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The Use of Slaked Lime in the Processing of Taro Chips (*Xanthosoma sagittifolium*)

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Abstract

According to Prana (2017), taro tubers (*Xanthosoma sagittifolium*) are generally processed into various types of food. In addition to being a source of carbohydrates, taro also contains protein, thiamine, riboflavin, iron, zinc, and vitamins (Alcantara et al., 2013). One of the advantages of taro is its adaptability as a potential food source. Taro can grow in a wide range of ecological conditions, including dry areas (Ganança et al., 2018; Gouveia et al., 2020), flooded environments (Hidayatullah et al., 2020a), and shaded conditions (Gondim et al., 2018). Slaked lime is a chemical compound known as calcium hydroxide with the chemical formula $Ca(OH)_2$. Calcium hydroxide may appear as colorless crystals or a white powder. It is produced through the reaction of calcium oxide (CaO) with water. This compound can also be formed as a precipitate by mixing a calcium chloride ($CaCl_2$) solution with a sodium hydroxide (NaOH) solution. This research was conducted from June to August 2023 at Jl. Kusuma Bhakti, Kubu Gulai Bancah, Mandiangin Koto Selayan District, Bukittinggi City, West Sumatra. The study employed organoleptic testing (taste, aroma, color, and texture) and economic analysis, including cost analysis, revenue analysis, profit analysis, R/C ratio, break-even point (BEP) of production (kg), and BEP of selling price (Rp), on the use of slaked lime at concentrations of 25 g, 50 g, 75 g, and 100 g with a soaking time of 15 minutes. The organoleptic test results showed that treatment A (25 g of slaked lime) was the most preferred by panelists, with scores of 60% for color, 75% for aroma, 52.5% for taste, and 55% for texture. The economic analysis for treatment A (25 g of slaked lime) indicated a profit of -3204, an R/C ratio of 0.9, a break-even production of 3.05 kg, and a break-even price of Rp 61.20.

Keywords: Taro Chips (*Xanthosoma sagittifolium*), Slaked Lime, Organoleptic Test

1. Introduction

The demand for food continues to increase along with population growth. Various types of food are produced by improving both their quantity and quality to meet community needs. In addition to increasing production, fulfilling food demand can also be achieved by optimizing the utilization of diverse food resources. This effort is part of food diversification by utilizing local food resources. One potential local food resource that can be developed as an alternative in food diversification is taro tuber (*Colocasia esculenta*). Tuber crops are an important source of carbohydrates as energy providers in tropical and subtropical regions [1].

Silk taro (*Xanthosoma sagittifolium*) is generally processed into various types of food. In addition to being a source of carbohydrates, it also contains protein, thiamine, riboflavin, iron, zinc, and vitamins. It is particularly rich in vitamin C, which acts as an antioxidant that helps strengthen the immune system by enhancing the activity of white blood cells. Furthermore, taro contains relatively high levels of vitamin E and vitamin B6, which are beneficial for the human body. Together with vitamin C, vitamin B6 supports immune function, while vitamin E helps reduce the risk of heart disease [2].

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One of the advantages of silk taro is its potential as a food source. It can grow across a wide range of ecological conditions, including dry areas [3], [4], flooded environments [5], and shaded conditions [6]. This adaptability is highly relevant in addressing food production challenges under climate change conditions. In addition, silk taro has small starch granules, contains resistant starch, and exhibits hypoallergenic properties [7]. These characteristics further emphasize its potential to be developed from an underutilized crop into a future food source. To increase its economic value, the use of slaked lime in product processing is considered important.

Slaked lime is a chemical compound known as calcium hydroxide with the chemical formula $Ca(OH)_2$. It can appear as colorless crystals or a white powder. Calcium hydroxide is produced through the reaction of calcium oxide (CaO) with water. It can also be formed as a precipitate by mixing a calcium chloride ($CaCl_2$) solution with a sodium hydroxide (NaOH) solution. The use of slaked lime in food processing helps improve the texture, making it crispier and crunchier, as in fried chips. Lime water can also enhance shelf life and contribute to a savory taste.

In the production of taro chips, if soaking in slaked lime solution is not performed, the resulting chips tend to be less crispy, bitter, mucilaginous, and may cause an itchy sensation when consumed [8]. The advantage of using slaked lime solution lies in its nature as a strong electrolyte, which easily dissolves in water, allowing Ca^{2+} ions to be absorbed into the food matrix. In addition, slaked lime can prevent non-enzymatic browning caused by interactions between Ca^{2+} ions and amino acids.

