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EFFECT OF DRYING TIME ON MOISTURE AND SENSORY QUALITY OF SAPODILLA SUGAR *(Manilkara zapota)*

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ABSTRACT

Sapodilla (Manilkara zapota L.) is a sweet fruit rich in dietary fiber and is known to help alleviate digestive disorders. In addition to being consumed fresh, sapodilla can be processed into various value-added products, making it a promising source of natural sweeteners. This study aimed to evaluate the effect of drying temperature and drying time on the quality of sapodilla sugar. The drying process was conducted at a constant temperature of 80 °C with five different drying times: P1 (60 minutes), P2 (90 minutes), P3 (120 minutes), P4 (150 minutes), and P5 (180 minutes). Analysis of variance (ANOVA) was used to determine the effect of drying time on sapodilla sugar quality, followed by Duncan's Multiple Range Test (DMRT) to identify significant differences among treatments. The results showed that drying time had a significant effect on moisture content, yield, and sensory characteristics of sapodilla sugar. Organoleptic evaluation indicated that drying time influenced color, aroma, and taste. In the hedonic test, the highest preference scores were obtained for treatment P1, with values of 3.84 for color, 3.56 for aroma, and 3.58 for taste. Meanwhile, the scoring test showed the highest values for color in P5 (4.00), aroma in P1 (3.58), and taste in P5 (4.82). Moisture content was significantly affected by drying time. In terms of yield, drying time also had a significant effect, with the highest yield obtained in treatment P5 (2.04%) at a drying time of 180 minutes.

1. Introduction

Sugar is one of the main trading commodities in Indonesia and is widely used as a sweetener in food and beverages. Based on its physical form, sugar is classified into three types: liquid sugar, rock sugar, and crystal sugar (Ekawati et al., 2017). Among these, crystal sugar is the most commonly consumed. Crystal sugar is typically produced from sugarcane or sugar beet and is widely used at the household level as well as in the food industry. Sugar serves as a source of calories and energy and can also function as a preservative; when consumed in appropriate amounts, it is not harmful to consumer health (Hartanto, 2014).

In Indonesia, most sugar is produced from sugarcane. However, sugarcane-derived sugar contains high caloric content and is not suitable for certain groups, such as individuals with diabetes (Ramadhani & Mahmudiono, 2018). This condition highlights the need for alternative sugar sources other than sugarcane. Several alternatives, such as stevia (Ramadhani & Isnawati, 2011) and sorghum (Noerhartati & Rahayuningsih, 2013), are considered low-calorie and healthier sweeteners. Nevertheless, these alternatives are only available in limited regions of Indonesia.

The increasing public awareness of healthy lifestyles has driven the demand for alternative sweeteners that are both healthier and widely available. One agricultural commodity that meets these criteria is sapodilla (*Manilkara zapota*), locally known as 'sawo', which is widely cultivated and easily obtained in many regions of Indonesia due to its extensive market distribution (Rachmawati, 2023). Sapodilla is a fruit commodity native to Indonesia that can grow in both lowland and highland areas. The fruit contains a high amount of dietary fiber, making it beneficial for alleviating digestive disorders such as constipation and diarrhea. In addition, sapodilla contains natural simple sugars and can be consumed fresh or processed into various food products.

Sapodilla is a climacteric fruit, meaning that ethylene production and respiration rates increase after harvest. During storage for 5–10 days, these physiological processes cause significant changes in fruit quality. Fully ripe sapodilla fruit has a short shelf life of only 3–5 days before becoming overripe (Agustiningrum, 2014, cited in Kusumiyanti et al., 2017). Consequently, sapodilla is usually harvested at an unripe stage and requires a ripening period before consumption. Due to its short shelf life, processing sapodilla into dry products, such as sapodilla sugar, can significantly enhance its shelf life and economic value. One method used to process sapodilla fruit into sugar is the pan evaporation (PE) process.

