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The Effect of Packaging Materials on Postharvest Quality of Salak Fruit Cultivar Pondoh (Salacca edulis Reinw.)

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Abstract
Salak fruit is generally considered to have a short storage life, because it is perishable fruit. The objective of this study was to investigate the effect of packaging material on the quality of salak fruit cultivar pondoh. In this research salak fruits were packaged in the three types of packaging materials: polyethylene plastic bags (PE), cardboard (CB), and bamboo baskets (BB), and it were stored at 26oC. Parameters of the research were considered in mass loss, water content, total soluble solid, and titratable acidity. The result of the research showed that packaging salak pondoh with polyethylene plastic bag has better quality than other packaging materials and can prolong its shelf life.

Keywords: packaging material, salak pondoh, fruit, quality

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INTRODUCTION

Salak is one of very popular fruit, which is can be eaten as fresh or preserved fruit and its nutritional value is very high. This snake fruit has been the local's favourite for its honeylike taste. It is famous among the east coast civilians whereby they grow the salak tree to harvest its fruit and in fact it provides income to some of the families in this region (Saleh, et al., 2018). The increased of domestic and foreign demand for salak must be followed by good distribution system to maintain the quality and prevent the damage during distribution and storage process.

Salak pondoh has a short shelf life caused by mechanical damage and friction or shaken during distribution process. Besides that, improper harvesting methods will damage the quality degradation of salak that accelerate the decay of the salak. The farmers need a solution to prolong the fruits lifetime, so it still can be sold after the peak season. So far, the farmers processed snake fruit traditionally. Innovation in postharvest treatment is needed to maintain the product quality (Anoraga and Bintoro, 2020).

Packaging technology as a proper horticultural handling is needed to maintain the quality of salak. Packaging technology in horticultural commodity is served to protect horticultural commodities from mechanical damage and environmental disturbances during handling and distribution process. The proper material packaging is one important factor to protect horticultural products from quality degradation, mechanical, physical, chemical, and microbiological damage. The objective of this research was to find the effect of material packaging of salak fruit during storage at room temperature.

RESEARCH METHOD

Materials and Equipment

Salak fruits were cultivar Salak Pondoh was harvested at 6 months after flowering, and it obtained from Bandungan, Semarang. Packaging materials that used were polypropylene plastic bag, cardboard, and bamboo basket. All of reagent that used was pro analysis.

Sample Preparation

Sample was treated by packaging into polypropylene plastic bag (PE), cardboard (CB), bamboo basket (BB), and control (without packaging). Each of packaging materials consists of six samples with three replicates. Packaged samples were stored at 26°C for 6 days.

Mass Loss

The percentage mass loss was determined according to the following expression:

$$\%ML_{(t)} = \frac{M_0 - M_{(t)}}{M_0} \times 100$$

where: $\%ML_{(t)}$ is the percentage mass loss at time t, M_0 is the initial sample mass and $M_{(t)}$ is the sample mass at time t.

Total Soluble Solids

Total soluble solids of salak juice were determined using a digital refractometer (Atago IPR-201, Tokyo, Japan) at 20°C and results were reported as °Brix.

Titratable Acidity (AOAC, 2000)

A total of 10 mL of salak juice is put in to a 100 mL measuring flask, diluted to a tera mark with aquades. Filtered sample, take 20 ml of obtained filtrate and inserted in to Erlenmeyer. The sample was added 2 drops of Phenolphtalein and titrated with 0.1 N NaOH until pink. The calculation of the total acid is done by the formula:

$$\text{Total acid} = \frac{b}{a}$$

where; a = amount of NaOH 0.1 N for titration (mL), and b = 10 mL of material.

Moisture Content (AOAC, 2000)

Weigh accurately about 5 g of sample in a previously dried and tared dish and place the dish with its lid underneath in the oven for 2 hours. The time should be reckoned from the moment the oven attains 130°C after the dishes have been placed. Remove the dish after 2 hours, cool in the desiccators and weigh. The dish should be placed back in the oven at half hour intervals till constant weight is achieved. The specification for the size of the dish should also be included. The calculation of the moisture content is done by the formula:

$$\text{Moisture content (\%)} = \frac{(W_2 - W_1)}{(W - W_1)} \times 100$$

Where,

W1 = Weight in g of the dish with the material before drying

W2 = Weight in g of the dish with the material after drying

W = Weight in g of the empty dish

Statistical Analysis

All data were subjected to one-way Analysis of Variance and means were separated using Duncan's multiple range tests using SPSS for Windows version 16.

