

The Effect of Traditional Ripening Methods on Weight Loss and Sensory Characteristics of Sapodilla Fruit

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Abstract — Sapodilla is a climacteric fruit that widely cultivated in tropical areas, so proper post-harvest handling is required. Natural ripening results in uneven levels of fruit ripeness. The proper ripening techniques can control fruit ripeness uniformly. This study aims to know the effect of traditional ripening methods on the percentage of weight loss and physical changes, including color and texture of sapodilla fruit. The ripening techniques used were: 1. sunlight, 2. soaked in rice, 3. wrapped in linen, and 4. wrapped in paper. Ripening was carried out for 5 days, and observations were made on days 0, 1, 3, and 5 for weight loss, color, and texture. Based on the results, the traditional ripening method significantly affected the percentage of fruit weight loss and affected color and texture during the ripening process. The rate of weight loss on the fifth day of observation from highest to lowest was sunlight treatment (10.68%), linen (10.31%), paper (9.31%), and rice (8.12%). Changes in color and firmness began to occur on the first day of ripening using linen and rice. The linen and rice ripening treatment produced the sapodilla with the fastest ripening rate, as observed in the color and firmness of the sapodilla fruit after five days of ripening.

Key words – sapodilla, climacteric fruit, ripening, weight loss, sensory

I. PRELIMINARY

Sapodilla is a fruit that grows abundantly in tropical regions, making it widely cultivated in Indonesia. Indonesia is one of the largest producers of sapodilla in the world, with a harvest of 1.6 million quintals in 2024^[1]. Based on its respiration rate, fruits are categorized into climacteric and non-climacteric fruits. Climacteric fruits, after being harvested, experience a respiration peak due to increased ethylene gas production, whereas non-climacteric fruits do not^[2]. Sapodilla belongs to the climacteric fruit category, requiring proper post-harvest handling.

Natural ripening of agricultural commodities such as sapodilla results in uneven fruit ripeness. Uniform ripening can be controlled with the appropriate ripening technique. Ripening aims to speed up and standardize fruit maturity by storing agricultural commodities in enclosed or conditioned environments. The ripening process increases ethylene gas production and respiration rates, which subsequently alters sensory characteristics such as color, texture, aroma, and taste of the ripened fruit. Ethylene (C₂H₄) is a natural hormone in plants that plays a key role in fruit ripening. Traditional ripening methods such as using sunlight, rice soaking, papers, and linen are known to speed up fruit ripening and are considered safe. This study aims to gather data on weight loss and sensory characteristics of sapodilla fruit, including color and texture, after ripening.

II. RELATED RESEARCH

The principle of traditional ripening involves increasing the ambient temperature and trapping ethylene produced by the fruit to ensure uniform ripening. The increase in temperature raises respiration, transpiration, and ethylene hormone production^[3]. Traditional ripening methods are safer than synthetic ethylene methods, such as carbide, which may be harmful to health due to possible chemical residues and cause the fruit to have a less sweet taste, rot faster, and develop blemishes^[4]. Traditional methods are easier to apply and safer, though there is limited data on the sensory characteristics of ripened fruit.

III. RESEARCH METHODS

A. Materials

The materials used in this study were sapodilla fruits purchased from a traditional market, ensuring uniform size and condition, rice, paper, and linen. Tools used in the study included a scale and containers.

B. Methods

Sapodilla fruits were weighed, and their color and texture were observed using sensory analysis. The fruits were stored using four traditional ripening methods:

1. Treatment 1 (P1): Sun-dried

2. Treatment 2 (P2): Soaked in rice until the fruit was covered
3. Treatment 3 (P3): Wrapped in paper
4. Treatment 4 (P4): Wrapped in linen

Treatments 2, 3, and 4 were stored at room temperature, while treatment 1 was placed under direct sunlight. A total of 12 fruits were observed (4 treatments and 3 repetitions). Weight loss, color, and texture observations were made on days 0, 1, 3, and 5. Weight loss was calculated using the following formula^[5]:

$$\text{Weight Loss (\%)} = \frac{A - B}{A} \times 100$$

Keterangan:

A= wight of sapodilla day-0 (first day)

B= wight of sapodilla day-n (observation day)

C. Sensory Testing

A descriptive sensory test was conducted, where panelists were asked to observe the color and texture of the sapodilla fruit during the ripening process on days 0, 1, 3, and 5, and record their observations on a provided questionnaire.

D. Statistical Analysis

The data obtained are analyzed using One-Way ANOVA with SPSS 29.0 Statistical Software. The significance level is set at $\alpha = 0.05$.

IV. RESULTS AND DISCUSSION

A. The Effect of Time on Sapodilla Weight Loss

ANOVA analysis of the changes in sapodilla weight loss over the 5-day ripening period showed that the traditional ripening methods using sunlight, rice, linen, and paper had a significant effect on the weight loss of sapodilla fruit. Duncan's test ($\alpha=5\%$) indicated that weight loss increased significantly during the ripening period. The effect of time on the weight loss of sapodilla fruit can be seen in Figure 1.

