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Formulation of Lactogenic Biscuits Based on Local Food Talas Flour (*Colocasia esculenta L. Schott*) with Substitution of Sweet Leaf Flour (*Sauropus androgynus L. Merr*) as an Alternative for Supplementary Feeding for Nursing Mothers (PMT)

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Abstract: The study explores the potential of utilizing talas tuber flour (*Colocasia Esculenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*) in biscuit production to enhance nutritional value and promote lactation in breastfeeding mothers. Talas, rich in complex carbohydrates, fiber, minerals, and vitamins, and katuk leaves, high in protein, vitamins A and C, iron, and lactogenic active substances, were used to develop biscuits in three different formulations: F1 (95%: 5%), F2 (90%: 10%), and F3 (85%: 15%). The organoleptic test identified F1 as the best formulation, and proximate analysis showed that F1 contained 6.14% moisture, 2.52% ash, 27.04% fat, 8.59% protein, 50.3% carbohydrates, and 6.70% crude fiber. The biscuits also contained 0.209% phosphorus, 80.4 mg/kg iron (Fe), and 142 mg/kg calcium (Ca). These findings suggest that biscuits made from talas tuber and katuk leaf flour can be a valuable nutritional supplement, potentially aiding in the improvement of breast milk production.

Keywords: Biscuits; Katuk leaves; Lactation; Nutritional value; Talas flour

Introduction

The abundance of local food can be maximized to support food security (Kusmiyati et al., 2021). One of the commonly utilized local foods in Indonesia is talas (*Colocasia Esculenta L. Schott*). Talas is known by various names in English, including talas, old cocoyam, dasheen, and eddoe. Talas (*Colocasia esculenta L. Schott*) is a type of local tuber that is widely grown in Indonesia, especially in West Kalimantan. The talas tuber contains little fat and is rich in vitamin A (Safriansyah et al., 2021).

Talas is a plant that can grow in tropical climates and is widely cultivated in Indonesia. Talas is often used in food processing as a substitute for flour. Talas flour contains 70-80% starch with small particle sizes, making it highly digestible. Talas can be processed into food products such as chips, noodles, cookies, and biscuits (Maulani et al., 2019). One alternative use of local food is in the production of biscuits.

Katuk leaves (*Sauropus androgynus L. Merr*), also known as sweet leaf, belong to the Euphorbiaceae family and are a shrub that grows in tropical, warm, and humid areas. They are commonly consumed as a vegetable. One of the well-known benefits of katuk leaves is their ability to enhance breast milk production (ASI). Consuming katuk leaves can increase the volume of breast milk. In katuk leaves (*Sauropus androgynus L. Merr*), the calorie, protein, and carbohydrate content is almost equivalent. Additionally, the iron content in katuk leaves is superior compared to papaya leaves and cassava leaves. Katuk leaves are also rich in calcium, and vitamins A, B1, and C. Moreover, katuk leaves contain other components

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such as tannins, saponins, and papaverine alkaloids (Rosdianah et al., 2021).

Katuk leaves are high in calcium and contain steroids and polyphenols, which can increase prolactin levels, a hormone that promotes milk production. Elevated prolactin levels enhance, accelerate, and facilitate breast milk production. Special attention should be given to breastfeeding mothers, especially in the context of exclusive breastfeeding programs. Prolactin plays an important role in the initiation and synthesis of breast milk during early lactation. A lack of prolactin can hinder the lactogenesis process and cause failure in breastfeeding during the early stages of a baby's life. The hormonal effects of the estrogenic sterol chemical compounds in katuk leaves are believed to contribute to increased milk production (Triananinsi et al., 2020). These biscuits can serve as an alternative additional food for breastfeeding mothers, providing a practical and ready-to-eat option, as well as diversifying nutritious food products (Barati et al., 2018; Motebejana et al., 2022; N. Sari et al., 2023).

Exclusive breastfeeding rates in West Kalimantan Province rank the eighth lowest, at 22.9%. One type of additional food for breastfeeding mothers that supports milk production is biscuits (Trisyani et al., 2022). Biscuits are commonly found as supplementary food products, conventionally produced in factories. According to SNI 01-2973-1992, biscuits are products processed by baking dough made from flour with the addition of other food ingredients, including permitted or non-permitted food additives (L. N. Sari et al., 2019). Biscuits are a favorite food for many people and are very practical because they can be eaten anytime. Good biscuits are those that contain essential nutrients, low added sugar, low saturated fat, and high fiber (Ayensu et al., 2019; Goubgou et al., 2021).

Breastfeeding mothers certainly require a more diverse nutrient intake. Not only do they need energy and protein from the biscuits provided as supplementary food, but they also need micronutrients that can enhance milk production, such as iron, calcium, vitamin D, and folic acid. The substitution of katuk leaves and talas flour can be an alternative in making lactogenic biscuits to provide the micronutrients needed by breastfeeding mothers for optimal milk production (Carretero-Krug et al., 2024; Husnah, 2024; Taneja et al., 2021).

Method

This study utilizes an experimental research design. The research was conducted using three treatment formulations to determine the acceptance of biscuits made from katuk leaf flour and talas flour. The product formula consists of three levels, each with three repetitions. The variations in the addition of mixed flour aim to enhance the nutritional content of the product. The ratio of ingredients used is F1 (95%: 5%), F2 (90%: 10%), and F3 (85%: 15%). After the biscuits are made, they will undergo organoleptic testing, proximate analysis, and analysis of phosphorus, iron, and calcium content.

