Aloe vera and beeswax based coating to maintain shelf life of salak cv. Madu

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Abstract. The coatings on fruits after harvested was applied to maintain the appearance and quality up to the consumer’s hands. This study aimed to maintain color and reduce the level of decay of salak madu during storage. Salak madu was obtained from Madding Fresh, trader and supplier salak from Sleman, Yogyakarta. The salak was coated with Aloe vera gel (20% and 50%) and beeswax (3, 6, and 10%). All samples were stored at 25–28 °C. The parameters used to measure the effect of treatment are skin color, percentage of decay, and weight loss. Observations were carried out for 12 days. The results of this study were found that dyeing on a coating made from Aloe vera 50% was able to slow down weight loss and percentage of decay until the 6 days, while Aloe vera 30% was better at maintaining color changes during storage. Beeswax 3% coating can slow down discoloration and percentage of decay until 6 days of storage. Long-term storage (12 days) with beeswax 10% was better in maintaining changes in the quality of salak madu, while for short-term storage (6 days), beeswax 3% gives better results.

1. Introduction
Snake fruit or salak is tropical fruit growing in Indonesia that can be freshly eaten or processed into products like dodol, chips or pickles. Salak was a good source of natural antioxidants [1]. Salak has higher antioxidant content than mangosteen, avocado, orange, and papaya [2]. Salak madu is one of the superior salaks from Sleman, Yogyakarta, with characteristic shiny brown skin, flesh that has a lot of liquid and sweet taste like honey [3].

Like other horticultural products, salak has a relatively short shelf life. The causes of the quality decline of salak fruit are not only by microorganisms but also due to the high evaporation of water [4]. The rate of respiration and transpiration causes the fruit to dry quickly and wrinkles making it difficult in the process of stripping and makes the appearance of the fruit becomes less attractive. The solution to overcome these problems is to use a coating.

Edible films and coatings have been used to inhibit gas, vapor, and volatile transfer, reduce respiration and aging, lose aroma, retain moisture, retard discoloration during storage, and are used to enhance the outer appearance of fruit and vegetable products [5; 6]. Coatings can also act as a barrier during processing, handling, and storage [7].

One of the coating materials that has been widely used to extend the shelf life of fruits and vegetables is Aloe vera gel. Aloe vera gel has been shown to reduce microbial infections, reduce weight loss, color, total soluble solids, and improve the qualitative characteristics of fruit such as taste and aroma [8; 9]. The application of Aloe vera in blueberries can reduce fungal infections, reduce water loss, and extend the shelf life of blueberries by about 5 days [10]. Beeswax is a coating material made from lipid and...
rich with hydrophobic properties [11]. The addition of 20 g/100 g beeswax to HPMC can extend the shelf life of Angeleno plums by reducing weight loss, softening of the flesh, and internal damage, without affecting the sensory quality of the fruit [12]. Based on these problems, the aims of this study are to maintain the appearance of skin color and suppress the percentage of decay from the salak madu during storage by application Aloe vera and beeswax as a coating.

2. Material and Methods

2.1 Sample preparation and coating material
Salak madu was obtained from Madding Fresh (trader and supplier of salak), Sleman, Yogyakarta with 75-85% maturity. The sample used had been sorted and grading according to the Madding Fresh procedure. The fruit was sent using a plastic basket. Two hundred sixty-six salak madu fruits were randomly selected and divided into 7 groups of treatment. For each treatment, 38 fruit were selected. The Aloe vera used was obtained from Aloe vera farmers in Semplak, Bogor, West Java.

