Development of Palm Oil Derivative Based Coating to Extend the Gedong Gincu Mangoes Freshness

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Abstract. One of the postharvest activities is to extend the freshness of mangoes by lengthening the climacteric stage and delaying fruit senescence using coating technology. Based on the result of the study, it showed that palm oil derivatives based coating could extend the life of the mango up to 16 days, compared to uncoated mangoes, which already rotted in 12 days. The coating had been able to suppress weight losses to 11.40%; TDS/Brix of coated mangoes was consistently lower at 18.6, compared to the uncoated at 20.7, the hardness level of the coated mangoes was consistently higher at 2.95 kg/cm^2 than uncoated at 2.82 kg/cm^2. Additionally, the O_2 respiration of the coated consistently below the uncoated.Yet, the CO_2 respiration was inconsistent. The fruit skin appearance of the coated mangoes was still green and fresh, while the uncoated ones on the fifth day already looked wilt and rot. The fruit flesh appearance of the coated mangoes was still yellow and fresh on day 16.

Keywords: Coating, Climacteric, Gedong Gincu Mango, and Palm Oil Derivatives

1 Introduction

The lengthening of the freshness of horticulture produced using coating technology has been widely practiced. It delays the rotten processes to benefit storage time for prolonged production availability and distribution time. Naturally, fruits are covered with a waxy coat. This layer is to maintain the exchange of CO_2 and O_2, as well as to prevent excessive water loss. The transpiration process causes the fruits to lose water. It progresses with storage time duration, causing them to shrivel and wrinkle, affecting unappealing appearance, unfreshness, and weight loss—the wax layer over the skin fruit leaches during washing in the postharvest handling process. The thinning of the waxy layer on the fruit surface can accelerate fruit metabolism by increasing respiration, especially in the ripening process.

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To restore the wax layer and to ensure fruit skin is covered with a wax layer, a coating is required using a wax emulsion. Thus, the coating is an attempt to slow down the ripening process, which aims to extend the life of the product by suppressing the rate of respiration, rate of intake of O_2, and rate of removal of CO_2. Hence, it slows down the metabolic process of fruit, prevents excessive water loss (transpiration), and inhibits the rate of formation of Ethylene. General requirements of coating fruit materials include not affecting smell and taste, drying quickly, not being sticky or easily broken, producing various thick surfaces, being non-toxic, and being obtained easily and cheaply. It is also expected to be more attractive due to its shiny appearance. It makes the product more acceptable and appealing to customers for extended periods.

The edible coating can be synthesis and formulated from sugarcane wax, carnauba wax, resin, thermoplastic, terpene, resin, shellac, honey beeswax, conventional wax, hydrocolloids (proteins, polysaccharides), lipids and composites (a mixture of hydrocolloids and lipids). These wax-coating bases indicate the possibility of using triglyceride as a base coating material. Meanwhile, synthesis products from palm triglyceride have also been developed, including for coating fruit formulations. Palm oil-based coating is made from palm oil derivatives, which are non-toxic [1], easy to obtain, cheap, biodegradable, and environmentally friendly. This palm oil raw material has drawn attention to be developed for diverse downstream products since Indonesia has abundant natural resources with a plantation area of more than 16.8 million hectares and production of around 47 million tons in 2022 [2]

Horticulture produces a vast spectrum of species and varieties; as a product of agriculture, they are perishable. Mangoes are one of the most favored fruits, with local-specific varieties and potential extensions of these produce trades. The lengthening of these fruits will have a significant economic impact on the business circle of this commodity. The *Gedong Gincu* mango variety, with a harvested maturity level of 90%, was chosen for this coating treatment [3]. Acccoridng to [4] in their paper, Arumanis used $CaCl_2$, spermidine, wax, and plastic packaging at two storage temperatures (24 -25^oC and 18-19^oC) to treat and handle the fruit. The results showed that the postharvest treatment still gave a good appearance after six days of storage, and the nine days of storage had a better appearance than the control. The temperature sore is 18-19^oC and was effective for inhibiting softness progress, BRIX (total soluble solid) increment, and acid content decrement but could not inhibit deterioration beyond 15 days after treatment.