The tools used in making katuk leaf and talas flour biscuits include an electric oven, knife, baking tray, sieve (100 mesh), blender, spoon, basin, mold, spatula, rolling pin, scale, and jars. The ingredients used are katuk leaf flour, talas flour, wheat flour, margarine, skimmed milk, granulated sugar, egg yolks, and baking powder.

Preparation of Talas Flour

Prepare 1 kg of talas tubers. Peel the talas, slice it into 2 cm pieces using a slicer, and soak it in 1 liter of water containing 7.5% salt concentration for 1 hour to remove the mucus. After that, rinse the talas with clean water and drain it. The next process is drying using a food dehydrator at 50°C for 18 hours. Once dried, the talas is ground into flour using a blender and then sieved using an 80-mesh sieve (Rialdi, 2021).

Preparation of Moringa Leaf Flour

Young and fresh Moringa leaves are washed under running water to remove dirt. Next, sorting is done to separate the leaves from the stems, and the leaves are wilted for 4 hours. After that, the leaves are dried in an oven at 70°C for 5 hours. The final step is grinding the leaves using a blender and sifting the ground leaves through an 80-mesh sieve (Fadila et al., 2023).

Preparation of Laktotaska Biscuits

The biscuit-making process begins with preparing the necessary ingredients, followed by weighing the ingredients using an analytical scale. The next step is the first mixing, where egg yolks are beaten with powdered sugar, baking powder, salt, margarine, skimmed milk, and vanilla for 15 minutes using a mixer. After the ingredients are evenly mixed, the second mixing is done by adding talas flour and katuk leaf flour, and the dough is mixed until smooth. The smooth dough is flattened and shaped using a mold. Finally, the dough is baked in an oven at 140°C for 30 minutes (Sariani et al., 2019).

Research Parameters

The observation parameters in this study include organoleptic testing analyzed using the Friedman method, proximate analysis (moisture content, ash content, fat content, protein content, carbohydrate content, and crude fiber content), and analysis of phosphorus, iron, and calcium content using SNI methods.

Analysis Procedures

Organoleptic Testing

In this study, organoleptic testing was conducted using the hedonic method involving semi-trained panelists. Samples were presented in a manner typical for biscuit consumption. The organoleptic test was carried out using forms distributed to 25 panelists, who assigned numerical values based on their preference levels. The hedonic scale used ranged from 1 to 5, with categories of dislike very much, dislike, like somewhat, like, and like very much. The parameters assessed included color, taste, aroma, and texture. The final results of the organoleptic test were analyzed using the Friedman method (Sariani et al., 2019).

Moisture Content Analysis (SNI 01-2354.2, 2006)

The first step is to stabilize the oven until it reaches a stable condition. Place an empty dish in the oven for at least 2 hours. After that, transfer the empty dish to a desiccator and let it cool for about 30 minutes until it reaches room temperature, then weigh it. Weigh 2 g of the sample and place it in a vacuum oven at 95°C-100°C, with air pressure not exceeding 100 mmHg, for 5 hours. After the baking process, transfer the dish to a desiccator for 30 minutes, then weigh it again (Daud et al., 2020). Next, calculate the moisture content using the following formula:

$$\text{Moisture content} = \frac{B-C}{B-A} \text{ x } 100\% \quad (1)$$

Ash Content Analysis

Place an empty dish in the muffle furnace and maintain the temperature at 550°C overnight. After that, lower the ashing temperature to around 40°C, remove the porcelain dish, and let it cool in a desiccator for 30 minutes before weighing. Weigh 2 g of the sample and place it in an oven at 100°C for 24 hours. After that, transfer the dish to the muffle furnace and increase the temperature to 550°C, maintaining it for 8 hours or overnight until the ash turns white. After this process, lower the temperature to around 40°C and place the dish in a desiccator for 30 minutes. Slowly moisten the ash with distilled water, dry it using a hot plate, and then re-ash it at 550°C until its weight is constant. Finally, lower the ashing temperature to around 40°C, remove the porcelain dish, and let it cool in a desiccator for 30 minutes (Liu, 2019).

$$\text{Ash content} = \frac{B-A}{sampel\ weight(g)} \text{ x } 100\% \quad (2)$$

Fat Content Analysis

Weigh 2 g of the sample and place it in a paper thimble lined with cotton. Seal the paper thimble with dry cotton and dry it in an oven at a maximum temperature of 80°C for 1 hour. After that, place the paper thimble in a Soxhlet apparatus equipped with a fat flask containing boiling stones that have been dried and weighed. Extract using hexane or another fat solvent for 6 hours. After the extraction process, evaporate the hexane and dry the fat extract in a drying oven at 105°C. Cool the extract and weigh it (SNI, 1992).