This study aimed to: (a) analyze the effect of drying time on the organoleptic properties of sapodilla sugar; (b) evaluate the effect of drying time on the moisture content of sapodilla sugar, the effect of drying time on the yield of sapodilla sugar.

2. Materials and methods

2.1. *Biomaterials*

The materials used in this study included locally sourced sapodilla (*Manilkara zapota*), maltodextrin, and Tween 80 as dough-forming agents, that were obtained from Lamenta Village in Sumbawa,

2.2. *Preparation of sample*

The sapodilla fruits were first sorted, and the flesh was separated from the peel and seeds. The flesh was then blended using a composition of 100 g of sapodilla and approximately 100 mL of water until a uniform slurry was obtained. The blended sapodilla was mixed with 10% maltodextrin and 3% Tween 80 and stirred until the mixture expanded evenly. The mixture was subsequently dried using a food dehydrator at various temperature and drying time combinations according to the experimental treatments: P1 (60 minutes), P2 (90 minutes), P3 (120 minutes), P4 (150 minutes), and P5 (180 minutes). The drying temperature was fixed at 80 °C. After drying, the product was ground using a blender and then sieved to separate fine powder from coarse particles. The resulting sapodilla sugar powder was then ready for further analysis.

2.3 *Quality assessment*

2.3.1. *Determination of scoring and hedonic scale*

The organoleptic evaluation was conducted using hedonic preference and scoring test methods to assess the quality of sapodilla sugar. The hedonic test measured panelists' levels of preference for color, taste, and aroma. A total of fifteen untrained panelists participated in the evaluation. In this study, a five-point hedonic scale was applied. Hedonic test scale were: 1) Strongly dislike; 2) Dislike; 3) Like; 4) Like Very Much; 5) Extremely like.
Scoring test scale for color: 1) Black 2) Blackish-brown
3) Dark brown 4) Light brown 5) Golden yellow.
Scoring test scale for taste: 1) Bitter; 2) Slightly sweet;
3) Moderately sweet ;4) Sweet; 5) Very sweet.
And for aroma scoring taste were: 1) Burnt; 2) None; 3) Slight sapodilla aroma; 4) Moderate sapodilla aroma; 5) Strong/Caramel-like.

2.3.2. *Determination of moisture content*

Moisture content was determined using the gravimetric method. Empty crucibles were first heated in an oven at 105 °C for 15 minutes and then cooled in a and (c) determine desiccator for 5 minutes. The empty crucibles were weighed, and the weights were recorded. A 2 g sample of sapodilla sugar was then placed into each pre- weighed crucible. The crucibles containing the samples were dried in an oven at 105 °C (Engelen, 2018) until a constant weight was achieved. Moisture content of the sample was subsequently calculated using the following equation:

$$\%\, moisture\ content = \frac{x - y}{x - a} \times 100\%$$

x = weight of the cup with the sample before drying (g) y = weight of the cup with the sample after drying (g) a = weight of the empty cup (g)

2.3.3. *Determination of Yield*

Yield is an important parameter in product manufacturing, representing the efficiency of the process. It is defined as the ratio of the dry weight of the final product to the weight of the raw material. Extract yield can be calculated by comparing the final weight (weight of the resulting extract) to the initial weight (weight of the raw material or biomass) and multiplying by 100% (Dewatisari et al., 2018).

2.3.4. *Data Analysis using ANOVA*

This study used a factorial Completely Randomized Design (CRD) with two factors: drying temperature (S) and drying time (W). Each treatment was replicated three times, resulting in a total of 15 experimental units. The data were analyzed using one-way Analysis of Variance (ANOVA). If significant differences were detected, the results were further evaluated using Duncan's Multiple Range Test (DMRT) at a 5% significance level.

3. Results and discussions

3.1. *Color*

Color is the first attribute noticed and evaluated by panelists. According to Lamusu (2018), it is the primary organoleptic parameter in product presentation. As the initial sensory cue, color engages the sense of sight, and an appealing hue can encourage panelists or consumers to sample the product.