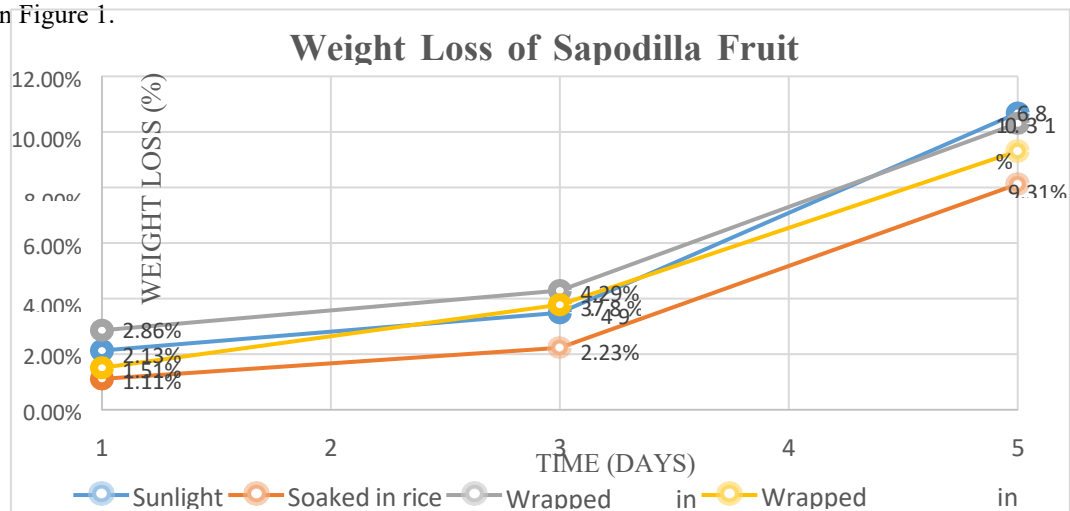


Fig. 1 The effect of ripening day on weight loss (%) of sapodilla fruit

Figure 1 shows that the longer the ripening time, the higher the percentage of weight loss in the fruit for each treatment. The increase in weight loss percentage indicates water loss and chemical changes that occur during the ripening process. The length of storage time naturally increases the respiration and transpiration rates (water evaporation) in banana fruit^[6]. The respiration process produces end products in the form of carbon dioxide (CO₂) gas, water vapor, and ATP, which are the result of the breakdown of complex compounds using oxygen as fuel. The gas and water vapor produced will evaporate, leading to weight loss in the fruit^[7].

The percentage of weight loss obtained reflects the percentage of water loss on the fruit's surface, which affects the fruit's quality, particularly its freshness and ripeness. The reduction in water content on the fruit's surface causes the fruit to wrinkle, soften, change color, and experience tissue damage^[8]. The weight loss in each treatment has a different percentage. This is due to the transpiration and respiration processes in sapodilla fruit being influenced by several factors, such as temperature, humidity, and the availability of oxygen in the environment, depending on the ripening method applied.

A. The Effect of Ripening Technique on Sapodilla Weight Loss

ANOVA analysis of the changes in weight loss of the fruit showed that traditional ripening techniques using sunlight, rice,

linen, and paper significantly affected the weight loss of sapodilla fruit on days 1, 3, and 5. The Duncan's test ($\alpha=5\%$) indicated that on day 1, ripening using rice and paper had the lowest weight loss percentage and did not differ significantly, while ripening using linen had the highest weight loss percentage. On days 3 and 5, the ripening techniques using sunlight, linen, and paper had the highest weight loss and did not significantly, while ripening using rice had the lowest weight loss percentage. The effect of ripening technique on sapodilla weight loss can be seen in Table 1.

TABLE 1.
SAPODILLA WEIGHT LOSS ON 3 AND 5 DAYS

Treatment	Weight Loss (%)		
	Time (days)		
	1	3	5
Sunlight	2,09±0.03 ^b	3,49±0.03 ^b	10,68±0.44 ^b
Soaked in rice	1,11±0.09 ^a	2,23±0.09 ^a	8,12±0.26 ^a
Wrapped in linen	2,85±0.53 ^c	4,29±0.53 ^b	10,31±0.68 ^b
Wrapped in paper	1,51±0.62 ^a	3,78±0.62 ^b	9,31±0.47 ^{ab}

*In the same column, a-c numbers that are followed by different letters indicate significant differences ($p < 0.05$)

Table 1 shows that on day 1, the ripening using linen had the highest weight loss percentage compared to other ripening methods. This is because linen can trap heat in the form of energy produced by the fruit during the respiration process. The trapped heat causes an increase in the ambient temperature, which results in an increase in respiration rate. Respiration rate is one of the factors that affects fruit weight loss during the ripening process. A decrease in respiration rate occurs by 2-3 times for every 10°C decrease in temperature^[9]. Similarly, an increase in temperature will result in a greater weight loss compared to lower temperatures^[10]. In addition to temperature, oxygen availability also affects sapodilla weight loss. Sapodilla fruit stored in containers that are not airtight experiences a faster increase in weight loss compared to those stored in plastic containers^[11]. In line with the research findings, ripening using rice causes the oxygen from the environment to have difficulty migrating into the rice due to its dense packing, which creates an airtight condition.

