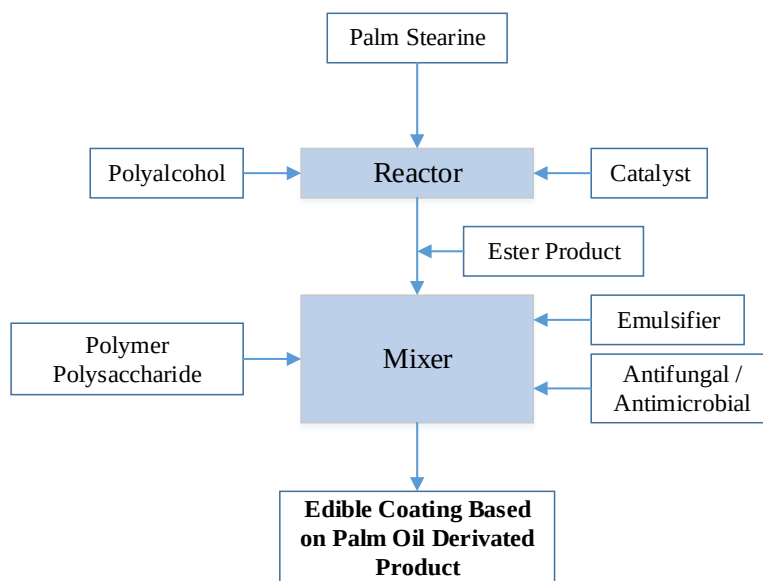


Figure 1. Flowchart of the Formulation Process for Palm Oil Based Edible Coating Products



Figure 2. Palm Derivative-Based Edible Coating Products for Mango

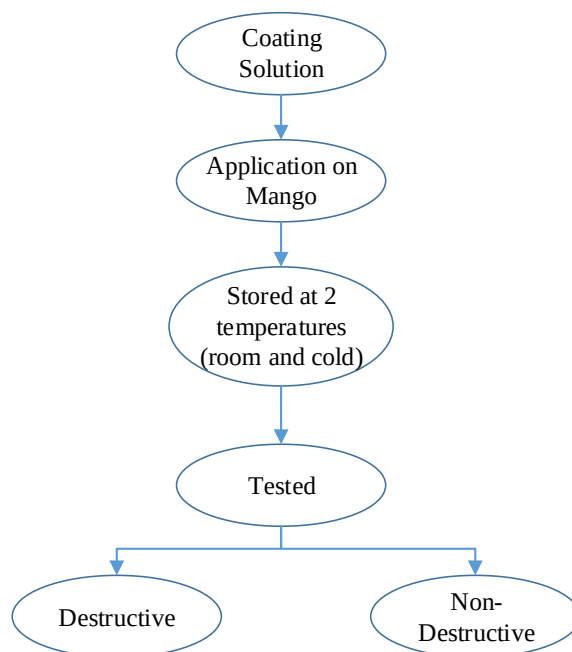


Figure 3. Stages of Testing Edible Coating Products Based on Palm Oil Derivatives on Arumanis Mango

RESULTS AND DISCUSSION

In this study, destructive and non-destructive testing were conducted. In the destructive test, the level of hardness, Total Dissolved Solids (TPT), and the appearance of the fruit flesh were measured. Meanwhile, non-destructive testing is when weight loss, respiration rate of O_2 and CO_2 , measurement of fruit skin color, and appearance of fruit skin were measured.

Outer Appearance (Fruit Peel)

The outer appearance (skin) of mangoes during storage at cold temperatures and high RH is shown in Figure 4. It can be seen that the coated and uncoated (control) mangoes at cold temperatures still looked fresh until the 4th week, but at the 5th week until the 6th week, the uncoated mangoes (control) had rotted and were unfit, while the coated mangoes still looked fresh. Mangoes that were coated with a palm-derived formula dried quickly (± 5 minutes), did not appear sticky nor shiny.

	1st week	2 nd week	3 rd week	4 th week	5 th week	6 th week
Coating Based on Palm Oil Derivated						
Non Coating					X	X

Figure 4. Changes in the Outward Appearance of Mangoes Maturity Level 80 - 85% (Float) which received Coating and Uncoated (Control) treatment during Cold Storage

Weight Loss

Changes in the weight of mangoes can be seen in Table 1 and Figure 5. It can be seen from the two graphs that in general the weight loss of mangoes in cold storage after the 3rd week without coating (control) experienced a change in weight loss of more than 5%, while coated mangoes was still experiencing changes in weight loss below 5%.