The hedonic scale showed that the lowest mean value (1.38) was obtained from sample P5, which was dried for 180 minutes at 80 °C (**Fig. 1**). This result indicates that, on average, the panelists disliked the color of the sapodilla sugar. In contrast, the highest mean hedonic value (3.84) was observed in sample P1, which was dried for 60 minutes at 80 °C, indicating that the panelists generally liked the color of the sapodilla sugar. On the scoring scale, the lowest mean value was found in sample P1 (1.11), corresponding to a golden yellow color, while the highest mean value was observed in sample P5 (4.00), indicating a dark brown color. Both samples were processed at 80 °C with drying times of 60 and 180 minutes, respectively.

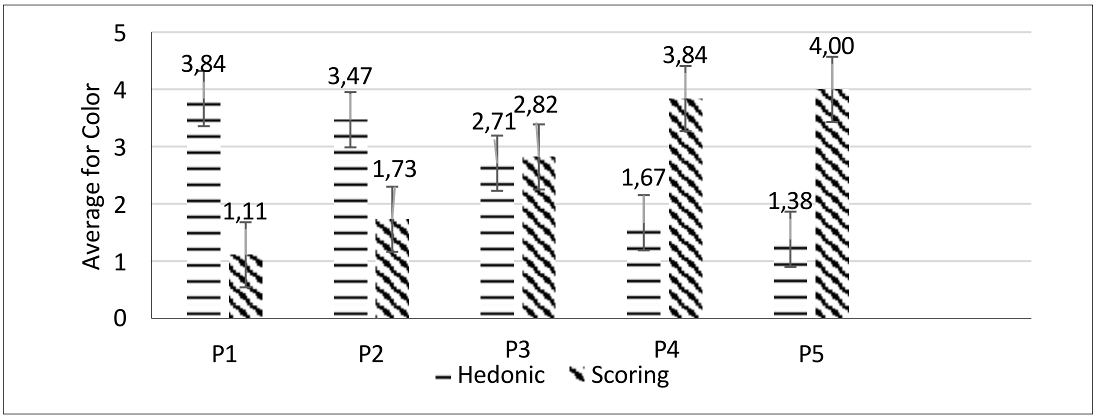

Fig. 1. Organoleptic test results for color parameters

Fig. 2 The color of the sapodilla sugar

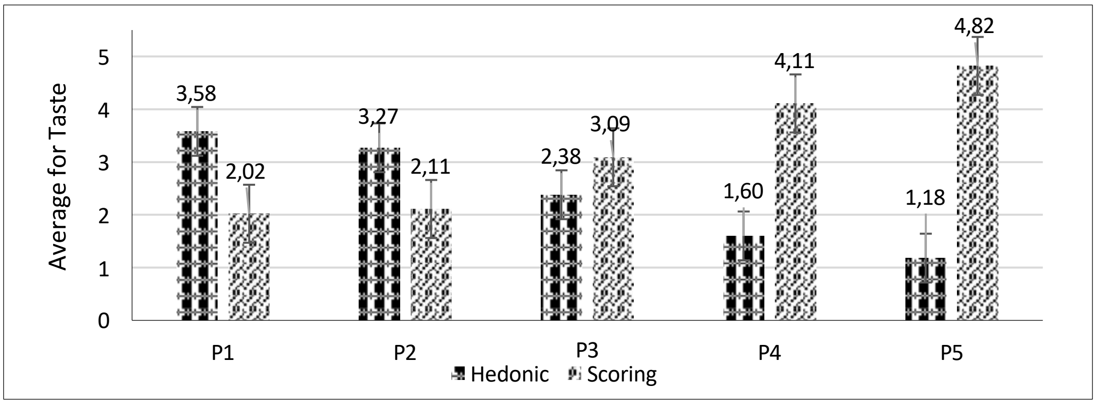

Fig. 3. Organoleptic test results for taste parameters

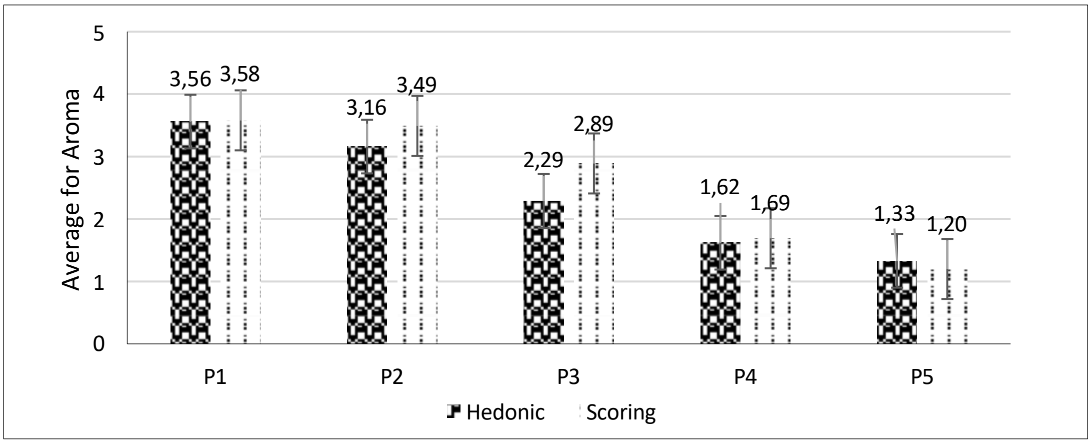

Fig. 4 Organoleptic test results for aroma parameters

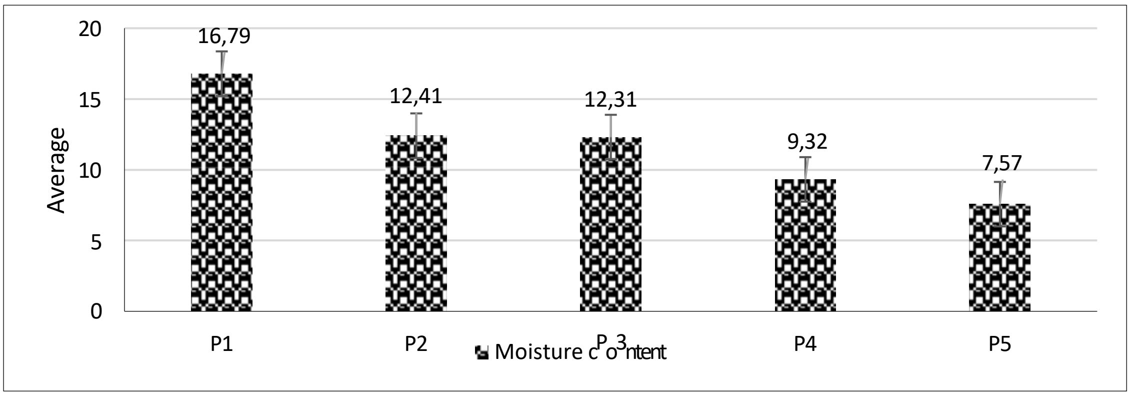

Fig. 5 Moisture content of sapodilla sugar

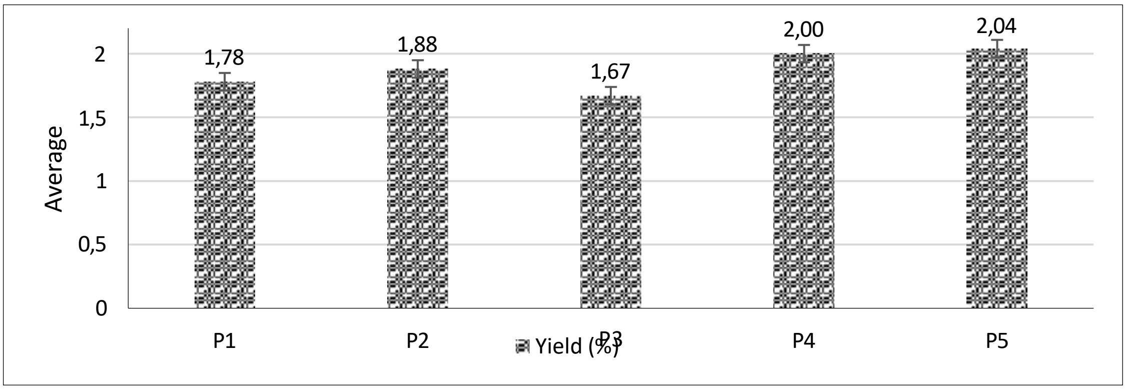

Fig. 3 Yield results of sapodilla sugar

Temperature and drying time significantly affect the color of sapodilla sugar in both the hedonic and scoring tests. Excessively high temperatures and longer drying times tend to produce a darker color, whereas lower temperatures and shorter drying times result in a brighter color of sapodilla sugar. According to Rosalia Dewi et al. (2014), the sugar drying process influences the