On days 3 and 5, there was an increase in weight loss for each treatment. Ripening using sunlight, linen, and paper resulted in higher weight loss compared to ripening using rice. This is suspected to be due to the increase in storage temperature and oxygen availability in the environment, which in turn increases transpiration and respiration rates. Fruit stored at 15°C is able to inhibit the transpiration process, as indicated by a lower weight loss percentage compared to fruit stored at room temperature, where transpiration occurs more rapidly^[12]. Ripening with rice helps to slow down the transpiration process by maintaining the environmental humidity^[13]. Transpiration is the main cause of weight loss in fruit, with part of it also attributed to respiration processes^[14]. The water loss due to high transpiration leads to the shrinkage of fruit tissue. This explains why fruit ripened in rice undergoes a slower transpiration process.

B. The Effect of Ripening Technique on Sapodilla Color

The observation of fruit color during the ripening process was done by monitoring the color changes in sapodilla through sensory analysis. Color is one of the important factors that affect the quality of sapodilla fruit. The color change in sapodilla fruit indicates that the fruit has reached the ripening phase, which is triggered by the increased production of ethylene gas. The color change in sapodilla fruit can be seen in Table 2.

TABLE 2
EFFECT OF RIPENING ON THE COLOR SAPODILLA FRUIT









Days	Treatment			
	Sunlight	Soaked in rice	Wrapped in linen	Wrapped in paper
0	greenish brown	greenish brown	greenish brown	greenish brown
1	greenish brown	Brown	Brown	greenish brown
3	gniform brown	Brown	Brown	Brown
5	uniform brown	Brown	dark brown	Brown
Day-3 picture				
Day-5 picture				

Table 2 shows that the observation of different ripening methods caused variations in the uniformity of color changes observed. Color change occurred on day 1 for the ripening methods using linen and rice, whereas the color change for ripening with sunlight and paper occurred only on day 3. The color change progressed from a greenish brown to a uniform brown, indicating chlorophyll degradation during storage. In ripening using rice and linen, the ethylene produced was trapped in the environment, which accelerated the ripening process. However, the fruits ripened using sunlight and paper did not undergo complete ripening, likely due to the evaporation of ethylene into the environment.

The color change in the skin of sapodilla during the ripening process is caused by the accumulation of carotenoid pigments resulting from chlorophyll degradation, which indicates fruit tissue damage^[15]. The duration of the ripening process affects the damage to the fruit's skin tissue due to the increased respiration and transpiration rates^[16]. The damage to the skin tissue is characterized by an enzymatic browning reaction involving polyphenol compounds that produce brown-colored quinone compounds, gradually reducing the visual quality of the fruit

C. The Effect of Ripening Treatments on the Texture of Sapodilla Fruit

The observation of fruit texture during the ripening process was carried out by monitoring changes in sapodilla texture through pressure testing. The main factors affecting the texture of the fruit are respiration activity and the increased production of ethylene gas in the fruit^[15]. The changes in the texture of the fruit can be seen in Table 3.

TABLE 3.
EFFECT OF RIPENING ON THE TEXTURE OF SAPODILLA FRUIT

Treatment	Days			
	0	1	3	5
Sunlight	Hard	hard	Firm	slightly soft
Soaked in rice	Hard	hard	Firm	soft
Wrapped in linen	Hard	hard	slightly soft	soft
Wrapped in paper	Hard	hard	Firm	soft

Based on the observations, changes in texture occurred on day 3 for all ripening methods: slightly hard for ripening using sunlight, rice, and paper; unevenly soft for ripening using linen. On day 5, the sapodilla fruit had ripened, indicated by the uniformly soft texture for all treatments except for the sunlight treatment. The softening of the fruit was caused by water evaporation from the fruit's cell tissues, leading to cell shrinkage and the merging of intercellular spaces, which causes pectin to bind together^[17]. However, the results obtained do not correlate directly with the weight loss, as it is suspected that many factors influence the softening of the fruit besides the reduction in water content, such as respiration activity and increased ethylene gas production.

During the softening process, pectinase and cellulase enzymes play an important role in breaking down the fruit's cell wall compounds. The activation of these enzymes is influenced by temperature and ethylene availability. During the respiration activity of fruit ripening, the cell wall, initially composed of insoluble protopectin, is broken down into pectin, leading to fruit softening^[18]. Ripening with rice and linen is thought to accelerate fruit softening by trapping the ethylene produced by the sapodilla fruit, thus activating the pectinase and cellulase enzymes. This is in contrast to ripening with sunlight, where this method cannot trap the ethylene produced by the fruit, meaning it is not utilized by the fruit for the ripening process.

V. CONCLUSION

The conclusion must clearly indicate the results obtained, the strengths and weaknesses, and the possibility of further development. Conclusions can be in the form of paragraphs, but preferably in the form of points using *numbering or bullets* . The conclusion contains the conclusions of the research conducted and suggestions for further research.

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