Non-enzymatic browning reactions generally occur during heating or drying processes, where brown coloration develops due to reactions between sugars and proteins or amino acids. Therefore, the use of slaked lime in the soaking process can help maintain the color of the material and improve the crispness of the resulting chips. The stages of taro chip processing include peeling, slicing, soaking in slaked lime solution, draining, and frying [9].

The results of a study that the optimal concentration of slaked lime solution for soaking silk taro chips was 15%, with an optimal soaking time of 15 minutes. The resulting product had a moisture content of 2.37%, with organoleptic scores of 3.73 for color, 8.95 for taste, and 4.03 for crispness. Based on the above explanation, the author is interested in conducting a final research project on the use of slaked lime in the processing of silk taro chips (*Xanthosoma sagittifolium*) [7].

2. Literature Review

Taro is one of the tuber crops that can be used as a food plant and belongs to the monocotyledonous group. It is commonly cultivated in tropical regions with sufficient rainfall (175–250 cm/year). This plant can grow in lowlands up to an altitude of 2,700 meters above sea level, with temperatures ranging from 21–27°C. Taro is classified as a herbaceous plant, with a height of about 0.5–1.5 meters, and most of its leaves are shield-shaped [10].

Taro is believed to have originated in Southeast Asia, likely from India, and then spread to China, Japan, other parts of Southeast Asia, and several islands in the Pacific Ocean through human migration. A similar view was expressed by Prana, who stated that taro is thought to originate from tropical regions of South and Southeast Asia [11]. Taro cultivars are highly diverse, especially in areas that serve as major production centers such as Bogor, Malang, the Mentawai Islands, Lampung, Sulawesi (South and North), and Papua.

The taro variety commonly grown in Indonesia is *C. esculenta* var. *esculenta*, which is characterized by large, elongated, and non-branching corms [12]. The morphological diversity of taro plants is quite high, which is influenced by differences in growth patterns and environmental conditions. Some taro plants grow in wetland areas, while others are cultivated in dry land [13].

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3. Methodology

3.1. Research Location and Time

The research was conducted from June to August 2023 at Jl. Kusuma Bhakti, Kubu Gulai Bancah, Mandiangin Koto Selayan District, Bukittinggi City, West Sumatra.

3.2. Research Tools and Materials

Tools; The equipment used in making taro chips includes a stove, wok, spatula, knife, plastic packaging, chip slicer, blender, oil strainer, tissue paper, and labels.

Ingredients; The materials required for making silky taro chips include 20 kg of taro, 250 grams of slaked lime, 5 liters of cooking oil, 100 grams of flavor enhancer, 600 grams of garlic, 300 grams of ground turmeric, 100 grams of fine salt, and 1,000 grams of chili powder.

3.3. Implementation Procedure

Procedure for Making Silky Taro Chips;

1. Prepare all the tools and materials to be used. Select taro that is free from defects or damage, with relatively uniform shape and size.
2. Peel the taro and wash it thoroughly. Slice the taro into thin, round pieces.
3. After slicing, soak the taro in 5 liters of water for one treatment that has been mixed with slaked lime. Soak for 15 minutes to reduce the mucus content in the taro.
4. Mix the crushed garlic, ground turmeric, and salt in a container, then add a small amount of water.
5. Drain the taro that has been soaked in the lime water, then place it into the seasoning mixture. Let it sit for 15 minutes until the seasoning is absorbed before frying.
6. Heat the oil, then fry the seasoned taro until it becomes dry and crispy.
7. Remove the taro and drain the excess oil. Let it cool.
8. Sprinkle chili powder mixed with garlic powder and fine salt.
9. Mix the taro chips evenly with the seasoning until well coated.
10. The taro chips are ready to be packaged to maintain their crispiness and savory taste (Gonzalez et al., 2017).

3.4. Activity Plan

This study uses organoleptic tests (taste, aroma, color, texture) and economic analysis (cost analysis, acceptance analysis, income analysis, R/C analysis, Production BEP (Kg), Sales BEP in price (Rp)) for the use of lime at 25 gr, 50 gr, 75 gr, 100 gr. Soaking time is 15 minutes. The results of this organoleptic test will be displayed in the form of images/graphs.