formation of sugar color, with higher processing temperatures leading to increased color intensity. The brownish coloration of sugar is primarily caused by Maillard browning reactions and caramelization, which result in the formation of melanoidin pigments responsible for the brown color.

3.2. *Taste*

Taste is one of the key factors determining consumer acceptance of a product. It is perceived through the sense of taste by the tongue. The human gustatory system recognizes four primary tastes— sweet, bitter, sour, and salty—with additional taste perceptions arising from their combinations or modifications (Aghata, 2018).

On the hedonic scale, the lowest mean value (1.18) was obtained from sample P5, which was dried for 180 minutes at 80 °C (**Fig 2**). This result indicates that, on average, the panelists slightly liked the taste of the sapodilla sugar. In contrast, the highest mean hedonic value (3.58) was observed in sample P1, which was dried for 60 minutes at 80 °C, indicating that the panelists liked the taste of the sapodilla sugar. On the scoring scale, the lowest mean value was found in sample P1 (2.02), indicating that the sapodilla sugar did not taste sweet, while the highest mean value was observed in sample P5 (4.82), indicating a sweet taste. Both samples were processed at a temperature of 80
°C with drying times of 60 and 180 minutes, respectively.

Both temperature and drying time were found to influence the taste of sapodilla sugar in the hedonic and scoring tests. Excessively high temperatures and prolonged drying times tended to produce a bitter taste, whereas temperatures and drying times that were too low resulted in a bland taste. In this study, the temperature and drying time most preferred by the panelists were observed in treatment P3U2, which used a drying time of 10 hours at a temperature of 80
°C.

According to Aghata (2018), the taste of sugar is closely related to its reducing sugar content, which contributes to sweetness. Reducing sugars consist primarily of fructose and glucose, both of which have high sweetness intensity. Fructose is a monosaccharide that naturally occurs in many fruits, vegetables, and honey (WHO, 2015). In addition, higher drying temperatures and longer drying times increase the total solids content, of which sugar components constitute the majority in sapodilla sugar. Meanwhile, volatile components such as water are lost more rapidly at higher drying temperatures, resulting in a higher sugar concentration and a sweeter taste.

3.3. *Aroma*

Aroma is one of the key parameters in sensory evaluation and is assessed through the sense of smell. Aroma is considered acceptable when the product exhibits a characteristic and desirable odor. Furthermore, aroma is a subjective sensory perception generated by olfactory stimulation (Lamusu, 2018). On the hedonic scale, the lowest mean value (1.33) was obtained from sample P5, which was dried for 180 minutes at 80 °C (**Fig. 4**). This result indicates that, on average, the panelists slightly liked the aroma of the sapodilla sugar. The highest mean hedonic value (3.56) was observed in sample P1, which was dried for 60 minutes at 80 °C, indicating that the panelists also slightly liked the aroma of the sapodilla sugar.