A study conducted by [5] studied room temperature storing in The Effect of Beeswax Coating and Packaging on the Characteristics of Apple Mango Fruit (Mangifera indica L.). It showed that the wax coating and packaging have a very significant effect on the characteristics of weight loss, total dissolved solids, fruit moisture content, texture, and organoleptic (color, aroma, taste, texture) of mango apple fruit for 12 days of storage. The best treatment was obtained using the effectiveness index method, namely the combination treatment of a 6% wax layer and plastic wrap packaging. Moreover, [6] in their study stated that the shelf life of mangoes soaked in a 4% $CaCl_2$ solution had increased linearly with increasing immersion time. However, increasing $CaCl_2$ concentration could have the opposite effect. Soaking in an 8% solution of $CaCl_2$, the mangoes were ripen faster.

2 Research Method

The materials used in this research involved Palm Oil based Wax by BRIN, Polysaccharide, Antifungal, Palm Oil Base Emulsifier, Aquadest, and Gedong Gincu variety Mango from Sumedang Regency with the ripeness 90% [CV Windy, Sumedang, 2023]. The equipments used in this study were a hotplate, homogenizer, beaker glass 1 L, thermometer, analytical scale, measuring cylinder, and volumetric flask.

The research was conducted by formulating a coating emulsion using Palm Oil Wax, preparing the mangoes for coating application, covering mangoes through soaking, and testing the relevant matureness or ripeness parameter. The coating emulsion was prepared by mixing 2% (b/v) of Palm Oil Wax, 0,03% (b/v) of polysaccharide, 0,7% (b/v) of *emulsifier*, and 0,2% (b/v) for 60 minutes at 80^{o}C. The product was then stored in a covered vessel to be applied on mangoes. The steps are shown in Figure 1.

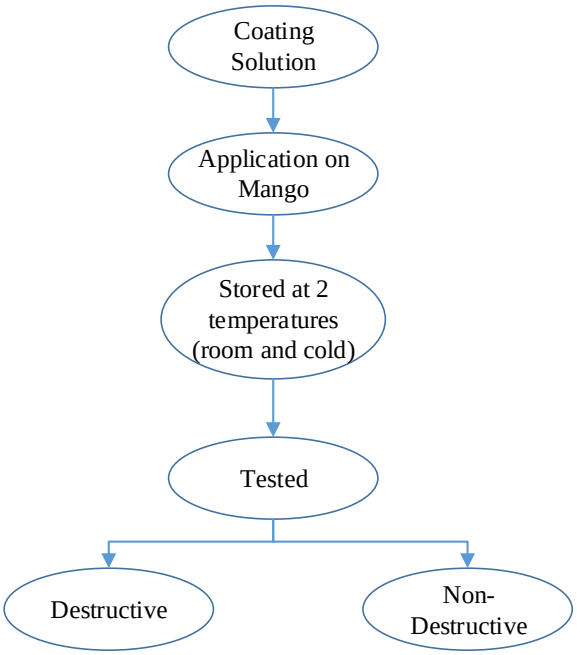

Fig 1. Application of Emulsion Coating Formula and Testing Block Diagram

3 Result and Discussion

The parameter testing in this study was conducted using both non-destructive and destructive methods. The non-destructive method was to measure the weight loss and respiration rate of O_2 and CO_2 and to observe the peel color and its appearance. The destructive method was to test fruit hardness, total dissolved solids (TDS), and endocarp appearance.

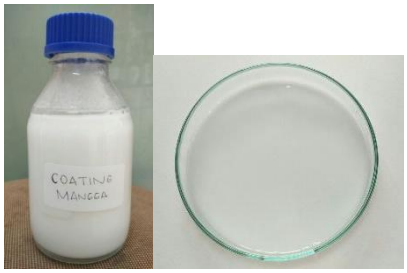

Fig 2. Palm Based Coating Emulsion for Mangoes

3.1 Weight Loss

The weight loss progress is shown in Table 1 and Figure 3. The coating hampered the losses during 16 days of the store time, 12.89% for uncoated and 11.40% for the coated fruit.