Table 1. Changes in Weight Loss of Arumanis Mangoes at Cold Temperatures with 80-85% Ripening Levels

Coating Formula	Day at					
	0	2	7	14	21	28
Coating Based on Palm Oil Derivated	386.5	383.7	380.4	375.2	369.9	367.4
	100%	99.3%	98.4%	97.1%	95.7%	95.1%
Non Coating	417.8	414.9	408.8	399.8	393.2	389.0
	100%	99.3%	97.8%	95.7%	94.1%	93.1%

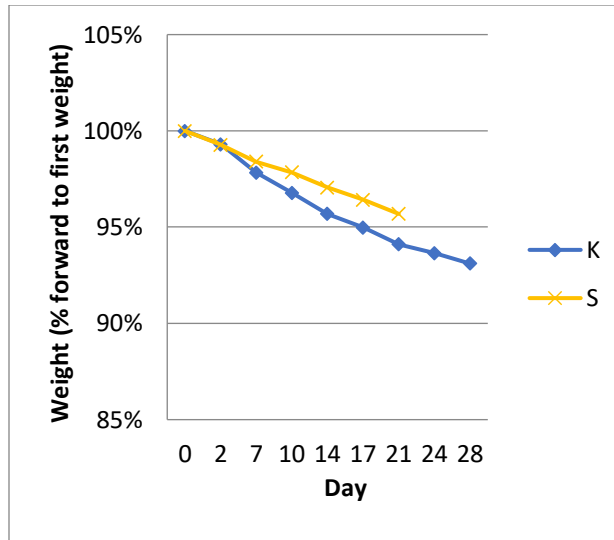


Figure 5. Changes in Weight of Mangoes (% of Initial Weight) That Get Coating and Without Coating Treatment in Cold Storage

In the storage of Arumanis mangoes at room temperature, it can be seen from the graph that the weight loss value had decreased drastically, both coated and uncoated and the weight loss value was above 5% on the 7th day. Therefore, the Arumanis mango test at room temperature was carried out for only 2 (two) weeks and after that it was declared as unfit.

Table 2. Changes in Weight Loss of Arumanis Mangoes at Room Temperature with Maturity Level of 80-85%

Coating Formula	Day at				
	0	2	7	10	14
Coating Based on Palm Oil Derivated	100%	97,1%	93,3%	91,6%	89,3%
Non Coating	100%	96,4%	92,0%	88,9%	85,0%

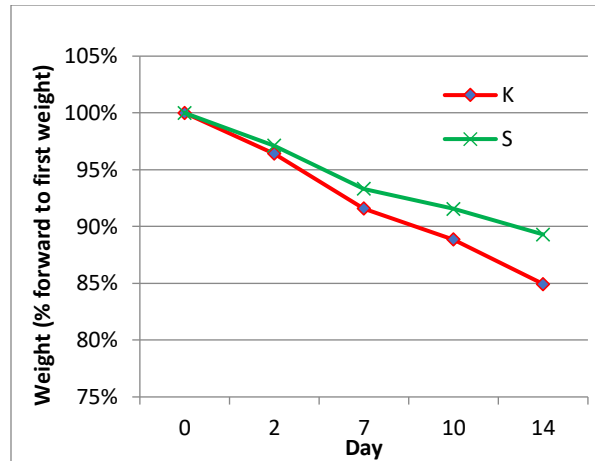


Figure 6. Changes in Weight of Coated and Uncoated Mangoes During Storage at Room Temperature

Fruit Flesh Appearance

The appearance of mango flesh during storage is shown in Figure 7. It can be seen that both coated and uncoated (control) mangoes at cold temperatures remained fresh until the 4th week, but at the 3rd week the uncoated (control) mango started to look more yellow than the coated mango, and at the 5th week the uncoated mango (control) was declared as unfit.