RESULTS AND DISCUSSION

Mass Loss

Mass loss increased with the duration of storage. Difference in mass loss of salak was detected due to the effect of packaging material during storage period. The mass loss varied between 0,6% to 18,2% (Table 1). The highest mass loss was recorded for control (without packaging), whereas the lowest was for salak fruit packaged with polyethylene bags. In general, mass loss of salak increased during storage period. Salak fruit packaged with cardboard (CB) and bamboo basket (BB) had a higher mass loss compared to PE. On day 6, maximum mass loss (18,2%) was noticed in non packaged fruits which was higher than the mass loss of fruit packaged in PE, CB, and BB. Whereas, fruits packaged with PE bags had the lowest mass loss compared to other packaging materials. This result was in line with research conducted by Ssemwanga and Thompson (1995) and Azene *et al.* (2014). Polyethylene film as a material packaging retard the development of water stress and softness in the papaya fruit tissues (Workneh *et al*., 2012). A study by Gonzalez *et al.* (1990) showed that, low density polyethylene (LDPE) and high density polyethylene (HDPE) packaging delayed fruit ripening, reduced weight loss, and did not result in any off flavor both in mango and avocado fruits.

Table 1. Mass loss (%) of salak fruit with the different types of packaging materials

Treatments	Day		
	0	3	6
Control	0±0,00 f	14,40±0,04 c	18,20±0,02 a
PE	0±0,00 f	0,60±0,08 f	2,10±0,02 e
CB	0±0,00 f	12,90±0,02 d	17,80±0,06 a
BB	0±0,00 f	12,70±0,02 d	16,90±0,01 b

PE: polyethylene; CB: cardboard, BB: bamboo basket. Values are means ± standard deviation of triplicate determinations. The mean values along the same column with different superscripts are significantly different ($p < 0.05$)

Fruit mass is one of the factors that affect the quality of the fruit. The faster and greater the mass loss that occurs, the fewer sales profit is obtained. Mass loss indicates that the fruit has lost water during the storage process. This water loss is influenced by the rate of respiration and transpiration through the peel of the fruit (Hernandez-Munoz *et al.*, 2008). The lower mass loss of fruits in the package could be due to slow rate of ripening and prevention of excessive moisture loss. Packaging of salak fruit using cardboard and baskets shows a higher mass loss compared to polyethylene. This is probably due to the high water vapor tranmission of the wood-based packaging materials. The high water vapor permeability is related to the increase in the transpiration rate of the fruit. Increasing the rate of transpiration will result in a greater mass loss of fruit. According to Ščetar *et al*. (2010), PE has a low water vapor permeability.

Total Soluble Solids

The changes in total soluble solids (TSS) content of salak fruits during the 6 days of storage are displayed in Table 2. TSS values of salak fruits varied between 18,5-21,48 ^{o}Brix. On day 3, salak fruits had more TSS compared with fruits on day 0. Packaged salak had lower TSS content compared to control treatments. This could be due to accelerated ripening because of free access of the non packaged fruits to O_2 which increases respiration rates, resulting in faster conversion of starch to soluble sugars (Lam, 1990). PE bag packaged fruits maintained their TSS content better than control, CB, and BB. The TSS content of fruits packaged with PE increased slowly and reached its maximum on 3rd day of storage and followed by decreasing trend. The decline of TSS of the fruits is most likely due to the use of soluble sugars as respiration substrate which is promoted by higher temperature (Irtwange, 2006). The fruits packaged with cardboard and bamboo basket attained their maximum TSS content on day 6.

Table 2. Total soluble solid (°Brix) of salak fruit with the different types of packaging materials

Treatments	Day		
	0	3	6
Control	18,50±0,01 c	18,67±0,00 c	20,17±0,02 a
PE	21,01±0,04 a	21,48±0,01 a	21,03±0,02 a
CB	18,66±0,02 c	19,11±0,01 b	19,39±0,04 b
BB	18,50±0,07 c	19,73±0,03 b	20,27±0,06 a

PE: polyethylene; CB: cardboard, BB: bamboo basket. Values are means ± standard deviation of triplicate determinations. The mean values along the same column with different superscripts are significantly different ($p < 0.05$)

The amount of total soluble solids has been used as an indicator of fruit product quality and authenticity (Camara et al., 1996). The food industry uses soluble solids content as an indicator of fruit quality (Bruckner *et al.*, 2002). Total soluble solids reflect the total sugars and organic acids in the fruit. The results showed that the total dissolved solids increased with the storage time of the fruit. This is due to the breakdown of complex compounds, such as starch into sugar. It occurs during the ripening process and resulting in a sweet taste. Polyethylene can inhibit the breakdown of sugar during storage which is used in the respiration process. Cardboard and baskets have different characteristics from PE in that access to O_2 is easier. This will have an impact on increasing of TSS during the fruit storage.