Table 1. Weight Loss Percentage of Gedong Gincu Mango During Room Temperature Storage

Weight Loss Percentage (%)		
Day	Control (Without Coating)	Coating Glossy
1st	-	-
2nd	1.42	1.21
5th	4.14	2.91
6th	4.92	3.56
7th	5.82	4.29
8th	6.60	4.94
9th	7.39	5.74
12th	9.33	7.95
13th	-	8.66
14th	-	9.53
15th	-	10.36
16th	-	11.40

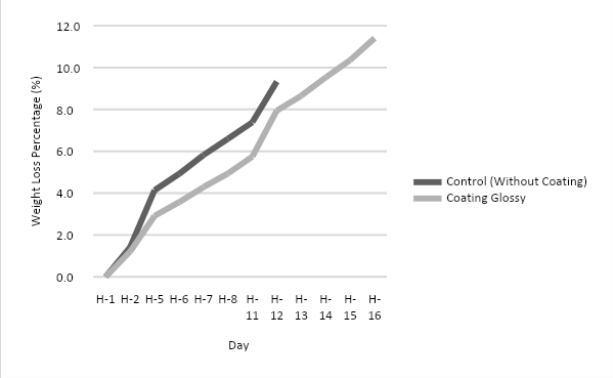

Fig 3. Weight Loss Percentage of Gedong Gincu Mango During Room Temperature Storage

3.2 Respiration

Mango respiration rate was observed for 16 days, both O_2 and CO_2. The measurement results are depicted in Table 2, Figure 4 for the O_2 respiration, while Table 3 and Figure 5 depict the CO_2 respiration. The O_2 respiration rate, either coated mangoes or uncoated mangoes (control), had the same pattern. The first day after harvesting, it dropped sharply and stabilized until day 8; it increased until 15^{th}-$16t^{h}$ day, and this O_2 respiration rate then surged after 15^{th}-$16t^{h}$ day. The O_2 respiration of the coated mangoes was always below the uncoated.

Meanwhile, the CO_2 respiration rate did not exhibit a specific pattern for both the coated and uncoated fruit, except on the day 1 after harvesting, and in the 15^{th}-$16t^{h}$ day, it rose. Between those days, it was up and down, and the coated mangoes were sometimes below the uncoated ones.

Table 2. O_2 Respiration Rate of Gedong Gincu Mango During Room Temperature Storage

O_2 Respiration Rate (ml/jam/g)		
Day	Control (Without Coating)	Coating Glossy
1^{st}	16.163,73	14.082,01
2^{nd}	14.412,93	13.000,58
5^{th}	14.195,48	13.262,99
6^{th}	13.960,78	12.825,13
7^{th}	13.635,22	12.494,64
8^{th}	14.097,23	12.755,13
9^{th}	14.253,74	12.896,79

12th	15.083,70	13.687,69
13th	-	13.695,84
14th	-	13.322,40
15th	-	13.720,87
16th	-	12.941,12

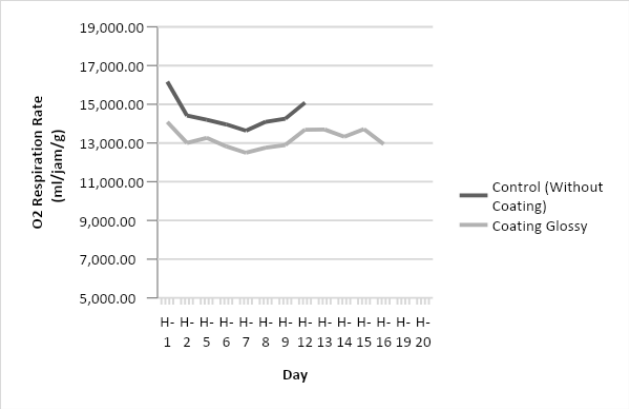

Fig 4. O_2 Respiration Rate of Gedong Gincu Mango During Room Temperature Storage

Table 3. CO_2 Respiration Rate of Gedong Gincu Mango During Room Temperature Storage

CO_2 Respiration Rate (ml/jam/g)		
Day	Control (Without Coating)	Coating Glossy
1st	4.542,35	3.370,65
2nd	7.380,98	6.362,53
5th	5.842,29	6.281,10
6th	6.974,63	6.162,78
7th	4.590,97	4.194,68
8th	5.303,27	4.473,03
9th	5.319,58	3.629,23
12th	5.673,72	5.972,81
13th	-	5.961,38