	1st week	2 nd week	3 rd week	4 th week	5 th week	6 th week
Coating Based on Palm Oil Derivated						
Non Coating					X	X

Figure 7. Changes in the Appearance of Mango Flesh Maturity Level 80-85% (Floating) That Gets Coating and Without Coating Treatment (Control) during Cold Storage

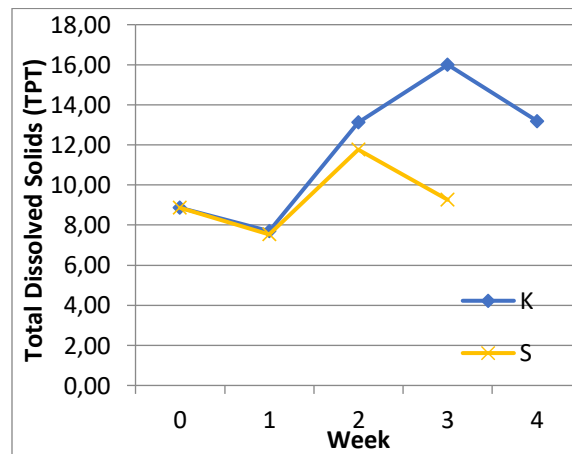
The appearance of the skin and flesh of the Arumanis mangoes on testing at room temperature showed that on the 14th day the mango skin had already looked brown and the flesh was also had ripen.

	7 th Days		14 th Days	
Coating Based on Palm Oil Derived				
Non Coating				

Figure 8. Outer Appearance and Flesh of Mango that Received Coating and Without Coating Treatment at Room Temperature Storage

Total Dissolved Solids (TPT)

Changes in the TPT value of mangoes at maturity level of 80-85% or groups of floating mangoes that were coated and without coating (control) for 4 weeks of storage at cold temperatures can be seen in Figure 9. Mangoes with coatings from palm-derived formulas were only measured up to a week. the 3rd.



Keterangan S : palm oil derived, K : Control (No coating)

Figure 9. Changes in Total Dissolved Solids (TPT) of Mangoes Treated with Coating and Non Coating (Control) during Storage at Cold Temperatures

In general, it was seen that the mango which was coated or uncoated at the maturity level of 80-85% (float) during 4 weeks of cold storage (11-15°C, 85-95% RH) tended to increase. The TPT of

uncoated mangoes was seen to be higher than that of coated mangoes, this means that the coated mangoes were able to slow down the ripening period of the fruit.

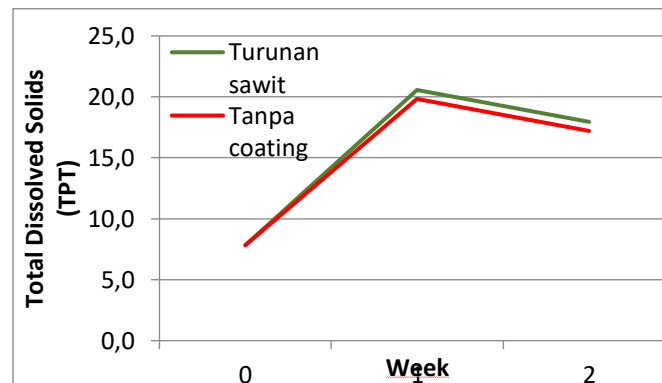


Figure 10. Changes in Total Dissolved Solids (TPT) of Coated and Uncoated Mangoes During Storage at Room Temperature

Hardness (Firmness)

In general, it can be seen that mangoes that are coated or uncoated, were ripen at 80-85% (float) during 4 weeks of cold storage (11-15°C, RH 85-95%) tend to decrease in hardness.

The Hardness level data on uncoated (control) mangoes with coated mangoes at cold storage experienced an insignificant change in the level of hardness, but in the 2nd week, mangoes coated with palm derivatives experienced a higher level of hardness change when compared to the uncoated. Although at the 3rd week it was seen that the control had a higher level of hardness change than the coated one. The graph of the hardness level can be seen in Figure 11.

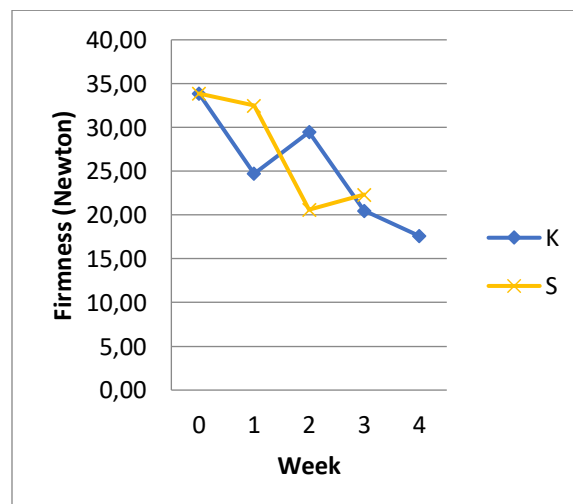


Figure 11. Changes in Hardness of Mangoes That Get Coating and Without Coating Treatment (Control) During Four Weeks of Storage at Cold Temperatures