2.2 Aloe vera gel and beeswax making
Aloe vera was washed with running water before the trimming and filleting process. Aloe vera fillets then washed with distilled water and soaked in a solution of citric acid for 30 minutes. After soaking, the fillets were washed with distilled water and continue soaking in ascorbic acid for 15 minutes. The fillet was washed again with distilled water, and the refinement process was carried out using a blender at low speed for 30 seconds. The process was continued by homogenizing the gel to make it smoother by using a mixer that has been modified (grinder parts). The speed used was 7000 rpm for 30 minutes at 5°C. Beeswax emulsion making refers to [13]. Beeswax, tween 60, span 60, and water were melted using hotplate at above 70°C. Tween and span were simultaneously poured into beeswax and stirred with a magnetic stirrer. After all the ingredients were together, distilled water was added slowly while still stirring. Then all the ingredients being homogenized at high rpm (8500) for 15 minutes.

2.3 Coating application
The application of the coating was done by a dipped method in different coating material for 30 seconds, then air-dried with a fan. Storage using a tray and stored at a temperature of 25-28°C. Observation of changes in the quality of salak madu (percentage of decay, changes in color, and weight loss) was observed every 2 days for 12 days.

2.4 Level of Decay
The percentage of decay was calculated by dividing the number of damaged fruits by the initial amount of storage. Criteria for damage were observed visually and physically, namely the dry skin, foul with a pungent odor or rot, and fungi. The level of decay was calculated using the following equation:

\[
\text{Decay} (\%) = \frac{\text{number of fruit decayed}}{\text{total number of fruit}} \times 100
\]

2.5 Color
Color changes were observed using a Minolta CR-400 chromameter on the 3 sides of the skin every 2 days. The data obtained in the form of values L, a, and b. The L value corresponds to the brightness with a scale value between 0 (black) and 100 (white). The a value has a coordinate with negative values for green and positive values for red. The value of b has positive coordinate values for yellow and negative values for blue.

2.6 Weight Loss
Weight loss measurements were carried out using the Mettler PM-4800 scales with a precision of 0.01 grams. Measurements were made by comparing the initial weight before storage and during storage. Measurements were made every 2 days with the same fruits. The weight loss was determined using the following formula and expressed as a percentage:
weight loss (%) = \frac{(W_0 - W_n)}{W_0} \times 100  \tag{2}

where

$W_0$ is the initial weight (g)

$W_n$ is weight loss under storage (g)

3. Result and discussion

3.1 Percentage of decay

The percentage of decay was measured to see the effect of coatings on maintaining the quality of salak madu during storage. The decay was caused by soft rot, dry skin, and fungus which causes a decrease in the quality of salak fruit. The percentage of decay on salak madu has increased in all treatments during storage (Table 1).

| Treatment | Storage time (days) |
|-----------|---------------------|
|           | 2       | 4       | 6       | 8       | 10      | 12      |
| K         | 5.71    | 15.71   | 35.71   | 55.71   | 74.29   | -       |
| A2        | 8.57    | 20.00   | 30.00   | 40.00   | 61.43   | -       |
| A3        | 4.00    | 15.71   | 27.14   | 42.86   | 57.14   | 70.00   |
| B1        | 5.71    | 5.71    | 14.29   | 22.86   | 48.57   | 75.71   |
| B2        | 5.71    | 25.71   | 25.71   | 42.86   | 65.71   | 80.00   |
| B3        | 0.00    | 20.00   | 31.43   | 45.71   | 62.86   | 74.29   |

Aloe vera coating concentration of 50% (A3) and 30% (A2) showed the ability to reduce decay until 6 days of storage with 27.14% (A3) and 30% (A2) damage compared to controls that had reached 35.71% with the component of decay were soft rot, dry matter, and fungus. Salak madu coated with Aloe vera coating 50% (A3) could reduce decay caused by dryness by 5.7%, soft rot by 17.1% and fungus by 4.3%, compared to the controls with the amount of decay to each component that were 17.1% (dryness), 12.9% (soft rot) and 5.7% (fungus). The low percentage of decay in salak madu coated with Aloe vera coating because of the ability of the gel as an antimicrobial that was able to suppress the population and control the growth of microbes in fruits like raspberry [6]. The low percentage of damage caused by fungus and dryness was also due to Aloe vera coating acting as a barrier that could limit water transfer and protect fruit skin from mechanical damage [9].