3.5. Observed Parameters

1. Organoleptic test

Organoleptic testing is a test based on the process of sensing. Sensing is defined as a physio-psychological process, namely the awareness or recognition by the sensory organs of the properties of an object due to the stimulation received by the sensory organs from the object. Sensing can also mean a mental reaction (sensation) if the sensory organs receive a stimulus. The reaction or impression caused by the stimulus can be in the form of an attitude to approach or avoid, like or dislike the object causing the stimulus. Awareness, impressions, and attitudes toward the stimulus are psychological reactions or subjective reactions. Measurement of the value/level of impressions, awareness, and attitudes is called subjective measurement or subjective assessment. It is called a subjective

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assessment because the results of the evaluation or measurement are highly determined by the examiner or the person conducting the measurement [14].

Organoleptic tests include taste, aroma, color, and texture. These organoleptic tests are conducted by panelists consisting of lecturers, students, MSME actors, and consumers.

2. Economic analysis

Economic analysis is carried out to see the costs incurred and the profits obtained.

1. Cost Analysis

   Calculate the total cost (Total Cost), it is obtained by adding fixed costs (Fixed Cost/ FC) to variable costs (Variable Cost) .

2. Revenue Analysis

   The calculation of total revenue (Total Revenue/TR) is the multiplication of the amount of production (Y) by the selling price (Py) and is expressed with the following formula: TR = Py . Y

3. Income Analysis

   According to income is the difference between revenue (TR) and total cost (TC) and is expressed with the formula: I = TR – TCA

4. R/C Analysis

   According to R/C is the ratio between revenue and total cost. R/C = Total Revenue (TR) : Total Cost (TC) [15].

5. Production BEP (Kg)

   According to Adrianto (2016), the calculation of the Break Even Point based on production is carried out using the following formula: BEP (Kg) = TC Price

6. Sales BEP in price (Rp)

   According to the calculation of the Break Even Point based on sales in price can be done using the following formula [16]:

   BEP (Rp) = TC/Y

4. Results and Discussion

4.1 Color

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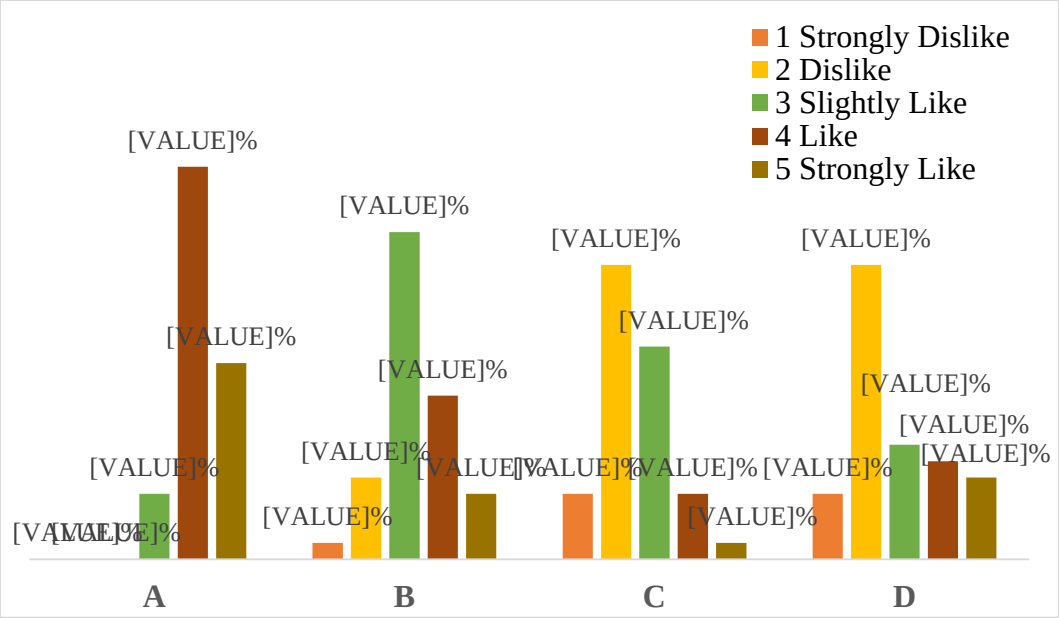


Figure 1. Color Comparison

Based on the results of organoleptic tests on color in the processing of silk taro chips, the highest percentage of preferred results was in treatment A at 60%, followed by treatment B at 25%, treatment C at 10%, and treatment D at 15.

