Aloe Vera as A Coating Material for Tropical Fruits Using Spray Method

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Abstract. Aloe vera is one of the coating materials that has begun to be widely studied. The application of spray method in fruit coating requires the formulation of a solution to generate droplets that are small, smooth and can form a film. The purpose of this research was to study the characteristics of the film and droplet produced by various concentrations of aloe vera solution applied by spray method. Observation variables for selection of the best concentration included droplet diameter, film thickness, and Water Vapor Transmission Rate (WVTR). Solution with 10% aloe vera resulted in droplet diameter of 0.26 mm, while at a concentration of 20% yielded a droplet diameter of 0.37 mm. The thickness of the film produced from both concentrations were 0.9 mm. The WVTR value was not significantly different, i.e. 3.02 g/m²-day and 3.03 g/m²-day for the concentration 10% and 20%, respectively. The application of 10% aloe vera coating using spray method on rambutan of Lebak varieties decrease respiration rate from 15.08 ml O₂/kg-hour to 5.77 ml O₂/kg-hour at 10°C storage temperature. Based on these result, the selected formula of coating using spray method was 10% aloe vera solution.

1. Introduction
Fruits generally have stomata which are one of the reasons for their high transpiration. Transpiration causes loss of water in the fruits that they appear wilted and unappealing for sale and consumption. One of postharvest treatments that can be used to maintain fruits freshness is coating. Coating material that begun widely studied is aloe vera gel. Some previous research showed success in the use of aloe vera gel as coating agent. The addition of aloe vera gel on some coating materials was able to improve the characteristics of the film/coating to maintain fruit quality. The addition of aloe vera gel as much as 20% in chitosan was able to improve the mechanical properties of the film [1]. Composite coating made from sellak and aloe vera was able to maintain the quality of tomatoes up to 12 days at room temperature storage (28 ± 2°C) compared to just plain sellak [2]. Aloe vera gel was combined with gum (tragacanth) with a ratio of 50:50 as a strawberry coating material, able to maintain the quality of strawberry up to the 20th day of storage at 1°C with 95% RH [3]. Coating using aloe vera gel added with ascorbic acid, citric acid were able to maintain the texture, taste and color of pomegranate seeds in packaging for 12 days at 3°C [4]. Application of aloe vera gel as a coating material was also capable in reducing microbial populations in papaya fruit during cold storage [5].
The method used for coating applications on fruits and vegetables was the dipping method. This method was selected due to its simple method for implementation. However, not all types of fruits or vegetables are proper for this method. As an example, for strawberries and beans, dipping is less effective to form a uniform layer [6]. The other method that was developed was the spray method. The advantage of coating using spray method is the formation of low layer thickness [7]. Coating materials are easily attached to the surface of the peel and efficient in the amount of materials used [8]. The results of field studies indicate that postharvest handlers more select coating treatment using spray methods, especially for tropical fruits such as rambutan, salak which have a rough surface. The concentration of coating solution and spray pressure are the main factors to produce a good coating result. The objective of this research was to assess the concentration of aloe vera gel solution and pump pressure to produce the best coating result by spray method. The best result was applied to rambutan.

2. Materials and methods

Aloe vera leaves were obtained from Parung, Bogor Regency. Rambutan fruits were harvested directly from farmer field in Sindang Sari Village, Cikaum District, Subang Regency and immediately transported to the laboratory. Chlorine (liquid 14%) and glycerol (90% gliserin) were purchased from Bratacham chemical store in Bogor. Equipment used were sprayer type B-16E Spray Smart, vacuum chamber, concord paper, scanner, cold storage, digital refractometer, rheometer (Anton Paar, Physica MCR 301, Austria).

2.1. Sample preparation

Rambutans that have been harvested are sorted based on uniformity in size and color, and not defect. After rambutan arrived in the laboratory, sorting was done again to choose rambutan with the uniformity of peel color, spintern were not defect, no bruising or no injury. Rambutan stems were cut using scissors. Aloe vera leaves obtained from farmers are cleaned from soil and sap with tap water.