14th	-	6.148,88
15th	-	5.038,40
16th	-	4.010,08

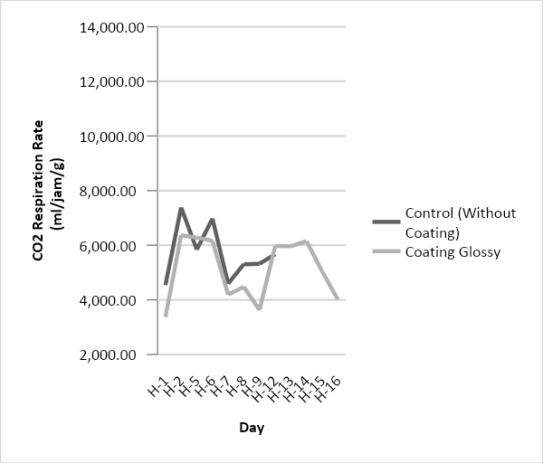

Fig 5. CO_2 Respiration Rate of Gedong Gincu Mango During Room Temperature Storage

3.3 Exocarp Appearance

The skin appearance of mangoes during storage at room temperature is shown in Figure 6. The mangoes' appearance changed and the peels became reddish-yellow with longer storage time. The uncoated mangoes changed quickly and almost evenly. The entire skin became reddish-yellow, and little black spots appeared. On day 7, the reddish-yellow color had evenly spread, and black spots were increasingly visible. On day 9, the uncoated mangoes were unappealing, and on day 12, black spots became larger and visible from the appearance of the skin, and the fruits were not suitable to be consumed.

Meanwhile, during 16 days of storing, the coated mangoes did not appear to have black spots, the fruit's skin was still mostly green with yellow having arisen, and the appearance of the fruit was still attractive.

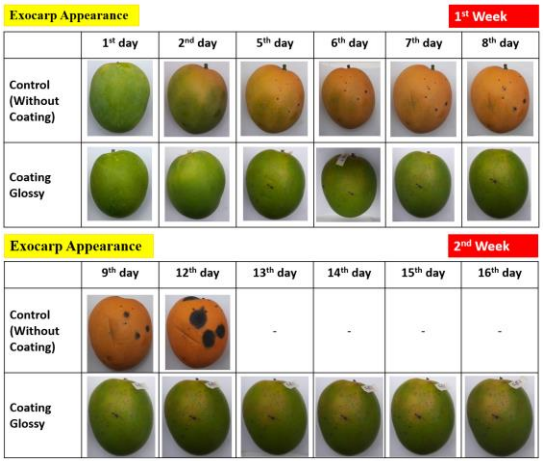

Fig 6. Exocarp Appearance of Gedong Gincu Mango During Room Temperature Storage

3.4 Mesocarp Appearance

The mesocarp mangoes appearance during storage at room temperature is shown in Figure 7. The appearance of the coated and the uncoated mangoes during six days of storage still looked fresh, although the uncoated mangoes became yellow since day 2. On the seventh day of storage, the uncoated mango began to have black spots and it continhued by the time of storage. On the twelfth day, the uncoated mangoes already looked bad to be consumed. Meanwhile, the coated mangoes still looked fresh until the 16th day of storage.

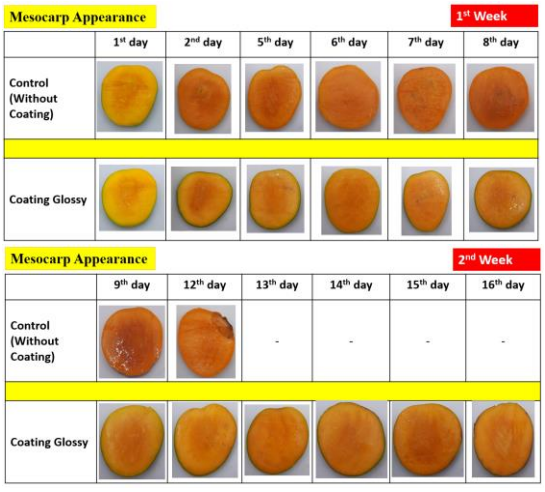

Fig 7. Mesocarp Appearance of Gedong Gincu Mango During Room Temperature Storage

3.5 Total Dissolve Solid (TDS)

The TDS value changes of the coated and *uncoated* mangoes during the 16th day of storage at room temperature are shown in Figures 8 and 9. During storage, the TDS mangoes either the coated or uncoated (control) increased. However, the uncoated mangoes' TDS value rose faster than the coated. The uncoated mangoes were kept only for 12 days and became rotten, meaning that the *coated mangoes* reduced the ripening period of the fruit.