Color is a very important component in determining the quality or degree of acceptance of a food material. The addition of chili powder and fine turmeric will affect the original color of silk taro chips. The quality determination of a food material depends on several factors, but before other factors are considered, the color factor visually appears first to determine the quality of the food material [17].

Color is the first impression that appears and is assessed by panelists. Color is the first organoleptic parameter in food presentation. Color is the first impression because it uses the sense of sight. An attractive color will invite the panelists' or consumers' appetite to taste the product [18].

Color testing is used in organoleptic tests because color plays an important role in the visual acceptance level of a product. A food material, even if it tastes good, will not be consumed if its color is unattractive. Generally, the quality determination of a food material depends on color because color appears first [19]. Color plays a crucial role in food acceptance. Additionally, color can provide clues about chemical changes in food. Color is influenced by the components within the material and the product processing methods [20].

A food item that is considered nutritious, tasty, and has excellent texture will not be eaten if it has an unpleasant color. Attractive and natural-looking food color can enhance the flavor [21].

The results of the organoleptic test show that among all treatments, the color most preferred by panelists was treatment A at 60%, which used 25 grams of slaked lime, as shown in Figure 8. The resulting taro chips' yellowish color was favored by the panelists. This is because soaking in slaked lime solution dissolves the sap and removes the itchiness present in silk taro.

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Slaked lime affects pigment degradation in the material, causing color changes. This occurs because, during processing, pigments are influenced by chemical, physical, and mechanical factors [22]. The color of silk taro chips tends to become browner with increasing concentration and soaking duration in slaked lime [23].

The frying process can cause the color of silk taro chips to turn somewhat brown. That browning reactions occur during frying [24]. The Maillard reaction is the browning reaction between carbohydrates, producing brown substances that are often undesirable or even indicate quality degradation. Besides this, oxidation processes during frying are suspected to darken the oil color, which ultimately affects the fried product's color. Additionally, frying likely causes the browning of the chips [25].

In the process of frying silk taro at moderate heat for 30 minutes, frying can also reduce the material content because some cooking oil occupies the food's pores, replacing the evaporated water, resulting in a lower concentration of material per unit weight [26].

The higher the percentage of slaked lime used, the more it reacts to produce pigments that are dark brown to black [27]. Food that looks unattractive is often assumed to taste bad [28]. The color of silk taro chips is also influenced by frying time. A paler color gives the impression of undercooked products, while overly brown color suggests burning [29].

4.2 flavour

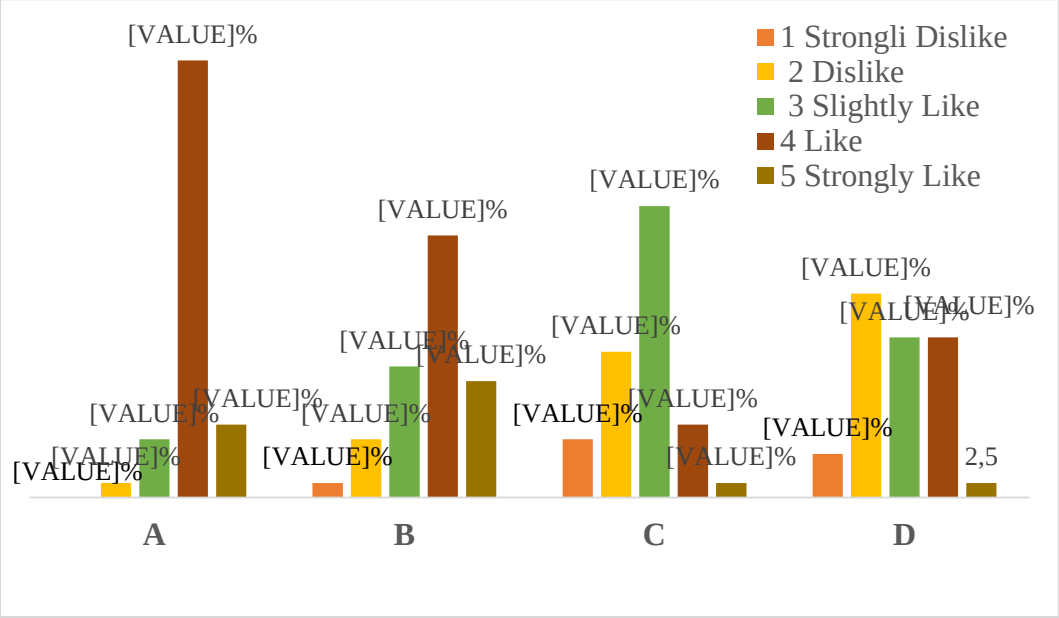


Figure 2. Aroma Comparison

Based on the results of the organoleptic test on the aroma in the processing of silk taro chips, the highest percentage of preference was for treatment A at 75%, followed by treatment B at 45%, treatment C at 12.5%, and treatment D at 27.5%.