2.2. Aloe vera gel preparation

Hand-filleting method of processing Aloe leaves was done. Margins of each leaf was removed to separate the rind from the inner leaf gel (gel fillet) by a sharp knife. The gel fillet was washed several times with tap water until the mucus was clear. The gel fillets were blended for 6 minutes (3 minutes at maximum speed and 3 minutes at minimum speed. Commercial blender consist of 3 button speed (max, 1 (minimum) and 2 (medium) button). Crude gel was obtained by this method and it was filtered to discard the fibrous fraction. The gel being used for treatment aloe vera 100%.

2.3. Aloe vera film preparation

Aloe vera gel diluted with distilled water to make 10% and 20% (v/v) as a coating solution. The solution was added 2% glycerol as a plasticizer and homogenized using a magnetic stirrer (1000 rpm, 24 hours). The film is made by pouring 25 ml of solution on a 10 cm diameter petri dish, and oven-dried using 35°C for accelerate the drying of the film. The film formed than measured the thickness and water vapour transmission rate (WVTR). WVTR measurement was done by measured change in weight per unit time on the surface area of the film (gr/m2/day). The Weight changes indicate the amount of water vapor absorbed.

2.4. Viscosity measurement

Viscosity of coating solution was measured by a rheometer (Anton Paar, Physica MCR 301, Austria). Cone types sample plate with a diameter of 50 mm was used in this method. The viscosity was measured at range of shear rate 0.1-500/s (mPa.s unit)

2.5. Sprayer pressue measurement
Pressure of spray was measured by a pressure gauge (bar) that was placed between the hose pipe and nozzle using a T connection. Diameter and density of droplet determine of pressure of spray which will applied to product coating (Rambutan fruit).

2.6. Diameter and density of droplet measurement
Coating solution was colored using a coloring textile with a ratio 350 ml : 2 g (v/g). The white concord paper (15cm x 21cm) was placed on the floor. The solution was sprayed over concord paper with three pressures (high, medium and low). Droplet on the concord paper was scanned as image data and analyzed using MatLab software. Output of the analysis was droplet surface area. Droplets diameter was calculated by a formula of circle area. Droplet density was calculated from wet area of droplet on the 10 cm x 10 cm of concord paper divided by droplet diameter.

2.7. Coating application on rambutan
The concentration of solution that produces the smallest droplet size with high density was selected for coating rambutan. Rambutan was sprayed using coating solution with pressure selected base on the best result of previous study. Coated rambutans were stored at 10 °C on a tray (without packaging). The quality changes were measured (weight loss, moisture content, color of peel and TSS) every two days. Consumer acceptance of rambutan quality was tested organoleptically (color and freshness of whole fruit, texture and flavor of fruit flesh). The test was conducted on 25 panelists with a score range of 1-7. The limit rate of consumer acceptance was 4.

2.8. Quality change of rambutan measurement
The weight loss of rambutan was measured based on the changes of their initial and final weight. Peel moisture content was measured using a gravimetric method. Peel color was measured by a chromameter. TSS of flesh was measured by a digital refractometer.

3. Results and discussion

3.1. Coating solution characteristic
Characteristic of solution that must be considered in spray-method were viscosity and particle size of solution [8]. The viscosity of aloe vera solution 10% and 20%, respectively were 1.83 mPa.s and 2.03 mPa.s (shear rate:500/s, shear stress:1). The viscosity was influenced by concentration of the solution and the method of gel preparation (temperature, speed and time of centrifugation). The viscosity of aloe vera gel of 0.675 stoke (67.5 mPa.s) was obtained by centrifuging 10000 rpm for 30 minutes at 50 °C for a concentration of 100%. [9]. Another researcher [10], produced a gel with viscosity of 2.781 poise (278.1 mPa.s). Variations in the viscosity of aloe vera solution was determined by the preparation method as their was used. In coating fruits and vegetables using spray method, proper viscosity was one which can produce small droplets and high density.

