ORGANOLEPTIC AND PROXIMATE CHARACTERISTICS OF COOKIES WITH TARO FLOUR *(Colocasia Esculenta)* SUBSTITUTION AS AN ALTERNATIVE SNACK

Karakteristik Organoleptik dan Proksimat Cookies dengan Substitusi Tepung Umbi Talas (Colocasia Esculenta) sebagai Camilan Alternatif

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ABSTRACT

Prediabetes is a condition charaterized by elevated blood glucose levels that have not yet reached the diagnostic threshold for diabetes mellitus. The rising prevalence of prediabetes has driven the development of low glycemic index snacks using local ingredients such as taro (Colocasia esculenta) and almonds (Prunus dulcis), which are rich in fiber and protein. This study aimed to evaluate the effect of incorporating taro root flour and almonds on the organoleptic properties and proximate composition of cookies intended as a healthy snack for individuals with prediabetes. A Completely Randomized Design (CRD) was applied. Organoleptic evaluation involved 40 semi-trained panelists, while proximate analysis was conducted in triplicate. The optimal formulation consisted of 25 g wheat flour and 75 g taro flour, producing cookies with a moderately distinctive taro flavor, acceptabel taste, and a fairly crispy texture. Although the sensory attributes were significantly affected (p<0.05), proximate analysis indicated significant differences (p<0.05) in moisture, ash, protein, fat, and carbohydrate content. These findings suggest that taro flour and almonds can enhance the nutritional quality of cookies and have potential as functional food products.

Keyword : *organoleptic; proximate; prediabetes; taro root flour cookies*

ABSTRAK

Prediabetes merupakan kondisi ketika kadar glukosa darah lebih tinggi dari normal namun belum mencapai batas diagnosis diabetes melitus. Meningkatnhya prevalensi prediabetes mendorong pengembangan camilan indeks glikemik rendah dengan memanfaatkan bahan lokal seperti talas *(Colocasia esculenta)* dan almond *(Prunus dulcis)* yang kaya serat dan protein. Penelitian ini bertujuan untuk menganalisis pengaruh penambahan tepung talas dan almond terhadap sifat orgnoleptik serta komposisi proksimat *cookies* sebagai camilan sehat bagi penderita prediabetes. Metode yang digunakan adalah Rancangan Acak Lengkap (RAL). Uji organoleptik dilaukan oleh 40 panelis semi-terlatih, sedangkan analisis proksimat dilakukan sebanyak tiga kali pengulangan. Hasil penelitian menunjukkan bahwa formulasi terbaik adalah 25 g tepung terigu dan 75 g tepung talas, menghasilkan *cookies* berwarna cokelat dengan aroma talas yang cukup terasa, rasa yang dapat diterima, dan tekstur cukup renyah. Secara statistik, terdapat pengaruh signifikan terhadap sifat organoleptik uji hedonik (p<0.05) dan analisis proksimat menunjukkan pengaruh signifikan

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($p<0.05$) terhadap kadar air, abu, protein, lemak dan karbohidrat. Kesimpulannya, penambahan tepung talas dan almond berpotensi meningkatkan nilai gizi *cookies* sebagai pangan fungsional.

Kata Kunci: *cookies* tepung talas; organoleptik; proksimat; pradiabetes.

INTRODUCTION

Prediabetes is a term used to describe a condition in which blood glucose levels are above normal but do not yet meet the criteria for a diagnosis of diabetes. Prediabetes and hypertension are among the health concerns that have garnered global attention. The standard criteria for prediabetes are fasting blood glucose levels of 100–125 mg/dL (known as Impaired Fasting Glucose) or 140–199 mg/dL two hours after an oral glucose tolerance test (known as Impaired Glucose Tolerance, or IGT), or both (Sattu, 2024). According to data from the West Nusa Tenggara Provincial Health Office, there were 71,031 diabetes patients in West Nusa Tenggara in 2023, representing 8.80% of the population. In the same year, data indicated that there were 2,612 diabetes patients in North Lombok Regency; this disease also ranked among the top 10 most prevalent conditions, with diabetes occupying the 7th position. The prevalence of prediabetes in Indonesia continues to rise, necessitating innovations in functional foods that can help control blood sugar levels. One approach is to develop low-glycemic-index food products, such as cookies, formulated using local food ingredients rich in fiber and resistant starch, such as taro root flour. The use of taro flour in making cookies is expected to reduce the amount of sugar and reduce dependence on wheat flour added to the dough and is thought to affect the physicochemical and sensory characteristics of the resulting cookies and can increase the fulfillment of nutritional content and can utilize local food ingredients (Suprapto, 2024). Taro root flour has the potential to be used as a cookie ingredient due to its high dietary fiber and resistant starch content, which can lower the glycemic index of the final product and enhance its nutritional value, making it suitable for individuals with prediabetes (Ayu, 2024).

Taro *(Colocasia esculenta)* is a tuberous plant that remains underutilized and undervalued despite being abundant and affordable. Taro contains carbohydrates, fiber, vitamins, and minerals, and has a higher protein content compared to other tuber crops. Taro has the potential to be

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utilized in the creation of food products, such as plant-based milk alternatives, frozen desserts, and yogurt substitutes (Juniawan *et al*., 2025). Taro contains a relatively high amount of carbohydrates in the form of starch and has a low glycemic index (<55), making it suitable for consumption by individuals with diabetes or prediabetes (Juniawan *et al*., 2025).