The aroma of a food product can be evaluated through the odor perceived by the sense of smell. Aroma assessment is closely related to the physiological condition of the panelists, as aroma is defined as the sensory perception of volatile compounds. In the food industry, aroma is considered an essential parameter in organoleptic evaluation because it reflects product quality. The role of aroma in food products is as important as color, as it significantly influences consumer acceptance [30]. Aroma refers to the composition of volatile compounds in food and their interaction with olfactory receptors. It is generally formed from a mixture of various odor-active compounds [31].

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Aroma is one of the key parameters in sensory (organoleptic) evaluation using the olfactory system. A product is considered acceptable when it possesses a characteristic and pleasant odor. Aroma is a subjective sensation perceived through olfaction. The formation of food aroma is primarily due to volatile compounds produced either through enzymatic reactions or non-enzymatic processes. The concentration of these compounds in the vapor phase affects aroma perception and is influenced by their volatility. Additionally, interactions between aroma compounds and food components such as carbohydrates, proteins, and fats also influence aroma perception and ultimately affect consumer acceptance [32].

The palatability of food is strongly influenced by aroma, which often becomes a determining factor in consumer preference. Aroma perception is mainly associated with the olfactory sense [33].

The results of the organoleptic test showed that the most preferred aroma among all treatments was treatment A (75%), which used 25 grams of slaked lime, as shown in Figure 8. The taro chips produced a distinctive and pleasant aroma characteristic of silk taro, which was favored by the panelists.

However, increasing the concentration of slaked lime resulted in decreased panelist preference for aroma. This is likely due to prolonged soaking, which leads to higher residual calcium content, causing a detectable lime-like odor. This phenomenon occurs because soaking in slaked lime solution promotes compound interactions within the taro. The aroma developed in the silk taro chips is also suspected to result from chemical reactions during the cooking process [34].

4.3 Taste

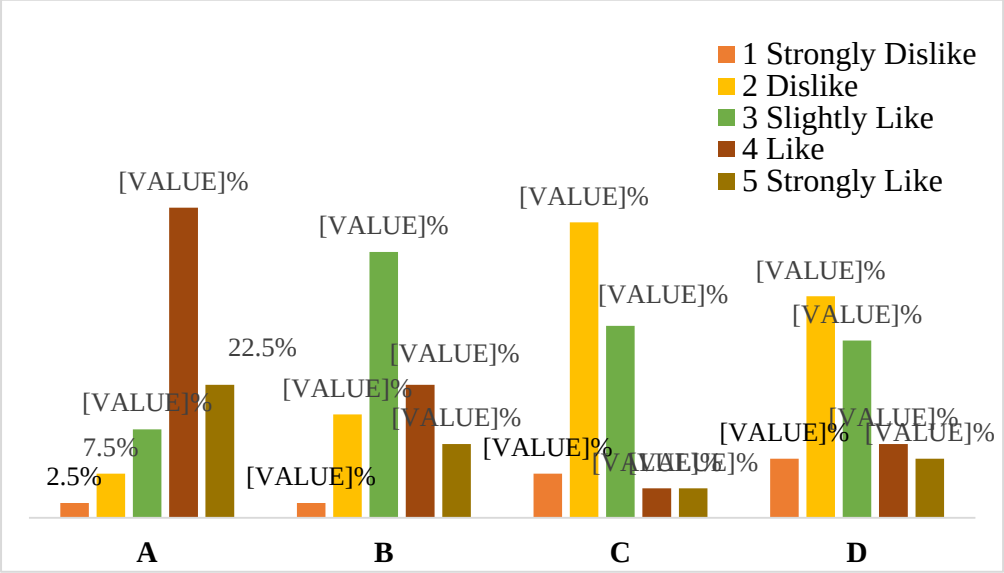


Figure 3. Comparison of Taste

Based on the results of the organoleptic test on taste in the processing of silk taro chips, the highest percentage of preference was for treatment A at 52.5%, followed by treatment B at 22.5%, treatment C at 5%, and treatment D at 12.5%.