3.2. Size and density of droplet
The highest pressure of the sprayer used in this study was 3.5 bar while the lowest pressure was 1.5 bar. Based on the range of pressure, three pressure levels were determined to be tested, i.e 3.5 bar, 2.3 bar and 1.5 bar respectively as high, medium and low pressure. The diameter and density droplet for two concentrations of aloe vera solution (10% and 20%) are presented in Table 1.
Table 1. Diameter and density droplet of the three pressure of sprayer

| Pressure of sprayer (bar) | Diamater of droplet (mm) (Solution 10%) | Diamater of droplet (mm) (Solution 20%) | Density of droplet (sum of droplet in 10 x 10 cm) (Solution 10%) | Density of droplet (sum of droplet in 10 x 10 cm) (Solution 20%) |
|--------------------------|----------------------------------------|----------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| High (3.5)               | 0.2643 ± 0.028                         | 0.3677 ± 0.163                         | 29124-30004                                                  | 8553-9185                                                     |
| Medium (2.3)             | 0.5167 ± 0.013                         | 0.8082 ± 0.058                         | 3228-3429                                                    | 1829-1890                                                     |
| Low (1.5)                | 0.9257 ± 0.079                         | 1.9612 ± 0.245                         | 1070-1453                                                    | 661-779                                                       |

Data in Table 1 shown pressure and concentration of solution were influenced to diameter and density of droplet. The high pressure and low concentration were produced small diameters and high of densities. A high droplet density will produce a better coating on surface of fruit. However, there is no droplet size reference for coating fruits and vegetables, so it was necessary to study the droplet size that was appropriate for the commodity to be coated.

3.3. Film characteristic

In this study, the WVTR subjected to the purpose of maintain freshness. The thickness and WVTR of each concentration of coating solution are presented in Table 2. The resulting film was thicker but higher WVTR value compared to wrapping plastic which has a thickness of 0.03 mm and WVTR of 0.19 g/m²/day. WVTR films can be reduced by adding other coating materials such as gum, beeswax, and sellac. However, using the spray-method application, it was expected to produce a thin layer on surface of rambutan.

Table 2. Thickness and WVTR of film

| Concentration | Thickness (mm) | WVTR (g/m²/day) |
|---------------|----------------|-----------------|
| 10%           | 0.086±0.004    | 3.030±0.012     |
| 20%           | 0.088±0.016    | 3.023±0.002     |

Based on the diameter and density of droplets, thickness of the film, therefore a solution with a concentration of 10% was chosen to be applied to coating rambutan.

3.4. Coating application on rambutan using spray method

Rambutans that have been sorted and cleaned were arranged on a hollow rack. Coating solution made from aloe vera 10% and 2% glycerol, sprayed with a pressure of 3.5 bar and a nozzle distance of 30 cm from the object. Spraying was carried out in two stages, the first stage was spraying for half of the rambutan surface and it was air fan dried. After drying, the rack was reversed and spraying was done for the reverse surface. The coated rambutan were placed in trays and stored in cold storage at 10 °C. During storage, an observation was done to the changing of quality and it was compared to controls (uncoated rambutan)

3.5. Respiration rate (Oxygen Consumption Rate)

Coating layer that formed on the surface of rambutan peel, was able to inhibit O₂ exchange. Figure 1, also shown oxygen consumption rate of rambutan coated with aloe vera 25% applied using dipping method [11]. The figure shown that the spray method produces a better coating than the dipping method. The advantages of coating with spray method are thinner formed layers [7], more strongly attached to the peel surface of fruit and more efficient in used of coating materials [8]
3.6. Quality change during low storage temperature