$$\text{Fat content} = \frac{W-W1}{W2} \text{ x } 100\% \quad (3)$$

Protein Content Analysis

Weigh 2 g of the sample homogenate on a weighing paper, fold it, and place it in a digestion vessel. Add 2 catalyst tablets and a few boiling stones. Pour 15 mL of concentrated H_2SO_4 and 3 mL of H_2O_2 slowly, then let it sit for 10 minutes in a fume hood. Digest at 410°C for 2 hours, then allow it to cool to room temperature. Add 50-75 mL of distilled water. Prepare an Erlenmeyer flask containing 25 mL of 4% H_3BO_3 solution with an indicator to collect the distillate. Attach the digestion flask to the steam distillation apparatus. Add 50-75 mL of sodium hydroxide-thiosulfate solution, perform distillation, and collect the distillate in the Erlenmeyer flask until the volume reaches at least 150 mL. Titrate the distillate with 0.2 N HCl until the color changes from green to neutral gray (Hayati et al., 2023).

$$\text{Protein content} = \frac{(VA-VB)\text{HCl}\text{x}N\ HCl\text{x}14{,}007\text{x}6{,}25\text{x}100\%}{W \text{ x } 1000} \quad (4)$$

Carbohydrate Content Analysis

Weigh 5 g of the sample into an Erlenmeyer flask. Add 200 mL of 3% HCl solution, then boil for 3 hours using a reflux condenser. After cooling, neutralize with 30% NaOH solution and add a small amount of 3% CH_3COOH. Transfer to a volumetric flask, add water up to the mark, and filter. Pipette 10 mL of the filtrate into an Erlenmeyer flask, add 25 mL of Luff's solution, a few boiling stones, and 15 mL of distilled water. Heat the mixture with a consistent flame, ensuring the solution reaches boiling within 3 minutes, and continue boiling for 10 minutes. Quickly cool in an ice bath. Add 15 mL of 20% KI solution and 25 mL of 25% H_2SO_4 solution slowly. Immediately titrate with 0.1 N thiosulfate solution (SNI, 1992).

Crude Fiber Analysis

Weigh 2 g of finely ground and fat-extracted sample using a Soxhlet apparatus. Dry the sample, then place it in a 500 mL Erlenmeyer flask. Add 50 mL of 1.25% H_2SO_4 solution and boil for 30 minutes. After that, add 50 mL of 3.25% NaOH solution and boil again for 30 minutes. Filter using a Buchner funnel lined with pre-dried and weighed ashless Whatman 41 filter paper. Wash the residue on the filter paper with 1.25% H_2SO_4, hot water, and 96% ethanol successively (SNI, 1992).

$$\text{Crude fiber content} = \frac{W-W1}{W2} \text{ x } 100\% \quad (5)$$

Result and Discussion

Organoleptic Test Results on Color

Based on the organoleptic test results conducted by the panelists, the modified biscuit samples made from taro flour (*Colocasia esculenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*) received a percentage evaluation for color, which can be seen in Figure 1.

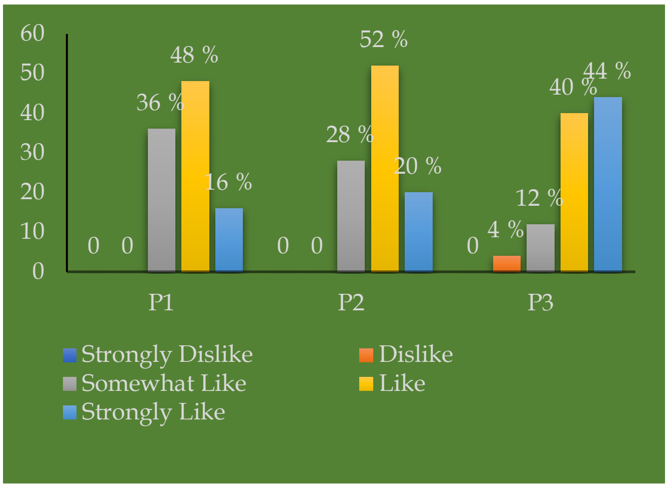

Figure 1. Organoleptic test results on color

Organoleptic test results on the color of biscuits made from talas flour (*Colocasia esculenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*) showed that in the P1 treatment, the highest preference level was "like" at 48%. In the P2 treatment, the highest preference level was also "like" at 52%. In the P3 treatment, the highest preference level was "strongly like" at 44%. In this study, statistical analysis using the Friedman test was conducted with data from the organoleptic test on color preference. The results of the analysis can be seen in Table 1.

Table 1. Results of the Friedman Test on Color Preference for Laktotaska Biscuits

	Calculation Results
	Color
A	334
B	304.58
T Calculated	3.74
F Table	3.19

Note: If T Calculated > F Table, the effect is significant; If T Calculated < F Table, the effect is not significant.

Based on the statistical results from the Friedman test with a 95% confidence level, it was found that the calculated T-value is greater than the F-table value (3.74 > 3.19), indicating that there is an effect of the formulation of biscuits made from taro flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*) on the color acceptability of the biscuits.

Color is the first sensory element that can be directly observed by the panelists. The quality of a product is often judged based on its color, and a color that meets expectations will create a specific impression on the panelists (Dewi et al., 2021). Physically, color greatly determines the quality of a product. The quality of processing can often be evaluated by the color. When determining the quality or degree of preference for a product, color is an important component. If the color does not match or deviates from the expected color, it may reduce the appeal or even decrease the value of the food product (Chairuni et al., 2020).