Titratable Acidity (TA)

The TA value of salak fruits varied between 0,13%-0,39% (Table 3). Generally, TA of salak fruits showed a trend of an increase from day 0 to day 6. The results of this study are in contrast to the research conducted by Rinaldi *et al.* (2017) which showed that polyethylene retains titratable acidity during storage. Increase TA content of fruit caused by its ripening. On day 3 of storage, the TA of PE packaged fruits was higher than TA values in all other treatments, while the BB treatment was the lowest. At the end of storage, the TA of PE and CB treatment had the higher than TA values of control and BB treatments. The atmospheric modification created when fruits are packaged with polyethylene bags may delay respiration and as a direct effect, the consumption of respiration substrates such as organic acids and sugars is retarded. Consequently, as the fruit respires, the O_2 level could decrease and the CO_2 level increases in the bags (Kader, 1985). Under these atmospheric conditions, the respiration rate of the fruit decrease which is helpful since high acidity in fruit has been suggested to contribute in part to the flavor retention of ripened fruit (Bron and Jacomino, 2006). The authors have observed a slight increase in total acidity during ripening, which is believed to be associated with an increase in free galacturonic acid (Workneh *et al.*, 2012).

Table 3. Titratable acidity (%) of salak fruit with the different types of packaging materials

Treatments	Day		
	0	3	6
Control	0,14±0,03 e	0,23±0,08 d	0,36±0,05 b
PE	0,13±0,03 e	0,31±0,03 c	0,39±0,03 a
CB	0,14±0,00 e	0,24±0,04 d	0,39±0,01 a
BB	0,14±0,01 e	0,22±0,02 d	0,37±0,07 b

PE: polyethylene; CB: cardboard, BB: bamboo basket. Values are means ± standard deviation of triplicate determinations. The mean values along the same column with different superscripts are significantly different ($p < 0.05$)

Titratable acidity is directly related to the concentration of organic acids (citric acid, malic acid, tartaric acid, benzoic acid, etc.) present in the fruit and is an important parameter in maintaining their quality. There is generally a decrease in total acidity with ripening of commodity, though the content of one or more acids may increase. The continuous decrease in titratable acidity content of the fruits leads to loss in the tartness and ultimately the TSS acid ratio leads to development of a perfect taste blend at a particular stage of maturity which is an important parameter for judging the harvest maturity of the commodity (Kumar and Thakur, 2018).

Moisture Content

Moisture content of salak fruits with various materials packaging that stored at 26^{o}C was shown in Table 4. The results showed that the moisture content of packaged salak during storage was varied. All fruits loss their moisture content aftar 6 days of storage. The control fruits had the highest change in moisture content compared to other treatments. PE bags tend to maintained the moisture content during storage, better than CB and BB. The lowest change in moisture content of PE treatment is most likely due to the difference in water vapor transmission rate of the packaging materials. Decreased rate of respiration and transpiration could be the another reason for lower moisture loss.

Table 4. Moisture content (%) of salak fruit with the different types of packaging materials

Treatments	Day		
	0	3	6
Control	79,15±0,00 a	78,64±0,03 a	76,64±0,02 c
PE	79,88±0,01 a	79,71±0,07 a	79,29±0,03 a
CB	78,36±0,02 a	77,77±0,04 b	76,27±0,03 c
BB	78,56±0,02 a	77,45±0,01 b	77,01±0,03 b

PE: polyethylene; CB: cardboard, BB: bamboo basket. Values are means ± standard deviation of triplicate determinations. The mean values along the same column with different superscripts are significantly different ($p < 0.05$)

According to the previous study (Anoraga and Bintoro, 2020), it was found that the packaging significantly affect the water content of snake fruit. Snake fruit with plastic could keep the moisture content. Another research was observed by Haile (2018), showed that polyethylene plastic protects the fruits from moisture loss.

Proper packaging can prolong the storage life of fresh fruits and vegetables by preventing moisture loss and thereby wilting (Matche, 2005).

CONCLUSION

Packaging had an effect on mass loss, total soluble solids, titratable acidity, and moisture content of salak fruits. Based on the result of this study it can be concluded that packaging salak in polyethylene bags resulted in better postharvest quality.

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