The percentage of fruit damage for all treatments were lower than the control with values for treatments B1 (3%), B2 (6%) and B3 (10%) respectively were 14.29%, 25.71%, and 31.34%, while damage to uncoated fruit (control) reached 35.7% after 6 days of storage. Salak treated with B1, all damage in the form of soft rot, and no damage was found due to dryness and fungi. Low damage to the fruit coated by beeswax because the lipid content in the coating material was able to produce a coating that limits the loss of fruit moisture [5]. The application of beeswax 3% could suppress damage better than beeswax 6% and 10%, which may be caused by high concentrations making respiration take place aerobically that could accelerate the damage [14].

3.2 Color Change

Skin color was one of the parameters that determine consumer acceptance when buying fruit. The level of fruit maturity could also be seen from the color of the fruit skin. Changes in the skin color of the salak fruit coated and controlled were measured by L, a, and b values. The value of the skin color of salak madu treated with a coating was presented in Figure 1.
Figure 1. Effect of Aloe vera gel and beeswax on L, a and b value of salak madu during storage

In Figure 1, it can be seen that the brightness of salak madu skin decreases at the end of storage. This showed that the skin color of the fruit was darkened due to dryness during storage. After the coating
application on salak madu with beeswax, salak madu skin had produced a higher brightness value than the control and *Aloe vera* gel. This was probably due to the whitish and mat look caused by beeswax [14].

The application of *Aloe vera* gel coating did not show any significant difference with the control. There was no significant difference between the fruit peels treated with control, which was the expected result because it is shown that the coating did not change the original color of the fruit during storage [16].

### 3.3 Weight Loss

All treatments showed an increase in weight loss during storage and have similar value when storage longer. Salak madu coated with *Aloe vera* coating with 50% (A3) and 30% (A2) concentration was better in maintaining weight loss until the 6th day of storage by 5.62%, and 5.79% compared to control by 5.85%. The low weight loss in the fruit treated with *Aloe vera* gel coating because *Aloe vera* can reduce the water loss in the fruit during storage [15]. The hygroscopic properties of *Aloe vera* also made the barrier between the fruit and the storage environment that allow the reduction of moisture loss [12].

| Treatment | Storage time (days) |
|-----------|---------------------|
|           | 0                   | 2 | 4 | 6 | 12  |
| K         | 0.00                | 2.14 | 4.09 | 5.85 | 12.21 |
| A2        | 0.00                | 2.03 | 3.93 | 5.79 | 11.17 |
| A3        | 0.00                | 2.02 | 3.82 | 5.62 | 10.84 |
| B1        | 0.00                | 2.09 | 4.10 | 6.04 | 10.92 |
| B2        | 0.00                | 2.16 | 4.14 | 6.02 | 12.27 |
| B3        | 0.00                | 2.01 | 4.12 | 5.89 | 11.24 |

Based on Table 1, salak madu coated with beeswax is better in maintaining the weight loss of salak for long-term storage. Beeswax concentrations of 3% (B1), 6% (B2) and 10% (B3) can maintain weight losses of 10.84%, 10.92%, and 11.24% until the 12th day of storage compared with controls of 12.21%. This is because wax-based coatings have low polarity so more effective at blocking moisture exchange [16].
Treatment and control fruits did not show significantly different results in maintaining the weight loss of salak madu. The absence of differences may be influenced by storage conditions, which can cause moisture loss [8]. The decrease in weight loss is caused not only by water loss but also due to differences in relative humidity from storage [14].

4. Conclusions

*Aloe vera* and beeswax as a coating on salak madu could reduce the percentage of decay but cannot maintain weight loss and skin color of the fruit. *Aloe vera* concentration of 50% is better in suppressing decay and preventing weight loss compared to control. The beeswax concentration of 3% is better to decrease the percentage of decay, and beeswax concentration of 10% is better used for long-term (12 days) storage.

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