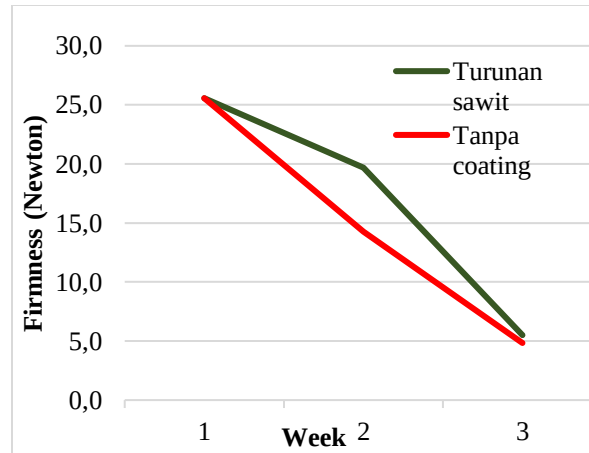


Figure 12. Changes in Hardness of Coated and Uncoated Mangoes During Storage at Room Temperature

Respiration

The results of measurement of respiration of mangoes coated with a palm-derived formula for respiration of mangoes without coating (control) during cold storage can be seen in Figure 13 for O_2 and Figure 14 for CO_2 .

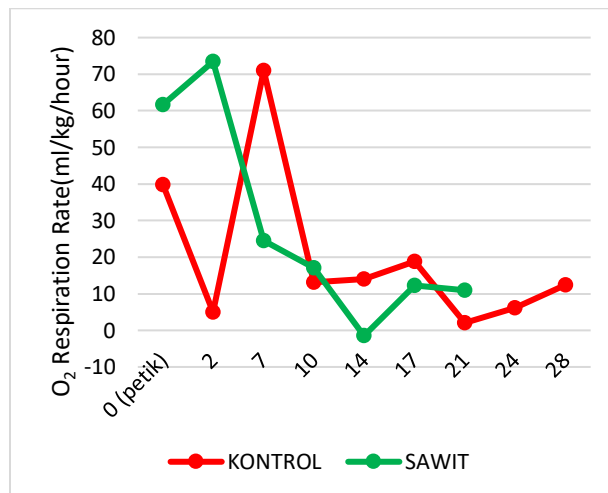


Figure 13. O_2 Respiration Rate of Mangoes That Get Coating Treatment During Storage at Cold Temperatures

It can be seen in Figure 13 that the respiration rate of O_2 in all treatments, both coated and without coating, seems to form a typical pattern of climacteric fruit, namely respiration increases to climax on the 9th day and then decreases, but what is difficult to understand on the 28th day is that it increases again. In CO_2 respiration (Figure 10) the climacteric pattern is not very clearly visible. This pattern also does not follow along with other parameters (weight loss, TPT and hardness).

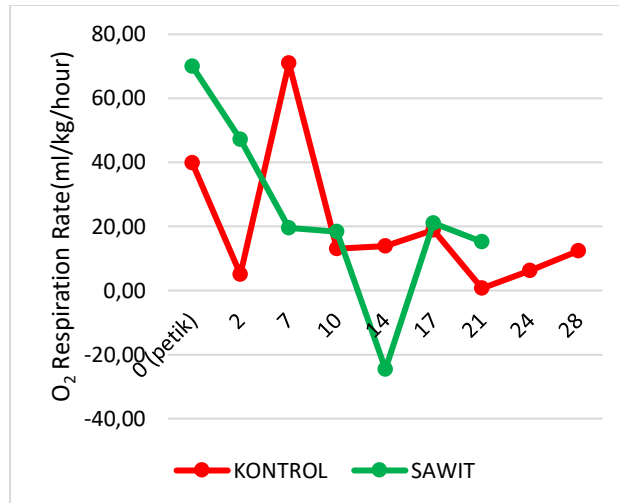


Figure 14. CO₂ Respiration Rate of Mangoes Treated with Coating and Without Coating (Control) During Storage at Cold Temperatures

CONCLUSION

The use of palm oil-based edible coating products has been able to reduce the weight loss to below 5 (five) percent for approximately 4 (four) weeks, so that this palm oil-based edible coating can be said that it is capable to extend the shelf life of mango fruit up to four weeks. In addition, this palm oil-based edible coating has a surface that is not shiny, not sticky, and dries quickly when applied to this arumanis mango with a maturity level of 80-85%.

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