Table 4. TDS Value of Gedong Gincu Mango During Room Temperature Storage

TDS Value (Brix)		
Day	Control (Without Coating)	Coating Glossy
1st	14.8	14.8
2nd	18.1	15
5th	19.3	17.2
6th	19.8	17.2
7th	20	17.2
8th	20.2	17.4
9th	20.4	17.6
12th	20.7	17.9
13th	-	18.2
14th	-	18.3
15th	-	18.5
16th	-	18.6

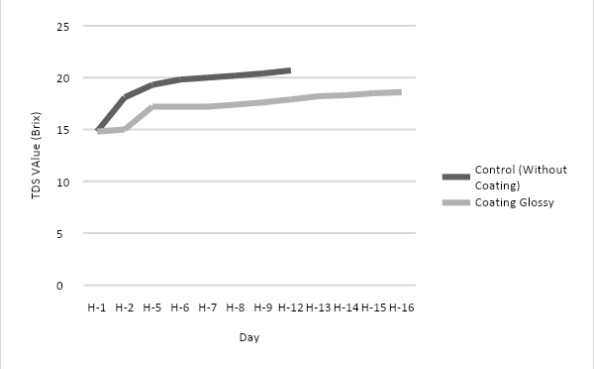

Fig 8. TDS Value of Gedong Gincu Mango During Room Temperature Storage

3.6 Hardness

The mangoes' hardness during storage at room temperature is shown in Table 5 and Figure 9. Both the coated or uncoated mangoes during storage until the 16th day at room temperature, decreased the mangoes' firmness. Although the uncoated mangoes' firmness value dropped faster. Thus, on the 16th day of storing, the coated mangoes had a firmness level of 2.7, while the uncoated ones had a hardness level of 2.13

Table 5. Hardness in Gedong Gincu Mango with a Ripe Level >=90% (Storage at Room Temperature)

Hardness (kg/cm^2)		
Day	Control (Without Coating)	Coating Glossy
1st	3.44	3.44
2nd	3.40	3.43
5th	3.15	3.16
6th	3.08	3.12
7th	3.00	3.11
8th	2.88	3.05
9th	2.83	3.04
12th	2.82	2.95
13th	-	2.92
14th	-	2.85
15	-	2.79

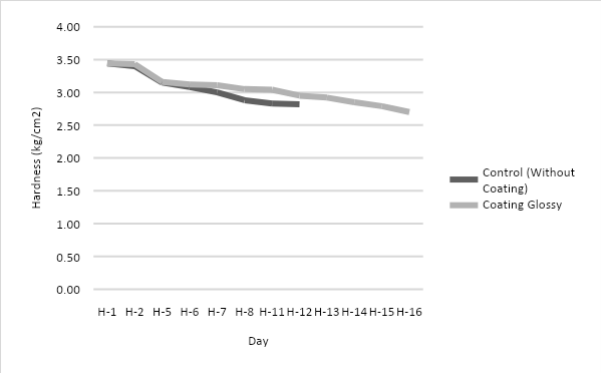

Fig 9. Hardness in Gedong Gincu Mango with a Ripe Level >=90% (Storage at Room Temperature)

4 Conclusions

During 16 days of storage, applying *palm oil-based* coating on Gedong Gincu variety mangoes reduced weight loss up to 11.40%. The Palm oil based coating maintained the appearance of exocarp and mesocarp. The fruit skin's appearance remained fresh, and the fruit flesh remained appealing after 16 days of storage. The application of this material withstood a decrease in the hardness value of the coated mangoes,compared to the uncoated ones. The slow-down in the increase of TDS also indicated that the palm oil based coating hindered the fruit's maturity rate.

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