Taste is an important factor alongside texture, color, and aroma that influences the flavor of a processed food product. An individual's acceptance of a food product is greatly affected by the taste it produces. The taste of a food can originate from the inherent properties of the raw materials or from the addition of other substances during processing [35].

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Flavor is a determining factor for consumer acceptance of the resulting food product (Naruki, 2015). Taste is primarily assessed using the sense of taste or the tongue. The taste factor plays a crucial role in consumers' product selection because even if the nutritional content is good but the taste is not acceptable to consumers, the goal of improving public nutrition cannot be achieved, and the product will not sell [36].

Taste is one of the key components in food because flavor is usually determined by the presence of spices, flavor enhancers, aroma, crispness, tenderness, savoriness, food temperature, and the degree of doneness. Varied flavors are far more favored than foods with a single taste [37]. A combination of flavors in one food is more enjoyable due to its variety [38].

Different food flavors can be perceived by the taste buds on the tongue, which contain red papillae. Taste is usually influenced by several factors, including chemical compounds, temperature, the combination of food with other additives, and cooking duration. Taste is mostly influenced by the addition of flavor enhancers [39].

The processing that occurs during food preparation affects the flavor and may cause a decline in the physical properties of the food. Excessively high heat over a long period can reduce the sensitivity of the food, damaging both flavor and texture. The consistency of food texture is a component that determines flavor due to the sensitivity of the taste receptors. Foods with a solid or thick consistency provide slower stimulation to the taste receptors [40].

Taste is a factor that can determine whether a product is accepted or rejected by consumers. Taste is perceived by the tongue. Human taste perception is divided into four main tastes: sweet, bitter, sour, and salty, with additional responses possible through modifications [41].

The complexity of flavor arises from the diversity of natural perceptions. Flavor is influenced by three factors: smell, taste, and oral stimuli (hot and cold). The first factor is detected by the olfactory sense, while the other two factors are detected by sensory cells on the tongue. Besides the flavor of silk taro chips being influenced by added spices during processing, these spices serve as flavor enhancers. The purpose of these spices and flavor enhancers is to provide flavor to the silk taro chips and primarily to increase palatability [42].

Flavoring processed foods can be done by adding various spices and permitted chemicals, such as table salt, sugar, and other ingredients. Flavor, which is a combination of smell and taste, depends on several factors, including cooking methods, salt addition, spices, and flavor enhancers. It is also caused by the starch source used, which has different chemical compositions, resulting in distinctive flavors [43].

The results of the organoleptic test showed that among all treatments, the flavor most preferred by panelists was treatment A at 52.5%, using 25 grams of slaked lime, as shown in Figure 8. The flavor of the resulting taro chips was favored by the panelists. If the concentration of the slaked lime solution increases, the flavor of the silk taro chips becomes highly disliked by the panelists. This is because the slaked lime solution affects the original taste of the silk taro chips, leaving only the taste of slaked lime itself on the chips.

4.4 Texture

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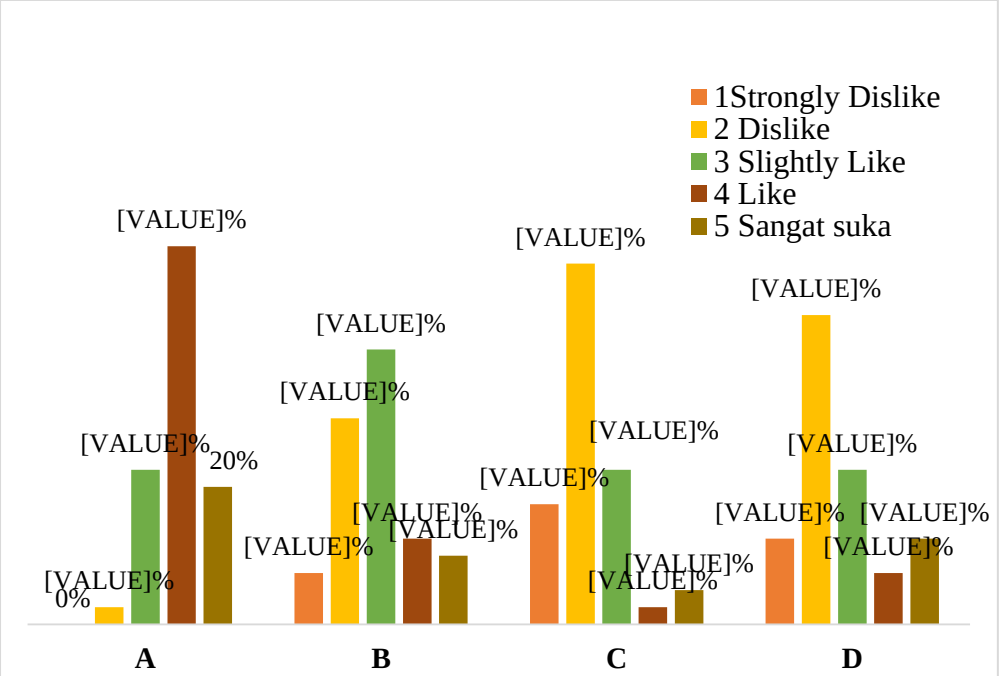