The results of the organoleptic test on the color of biscuits using taro flour and katuk leaf flour showed that the 90% taro flour and 10% katuk leaf flour concentration in the P2 treatment was preferred by 52% of the panelists because of its brownish-green color. The color differences in the product are due to the influence of the ingredients used, namely katuk leaf flour and taro flour. The light green color produced in the biscuits comes from the katuk leaf flour. The addition of 10 grams of katuk leaf flour results in a slightly darker green color, making the biscuits more appealing, which also affects the taste, aroma, and texture of the biscuits. The more katuk leaf flour added, the greener and darker the biscuits will become.

This is consistent with Merlinda's (2020) research, which states that the preference test results for the color of Rich Biscuit, which has a brownish-green color, are influenced by the use of katuk leaf flour. Katuk leaves are known as "multi green" because they are rich in nutrients. Additionally, katuk leaves can function as a natural colorant due to their high chlorophyll content. Winarno (2004) also states that the color in food ingredients can be produced by natural pigments in plants and animals, caramelization processes, enzymatic oxidation, and the addition of colorants (Erdiyawati et al., 2020).

Hariyani's (2019) research also states that based on the organoleptic test results conducted by panelists on the color of sago biscuits, the addition of katuk leaf flour to this product has a significant effect on the color of the biscuits. This color change occurs due to the Maillard reaction, where the more katuk leaf flour is added, the biscuit color changes from brownish-green to dark green (SNI 01-2354.1, 2010).

Organoleptic Test Results on Taste

Based on the organoleptic tests conducted by panelists on the modified biscuit samples made from taro flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*), the percentage results of taste evaluation can be seen in Figure 2.

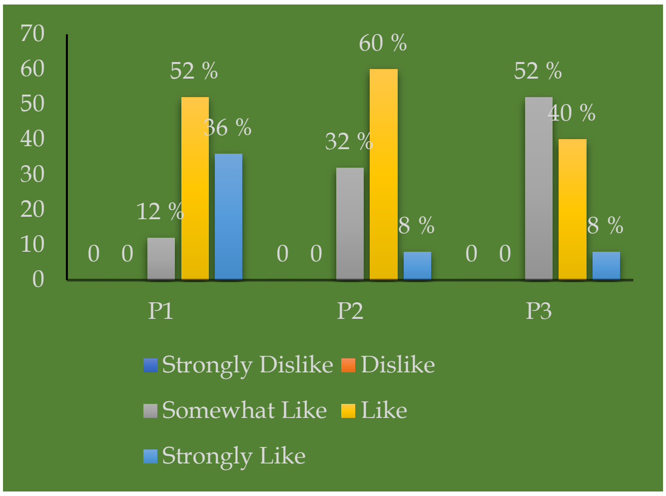

Figure 2. Organoleptic test results on taste

The organoleptic test results on the taste of biscuits made from talas flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*) showed that for the P1 treatment, the highest rating was at the "like" level, with 52%. For the P2 treatment, the highest rating was also at the "like" level, with 60%. For the P3 treatment, the highest rating was at the "somewhat like" level, with 52%.

In this study, a statistical analysis was performed using the Friedman test with data from the organoleptic taste preference test. The results of the analysis can be seen in Table 2.

Table 2. Friedman Test Results for Taste Preference of Lactotaska Biscuits

	Results
	Color
A	338
B	310.5
T-value	9.16
F-table value	3.19

Notes: If T-value > F-table value, the effect is significant; If T-value < F-table value, the effect is not significant.

Based on the statistical results from the Friedman test with a 95% confidence level, it was found that the T-value is greater than the F-table value (9.16 > 3.19), indicating that there is an effect on the taste acceptability of biscuits made from taro flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*).

Taste is a sensation perceived by the taste buds (tongue) through chemical stimulation. Taste is influenced by several factors, such as chemical compounds, temperature, concentration, and the interaction between various taste components. The taste buds are located in the mouth, tongue, and palate. There are five basic tastes: sweet, bitter, salty, sour, and umami (G. I. G. Putri et al., 2023; Spence, 2022).

Based on the organoleptic test results on the taste of the biscuits, the three treatments produced average taste ratings, with the highest average in the P2 treatment at 60%. The panelists preferred the P2 treatment because of the distinct, slightly bitter taste of katuk leaves, balanced by the sweetness and savoriness of taro, with a ratio of taro flour to katuk leaf flour of (90 grams: 10 grams). The resulting taste was liked because the biscuits had a distinct flavor from the katuk leaf flour. In addition to the concentration of katuk leaf flour, the taste of the biscuits was also influenced by the ingredients used.

The quality of the biscuits is influenced by the properties and quantity of the ingredients used. Several researchers have explained the influence of ingredients in the dough and the balance of the formula on the final structure of the product, as well as the correlation between the characteristics of the ingredients and the quality of the product (Adeola et al., 2018; Manohar et al., 2002; Saha et al., 2011). The addition of katuk leaf flour and moringa leaf flour to cookies reduced the chocolate flavor and resulted in a taste less favored by the panelists, due to the distinctive bitter taste of katuk leaf flour and moringa leaf flour. The more katuk leaf flour and moringa leaf flour added, the stronger the unpleasant distinctive taste in the product, which can affect the panelists' level of preference. The distinctive taste of moringa leaves is due to the presence of tannin compounds, which cause a dry and astringent sensation (Nu'man et al., 2021). Katuk leaves have a dark green color due to their high chlorophyll content. These leaves also contain papaverine, an alkaloid also found in opium. In addition to serving as a source of nutrition, katuk leaves also have antioxidant properties. Due to their high fiber content, katuk leaves have the potential to be utilized as a new food source and processed into biscuits (Irmayanti et al., 2019).