Moisture content of peel was one of the fruit freshness factors. Rambutan’s peel moisture content on the 10th day storage, decreased by 7.97% while the control was 12.83%. Using Scanning Electron Microscope (SEM) test, the coating formed on surface of spintern was shown in Figure 2, while on the surface of peel was presented in Figure 3. In the picture, it can be seen that the coating of the sprinter is quite evenly good distributed. The appearance of the spray method can get smoother results (evenly) [12]. While on the surface of peel, there were some parts that are not coated. The surface of peel covered by spintern was not easily reached by droplets. Repetitive coating, besides being able to cover the peel surface better, it can increase water vapor permeability and with this result can increase effectiveness in maintaining of peel freshness.

![Figure 1. Oxygen Consumption Rate of Rambutan during storage at 10 °C Temperature](image)

![Figure 2. Image layer on the surface of spintern obtained using SEM](image)

![Figure 3. Image layer on the surface of peel obtained using SEM](image)
Peel color was also a quality attribute that also shown the freshness of fruit. Brightness is expressed by the value of L, explaining that the coated rambutan is able to maintain brightness better than the control. At the beginning of storage, the value of L was 33.33. After 10 days of storage at 10 °C, the L value becomes 20.00 for the coated rambutan, while the control becomes 11.67. Meanwhile, the value of a and b for the coated rambutan was decreased by 12.33 and 14.67 points respectively, while for controls were 18.33 and 23.00. High color change was yellow to dark (value b). This result was supported by changes in the degree of hue value. Changes in L and Hue values for 10 days of storage can be seen in Figure 4. The degree of hue value 60-0 shows yellow to red discoloration, so the color of coated rambutan was much better than control.

In addition to water content and peel color, weight loss also has an influence on freshness of the fruit. The weight loss after 10 days of storage for the coated rambutan was 4.77% while the control rambutan reached 9.26%. The weight loss below 5% indicates freshness was still maintained. Besides being fresh, the TSS value of rambutan coated was also high at the 10th day of storage. TSS value of rambutan coated reached 24.87 °Brix higher than control 23.83 °Brix. Other study states that the TSS value of rambutan was in the range of 17.8 - 20.4 °Brix [13].

3.7. Organoleptic test
Organoleptic test was intended for determining the limits of consumer preferences. The variables used were the overall color of the fruit (peel and spintern), freshness of the peel, texture and taste of the flesh. For the coated rambutan, all quality variables are above 4 (the limit of consumer preference) up to the 10th day of storage. While for rambutan control, all quality variables tested were 4 and below 4. This result is better than the results of [11] research, where consumer acceptance is only up to the 8th day of storage in the same temperature.

4. Conclusion
Aloe vera solution with concentration of 10% had a viscosity of 1.38 mPas. Spraying at 3.5 bar (the highest pressure on the sprayer used), the droplet produced by the solution had the smallest size (0.264 ± 0.028 mm) with the highest density (29124-30004 droplet in the area of 10x10 cm). Application with spray method was able to produce layers that can inhibit respiration and decrease the freshness of rambutan compared to controls and dipping methods. Until the 10th day of storage in 10 °C, consumers give a rate above 4 (the limit of consumer acceptance was 4) for the color and freshness of peel, texture and taste of the flesh.

5. Suggestion
Optimization of repetitive coatings needs to be studied to produce the characteristics of the coating that can reduce transpiration and respiration better. The method of gel preparation will affect to the viscosity...
and size of the particles, therefore it is necessary to study the method of gel preparation which produces small size of the particles in order to obtain better characteristics of droplets and density.

6. References

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Acknowledgments
Presented gratitude to Ministry of Research, Technology and Higher Education of the Republic of Indonesia and Research Institutions and Community Service at Bogor Agricultural University has been funded this research as Applied Research Program with the title “Formulation Coating and It’s Application Techniques to Maintain Freshness for Support the Availability of Export-Quality Tropical Fruits.