Figure 4. Texture Comparison

Based on the results of the organoleptic test on taste in the processing of silk taro chips, the highest percentage of preference was in treatment A at 55%, followed by treatment B at 12.5%, treatment C at 2.5%, and treatment D at 7.5%.

Texture is a prominent characteristic of dry food products and snacks made from starch-based materials. One of the factors determining consumer acceptance of chips is texture. The texture of a food depends on the compactness of its constituent particles, their size, shape, firmness, uniformity, and the ease with which these particles break when the product is chewed. The larger the air cavities, the more porous the structure, making it easier to break [41]. Texture refers to the ease with which food materials crack, break, or become crispy. Texture is closely related to crispiness; for chip products, texture is an important quality attribute. Desired chips are those that are crispy.

Stated that soaking in slaked lime water results in a firmer texture[40]. Explained that calcium ions in slaked lime bind with carboxyl groups of pectin to form Ca-pectin, which helps maintain a firm texture [23].

Texture is a sensory attribute associated with touch or tactile sensation. Sometimes, texture is considered as important as smell, taste, and aroma because it influences the perception of food. Texture is most important in soft and crispy foods. The most commonly overlooked characteristics are hardness, cohesiveness, and moisture content. Texture testing of silk taro chips involves assessing ease of chewing and biting. Observing the texture of silk taro chips is crucial because the texture can harden during frying [43].

The results of the organoleptic test showed that among all treatments, the texture most preferred by panelists was treatment A at 55%, using 25 grams of slaked lime, as shown in Figure 8. The crispy texture of the resulting taro chips was favored by the panelists.

Texture refers to the size and arrangement (structure) of parts of an object or food. Texture can be determined by touch and described as hard, soft, smooth, rough, intact, dense, liquid, dry, moist, sticky, crispy, tender, or chewy [42].

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Texture can be observed by fingers through tactile sensation and by the mouth during biting, chewing, and swallowing, which increases the sensory experience (Kartika et al., 2019). Texture attributes that can be assessed include juiciness, dryness, smoothness, hardness, and oiliness [33].

Texture is a component and structural element arranged and combined into micro and macro structures in terms of deformation flow. The texture of a material depends on its physical state; thus, texture assessment can include hardness, crispiness, and elasticity [44].

The more slaked lime used, the lower the crispiness of the resulting silk taro chips. Texture is also affected by high-temperature heating during frying. The lower the moisture content, the crispier the chips; however, excessive use of slaked lime and prolonged soaking time prevent the chips from becoming crispy even with extended frying [45].

Increasing the percentage of slaked lime use tends to decrease panelist preference for texture, possibly because longer soaking times cause the silk taro chips to become more porous and soft. Test results show that the amount of slaked lime used has a significant effect on the crispiness of the resulting silk taro chips.

5. Conclusion

Based on the results of the study on the effect of using slaked lime on silk taro, it can be concluded that among all treatments, the one that had the color, aroma, taste, and texture most preferred by the panelists was treatment A with the use of 25 grams of slaked lime.

1. The color preferred by the panelists was treatment A by 60% with the use of 25 grams of slaked lime, which resulted in a yellowish color.
2. The aroma preferred by the panelists was treatment A by 75% with the use of 25 grams of slaked lime, which resulted in the distinctive fragrance of silk taro chips.
3. The taste preferred by the panelists was treatment A by 52.5% with the use of 25 grams of slaked lime, which resulted in a savory taste.
4. The texture most liked by the panelists was treatment A by 55% with the use of 25 grams of slaked lime, which resulted in a crispy texture.

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