Organoleptic Test Results on Aroma

Based on the organoleptic tests conducted by panelists on the modified biscuit samples made from taro flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*), the percentage results of the aroma evaluation can be seen in Figure 3.

The organoleptic test results on the aroma of biscuits made from taro flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*) showed that for the P1 treatment, the highest rating was at the "like" level, with 56%. For the P2 treatment, the highest rating was at the "somewhat like" level, with 60%. For the P3 treatment, the highest rating was at the "somewhat like" level, with 68%.

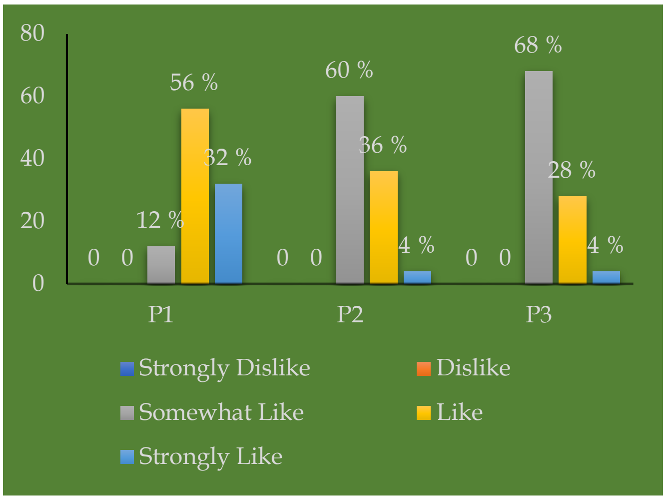

Figure 3. Organoleptic test results on aroma

In this study, a statistical analysis was performed using the Friedman test with data from the organoleptic aroma preference test. The results of the analysis can be seen in Table 3.

Table 3. Friedman Test Results for Aroma Preference of Biscuits

	Results
	Color
A	333.5
B	312.62
T-value	14.51
F-table value	3.19

Notes: If T-value > F-table value, the effect is significant; If T-value < F-table value, the effect is not significant.

Based on the statistical results from the Friedman test with a 95% confidence level, it was found that the T-value is greater than the F-table value (14.51 > 3.19), indicating that there is an effect on the aroma acceptability of biscuits made from talas flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*).

Based on the organoleptic test results on the aroma of the biscuits, the highest average result was in the P3 treatment, with 68%. The panelists somewhat liked the aroma of biscuits with a ratio of taro flour to katuk leaf flour of (85 grams: 15 grams). The distinctive aroma of the biscuits came from the katuk leaf flour, where the more katuk leaf flour added, the stronger the katuk leaf aroma became.

Aroma is one of the key parameters in determining the preference level for a food product. A distinctive aroma can be perceived by the sense of smell, depending on the ingredients and additives used in the food. The aroma of a food ingredient determines the deliciousness of the food product. Testing the aroma of food products serves as a parameter for consumers to accept or reject the product (Calín-Sánchez et al., 2021). The food industry considers aroma testing to be very important because it can quickly provide results on consumer preference for a product (Calín-Sánchez et al., 2021; Mihafu et al., 2020).

The addition of katuk leaf flour and moringa leaf flour to cookies can produce a musty odor that may reduce the panelists' preference for the aroma of the cookies. Using large amounts of katuk leaf flour tends to produce a strong musty odor, thereby reducing the panelists' preference for the aroma of the sago biscuits (10). The higher the concentration of katuk leaf extract added, the more panelists disliked the aroma of the donuts. This is due to the strong, distinctive aroma of katuk leaves (Arza et al., 2018).

Organoleptic Test Results on Texture

Based on the organoleptic tests conducted by panelists on the modified biscuit samples made from talas flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*), the percentage results of the texture evaluation can be seen in Figure 4.

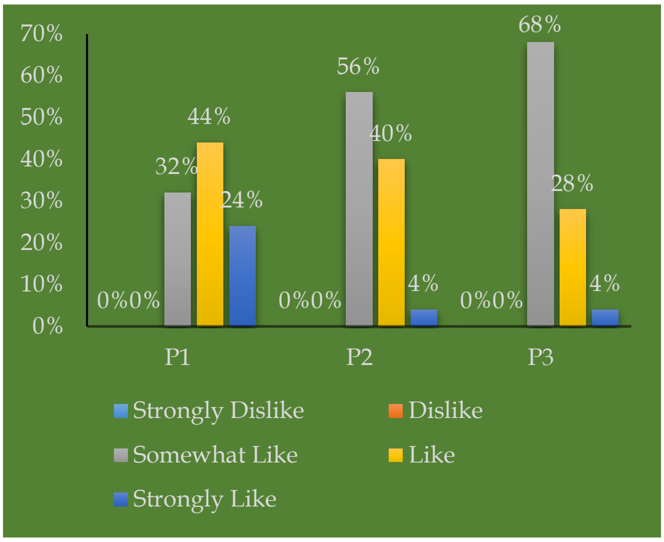

Figure 4. Organoleptic test results on texture

The organoleptic test results on the texture of biscuits made from taro flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*) showed that for the P1 treatment, the highest rating was at the "like" level, with 44%. For the P2 treatment, the highest rating was at the "somewhat like" level, with

56%. For the P3 treatment, the highest rating was at the "somewhat like" level, with 68%.