On the scoring scale, the lowest mean value was found in sample P5 (1.20), corresponding to a slightly sapodilla-like aroma containing volatile compounds. Meanwhile, the highest mean value (3.58) was obtained from sample P1, which was dried at 80 °C **Fig. 4**), indicating a more pronounced sapodilla aroma. Aroma is produced by volatile compounds that evaporate easily, particularly as a result of heat exposure during processing. In sapodilla sugar, aroma development occurs during the heating and drying processes, which promote the release of volatile compounds naturally present in sapodilla. Volatile compounds are small molecules that readily evaporate and contribute to the characteristic aroma of fruits (Sagrin & Pino, 2017). In addition, ingredients such as raisins, honey, and chocolate powder, as well as caramelization reactions involving reducing sugars and other components, contribute to aroma formation. Higher heat exposure during processing intensifies these reactions, resulting in a stronger sugar aroma (Andriani & Saputri, 2019).

3.4. *Moisture content*

Water content is one of the most important chemical parameters in food analysis, as it is used to determine product quality and shelf-life stability. The lowest moisture content was observed in treatment P5, which was dried for 180 minutes at 80 °C, with a value of 7.57%. In contrast, the highest moisture content was obtained in treatment P1, which was dried for 60 minutes at 80 °C, with a value of 16.79% (**Fig. 5**).

Based on the Indonesian National Standard (SNI) for palm sugar, the best treatment was P4, which involved a drying time of 150 minutes at 80 °C, with an average moisture content of 9.32%. This value is closest to the SNI requirement for palm sugar, which specifies a maximum moisture content of 10%. The decrease in moisture content is attributed to increased water evaporation at higher temperatures and longer drying times. Moisture content is a critical chemical property that influences the quality, stability, and shelf life of food products (Tambunan et al., 2021).

3.5. *Yield of sapodilla sugar*

Yield refers to the ratio of the weight of the extract obtained to the weight of the raw material, with a higher yield indicating a greater amount of extract produced (Nahor et al., 2020). Based on the results of the sapodilla sugar yield calculation, the lowest yield was observed in treatment P3, which was dried for 120 minutes at 80 °C, with a value of 1.67%. The highest yield was obtained in treatment P5, which was dried for 180 minutes at 80 °C, with a value of 2.04%. This result was in contrast with Manil et al., (2019), stated that heat causes more water to evaporate from the material, reducing the overall weight of the product (Manik et al., 2019).

Based on the study, temperature and drying time still influence the yield of sapodilla sugar in practical terms. Higher temperatures and longer drying times tend to produce a higher yield. The loss of sapodilla sugar weight during processing is attributed to the degradation of compounds in the sapodilla fruit. This is consistent with the findings of Cahayanti et al. (2016), which indicate that color changes and other quality alterations are caused by the breakdown of heat- sensitive compounds in the material. In general, higher drying temperatures result in lower yields.

4. Conclusions

Temperature and drying time significantly affected the color, aroma, and taste of sapodilla sugar. In the hedonic test, the highest mean scores were obtained for color in sample P1 (3.84), aroma in sample P1 (3.56), and taste in sample P1 (3.58). In the scoring test, the highest values were observed for color in sample P5 (4.00), aroma in sample P1 (3.58), and taste in sample P5 (4.82). In the moisture content analysis, both temperature and drying time had a significant impact on sapodilla sugar production. The highest moisture content was recorded in sample P1 (16.79%), which was dried for 60 minutes at 80 °C. In the yield analysis, temperature and drying time also influenced sapodilla sugar production. The highest yield was obtained in sample P5 (2.04%), with a drying time of 180 minutes at 80 °C.

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