In this study, a statistical analysis was performed using the Friedman test with data from the organoleptic texture preference test. The results of the analysis can be seen in Table 4.

Table 4. Friedman Test Results for Texture Preference of Biscuits

	Results
	Texture
A	337
B	306.54
T-value	5.15
F-table value	3.19

Notes: If T-value > F-table value, the effect is significant; if T-value < F-table value, the effect is not significant.

Based on the statistical results from the Friedman test with a 95% confidence level, it was found that the T-value is greater than the F-table value (5.15 > 3.19), indicating that there is an effect on the texture acceptability of biscuits made from talas flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*).

Texture in food is the result of the tactile sense response to physical stimuli when there is contact between parts inside the mouth and the food (Tarwendah, 2017). Texture is directly associated with touch or feel. The texture of biscuit products includes crunchiness, ease of breaking, and consistency upon the first bite. Generally, the desired texture for biscuits is crisp, crunchy, not easily broken but not hard. The crunchiness of a product is assessed based on how easily it can be bitten and broken.

Based on the organoleptic texture test results of the biscuits, the highest average was found in the P3 treatment, at 68%. The panelists somewhat liked the texture of biscuits with a ratio of taro flour to katuk leaf flour of (85 grams: 15 grams).

Texture can be perceived through sight (visual texture), touch (tactile texture), and sound (auditory texture). For some types of food products, texture is the most important sensory attribute, while for other types of food, texture remains an important attribute but not the primary one. Texture defects can negatively impact consumer preference for the product (Rustagi, 2020). The addition of large amounts of katuk leaf flour and moringa leaf flour can make the product texture hard and dense. The higher the amount of flour added, the less favored the texture becomes by the panelists (Sariani et al., 2019).

The crunchiness of a food product can be influenced by its moisture content. The more water evaporated during baking, the more air pockets are formed, making the product crisper. Katuk leaf flour has characteristics that absorb water more easily compared to mocaf flour, so the more katuk leaf flour used as a substitute, the less desirable the texture of the resulting product becomes (Ratnasari, 2024).

Acceptability

The acceptability test results for the three treatments of biscuits made from talas flour (*Colocasia Esulenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*) with different formulations were evaluated based on the ranking of the panelists' preferences, which include color, aroma, taste, and texture. The results can be seen in Figure 5.

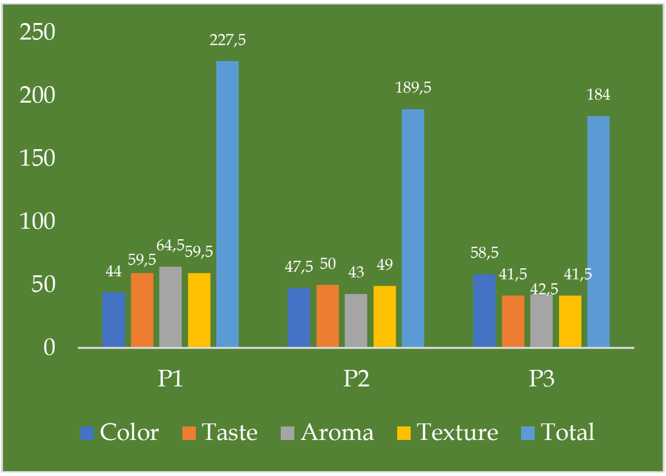

Figure 5. Acceptance test results for three treatments on biscuits made from taro flour (*Colocasia esculenta L. Schott*) and Katuk Leaf Flour (*Sauropus androgynus L. Merr*)

Results of the Overall Acceptability Test based on the ranking of color, aroma, taste, and texture of taro flour (*Colocasia esculenta L. Schott*) and katuk leaf flour (*Sauropus androgynus L. Merr*) biscuits show that the highest score was achieved by the P1 treatment with a total score of 249.

Based on the scoring, which includes color, taste, aroma, and texture, the biscuit that was most liked and accepted by the trained panelists was the one from the P1 treatment with a total score of 249. In treatment P1, the biscuits produced had a brownish-green color, a distinctive biscuit aroma with a hint of katuk leaf aroma. This is due to the ratio of taro flour to katuk leaf flour being 95 grams to 5 grams, which imparted a slight katuk leaf taste due to the blending of ingredients and the crisp texture. This aligns with the research which states that adding other ingredients, such as milk powder, to each treatment does not cause significant differences in color, aroma, and texture among treatments (Syarif et al., 2021).

A lower proportion of katuk leaf flour reduces the bitter taste, thus increasing the panelists' preference.

Additionally, the crispier texture further enhances panelists' liking. The texture of food is determined by the composition of its components, namely cellulose, pectin, protein, and carbohydrates.

Proximate Analysis

Nutritional value analysis is conducted to determine the nutrient composition of a food ingredient or product, such as moisture content, ash content, protein content, fat content, and carbohydrate content. Information about the nutritional content of a product is crucial for understanding the amount of energy it contains. The nutritional content of the selected biscuit product from the organoleptic test is from the P1 treatment (95% taro flour: 5% katuk leaf flour). The results of the analysis are shown in Table 5.

Table 5. Proximate Analysis Results of Lactotaska Biscuits

Test Parameter	Test Result	Unit	Test Method
Moisture Content	6.14	%	SN 01 – 2891 - 1992
Ash Content	2.52	%	SN 01 – 2891 - 1992
Carbohydrates	50.3	%	SN 01 – 2891 - 1992
Total Fat Content	27.4	%	SN 01 – 2891 - 1992
Protein Content	8.59	%	SN 01 – 2891 - 1992
Crude Fiber	6.70	%	SN 01 – 2891 - 1992

The proximate analysis results in Table 5 show the nutritional content of the taro flour and katuk leaf flour biscuits. The proximate analysis of the biscuit product was performed using the Indonesian National Standard.

Moisture Content

Moisture content is a physical property of a material that indicates the amount of water present. Moisture content can be expressed based on either wet basis or dry basis (29). The moisture content of the P1 treatment biscuits is 6.14%, which exceeds the SNI 01-2973-1992 standard for biscuits, which requires a moisture content of no more than 5% (L. N. Sari et al., 2019). The main ingredients used in the biscuit-making process have relatively high moisture content. Katuk leaf flour has a moisture content of 12% and taro flour has a moisture content of 9.4% (Fadila et al., 2023; Rialdi, 2021). The high moisture content in the ingredients is due to the high starch content, where starch gelatinization allows water to enter the starch granules. This water then forms hydrogen bonds with amylose and amylopectin (Cornejo-Ramírez et al., 2018). During baking, much of the water evaporates from the biscuit dough. Each type of biscuit requires different baking conditions because the structure formation and the amount of moisture to be removed depend on the recipe composition. One observable change in the biscuit dough during baking is the reduction of moisture content to 1-4%. During baking, moisture also evaporates from the product surface, followed by the transfer of moisture to the surface, which continues to evaporate into the oven environment. The desired moisture content in biscuits is determined by two factors: if the moisture content is too low, biscuits will taste burnt and be too dark, while too high moisture content will make biscuits soft, prone to breaking (checking), and lead to faster flavor changes during storage (Balestra et al., 2019; Červenka et al., 2006).

Ash Content

The ash content of the P1 treatment biscuits is 2.52%. This result exceeds the requirement specified in SNI 01-2973-1992 for biscuits, which states that the maximum allowable ash content is 1.6% (R. H. Putri et al., 2018). The highest mineral contributor to the biscuit product is katuk leaf flour, with 8.91% per 100 grams (Irmayanti et al., 2019). Minerals in katuk leaf flour include calcium, phosphorus, and iron. Ash is the inorganic residue remaining after burning organic material. The amount and composition of ash depend on the type of material and the ashing method used. Ash content indicates the mineral content of the material. Ash content is useful for assessing the quality of a processing method, identifying the type of material used, and as a parameter of a food's nutritional value (Yalindua et al., 2021).

Carbohydrates

Carbohydrates are a primary and essential nutrient for living organisms because their molecules provide carbon elements that can be used by cells (Ramaprabha et al., 2024). The carbohydrate content in the P1 treatment is 50.3%, which does not meet the SNI 01-4270-1996 requirement, which states that carbohydrates should have a minimum value of 70% (30). Taro flour has a carbohydrate content of 70.73% (13), whereas katuk leaf flour has only 29.64% per 100 grams (14). The main ingredients in this biscuit product already have a high carbohydrate content. Carbohydrate content in biscuits provides energy for lactating mothers, who should consume at least 50 grams of carbohydrates per day (Kementrian Kesehatan, 2014).

Fat Content

Fats in food serve as solvents and carriers for fat-soluble vitamins (A, D, E, K). Fats also enhance palatability (taste). Most compounds responsible for food flavor are fat-soluble (29). The fat content in this study is 27.4%, which meets the SNI 01-2973-1992 requirement stating that the minimum fat content should be 9.5% (R. H. Putri et al., 2018). This level meets the quality standards for biscuits. Additionally, the high fat content in the biscuits contributes to the energy value of the biscuits. Fats have a shortening effect on baked goods like biscuits, cookies, and bread, making them delicious and crisp. Fats break down the structure and coat starch and gluten, resulting in a crisp product. The fat content of a material is related to its moisture content, with higher fat content generally leading to lower moisture content (R. H. Putri et al., 2018).

Protein Content

Protein is a complex organic compound that contains amino acids linked together by peptide bonds. Protein is a major food component found in both plants and animals, serving as a cellular building block and a primary source of essential amino acids (Małecki et al., 2021). The protein content in the P1 treatment is 8.59%. This result shows that the protein content of the biscuits meets the SNI 01-2973-1992 standard, which requires a minimum protein content of 6% (R. H. Putri et al., 2018).

The protein content in biscuits can be influenced by the ingredients used in the biscuit-making process, such as flour, egg yolks, milk, powdered sugar, and margarine. In this case, the protein content of the main ingredients is 28.85% for katuk leaf flour and 20.64% for taro flour. The measured protein content can vary depending on the amount of water evaporated (dehydration) from the materials. The measured protein content tends to increase with the amount of water lost (Pratama et al., 2014).

Crude Fiber Content

There are two types of fiber: dietary fiber and crude fiber. The main role of fiber in food is its ability to bind water, including cellulose and pectin. Crude fiber is the part of food that cannot be hydrolyzed by chemical or strong acid and base methods used to determine fiber content, such as sulfuric acid and sodium hydroxide (Irmayanti et al., 2019). The crude fiber content in the P1 treatment is 6.70%. This result exceeds the SNI 01-2973-1992 standard, which states that crude fiber in a product should not exceed 1.5% (R. H. Putri et al., 2018). The fiber content in the product is also influenced by the type of flour used. Katuk leaf flour contains 19% crude fiber and taro flour contains 2.94% (Rialdi, 2021). This results in the biscuit's fiber content being higher than the SNI biscuit quality standard. Crude fiber is a type of dietary fiber that is insoluble in water. Dietary fiber itself is a complex carbohydrate found in plant cell walls. Although dietary fiber cannot be digested and absorbed by the human digestive system, it plays an important role in maintaining health, preventing various diseases, and is a crucial component in nutritional therapy (José et al., 2023).

Phosphorus Content Analysis Results

The phosphorus content value in biscuits with the addition of katuk leaf flour and taro flour in the P1 formulation with a ratio of 95:5 can be seen in table 6. The phosphorus content in the P1 treatment is 0.209%. This indicates that both taro flour and katuk leaf flour contain phosphorus in the biscuit product. The phosphorus content in these ingredients can contribute to the daily phosphorus intake, which is important for supporting various biological functions in the body. The study results show that cereal-based snack products can also be considered a significant source of phosphorus in daily nutrition. The results indicate that 100 grams of whole wheat flour-based biscuits can provide 13.65% to 37.3% of the daily recommended intake for adults (800 mg per day). The use of whole wheat flour in biscuits results in decreased phosphorus availability but, more significantly, an increase in total phosphorus content across all tested samples. Therefore, it can be concluded that the modifications made resulted in samples providing a higher amount of phosphorus and can be used in daily nutrition, even though the relative availability of phosphorus decreased (Nirmal et al., 2023).

Table 6. Phosphorus Content Analysis Results for Biscuits

Test Parameter	Test Result	Unit	Test Method
Phosphorus in food	0.209	%	Spectrophotometry

Iron Content Analysis Results

The iron content in biscuits with the addition of katuk leaf flour and taro flour in the P1 formulation at a ratio of 95:5 is shown in Table 7.

Table 7. Iron Content Analysis Results for Biscuits

Test Parameter	Test Result	Unit	Test Method
Iron (Fe)	80.4	mg/kg	Atomic Absorption Spectrophotometry

The iron content in the P1 treatment is 80.40 mg/kg. This result indicates that the biscuits made with taro flour and katuk leaf flour have a relatively high iron concentration. This significant iron content can impact the nutritional value of the biscuits. This shows that adding katuk leaf flour can increase the iron content in biscuits. Food fortification has proven effective in reducing and preventing iron deficiency at the population level. Various foods have been tested for iron fortification and have shown positive results in addressing iron deficiency in different patient groups. However, major challenges in producing iron-fortified foods include maintaining iron stability in the product, preserving acceptable organoleptic properties, and ensuring adequate absorption and bioavailability of iron (Samarakoon et al., 2023).

Calcium Content Analysis Results

The calcium content in biscuits with the addition of katuk leaf flour and taro flour in the P1 formulation at a ratio of 95:5 is shown in Table 8.

Table 8. Calcium Content Analysis Results for Biscuits

Test Parameter	Test Result	Unit	Test Method
Calcium (Ca)	142	mg/kg	Atomic Absorption Spectrophotometry

The calcium content in the P1 treatment is 142 mg/kg. This result shows that the P1 treatment yields a relatively high calcium concentration. The significant calcium content can contribute to the nutritional value of the biscuits. Research indicates that a serving of biscuits using a 5% substitution of katuk leaf and oatmeal provides 48 mg of calcium and 1.12 mg of iron when consuming 5 biscuits(Lestari et al., 2020). The Institute of Medicine Committee highlights the role of calcium in health, providing the basis needed for the average adequacy and recommended dietary allowance (RDA) (Ross et al., 2011).

Conclusion

Formulation P1, consisting of 95% talas flour and 5% katuk leaf flour, was found to be the most preferred by panelists based on sensory evaluation of color, aroma, taste, and texture. The proximate analysis revealed that every 100 grams of these biscuits contains 6.14% moisture, 2.52% ash, 27.04% fat, and 8.59% protein, indicating a product with good sensory attributes and a balanced nutritional profile.

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Conceptualization, Mulyanita; methodology.; validation, Ayu Rafiony and Ismi Trihardiani; formal analysis, Dedi Satria; investigation, Mulyanita; resources, Dedi Satria; data curation, Ayu Rafiony; writing—original draft preparation, Mulyanita and Ismi Trihardiani; writing—review and editing, Mulyanita; visualization, and Ayu Rafiony And Dedi Satria. All authors have read and agreed to the published version of the manuscript.

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