This study aims to analyze the effect of taro flour substitution on the organoleptic and proximate characteristics of cookies as a healthy snack for people with prediabetes. Taro flour can increase the fiber and resistant starch content and lower the glycemic index of cookies without significantly reducing their organoleptic quality. Cookies made with 50% taro flour have the same organoleptic quality as cookies made with wheat flour. The use of taro flour in cookie production is expected to reduce the amount of sugar and decrease reliance on wheat flour added to the dough; it is also expected to influence the physicochemical and sensory characteristics of the resulting cookies, enhance nutritional content, and utilize locally available food ingredients. The formulation of cookies with added tuber flour has been shown to improve proximate values namely protein, fiber, and minerals while remaining acceptable to panelists in terms of sensory quality. Therefore, researchers are interested in using taro as one of the raw materials used in cookie production. This means that partially substituting wheat flour with tuber flour, such as taro, can produce cookies that are not only nutritious but also have good organoleptic quality and are safe for consumption by individuals with prediabetes. Therefore, research on the organoleptic and proximate characteristics of cookies made with taro flour and almonds is needed to support the development of locally sourced functional foods that are suitable for individuals with prediabetes.

RESEARCH METHODOLOGY

Time and Location

This study was conducted from January to February 2026 at the Analytical Laboratory of Mataram University for proximate analysis and at the Food Technology Laboratory of Bumigora University for organoleptic testing and product preparation.

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Type and Design of the Study

This study employed an experimental design using a completely randomized design (CRD) with three replications per treatment and six formula units.

Table 1. Formulation Unit

Ingredients	F0	F1	F2	F3	F4	F5
Wheat Flour (%)	100	60	50	40	25	0
Taro Flour (%)	0	40	50	60	75	100
Brown Sugar (g)	20	20	20	20	20	20
Butter (g)	15	15	15	15	15	15
Eggs (item)	1	1	1	1	1	1
Baking powder (g)	1	1	1	1	1	1

Notes:
F0 = 100 % wheat flour (control)
F1 = 60% wheat flour : 40 % taro flour
F2 = 50% wheat flour : 50% taro flour
F3 = 40% wheat flour : 60% taro flour
F4 = 25% wheat flour : 75% taro flour
F5 = 100% taro flour

Population and Sample

The subjects selected for this study were 40 randomly selected panelists aged 19–23 years. According to SNI 01-2346, the standard number of semi-trained panelists is 30 people. The panelists involved in this study were 40 nutrition students who were semi-trained panelists with prior experience in conducting organoleptic tests and who had taken the Food. The sampling technique used in this study was purposive sampling, in which nutrition students at Bumigora University met criteria established by the researcher. The sample size was set at 40 students who already had experience conducting organoleptic tests.

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Types and Techniques of Data Collection

The type of data collected is primary data, which is data collected directly using organoleptic testing methods (color, aroma, taste, texture). Primary data collection was conducted using organoleptic testing forms.

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Data Analysis

In this study, the software used for data processing was Microsoft Excel 2019 and SPSS. Data analysis in this study was performed using several statistical tests appropriate for the type of data obtained. Data from the organoleptic tests and chemical quality tests were analyzed using a one-way ANOVA because there was a single treatment factor with five treatment groups that met the principle of homogeneity. If the ANOVA results indicate significant differences, a post-hoc test using Duncan's test will be performed to determine which treatment groups exhibit significant differences. This analytical method is expected to yield valid results that can be well interpreted in determining the effect of adding taro flour on the organoleptic and chemical quality of taro flour cookies.

METHOD

Making Taro Flour

The process of making taro flour begins with preparing the taro roots. The roots are first sorted by selecting only those that are fresh, undamaged, and free from rot. After sorting, the taro roots are peeled to separate the skin from the flesh. The peeled taro root are then washed thoroughly with clean water to remove any dirt or impurities. After washing, the taro roots are sliced thinly to facilitate the drying process. The slices are sun dried for approximately 2-3 days until they are completely dry. Once fully dried, the taro slices are ground into powder and sifted using an 80 mesh sieve to obtain fine taro flour. The taro flour is the ready for further use or processing.

Making Cookies

The process of making cookies starts with preparing all the required ingredients, namely taro flour, al purpose flour, eggs, brown sugar, baking powder, and butter. The taro flour and all purpose flour are first sifted together to ensure a smooth texture and even mixing. In a separate bowl, the egg and brown sugar are beaten until the mixture becomes smooth and well combined. Butter is then added and mixed thoroughly. After that, the flour mixture is gradually added while stirring gently with spatula until a uniform dough is formed. The dough is then shaped into cookies according to preference and topped with sliced almond. Next, the shaped dough is arranged neatly on baking

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paper placed on a baking tray. Finally, the cookies are baked for about 20-25 minutes until fully cooked and golden brown.

RESULTS AND DISCUSSION

The organoleptic tests conducted consisted of two tests: the Hedonic Test and the Hedonic Quality Test. These tests were carried out at the Food Technology Laboratory of Bumigora University with a panel of 40 semi-trained panelists consisting of Bumigora University students. Several sensory attributes were evaluated, namely color, aroma, taste, and texture of the taro flour cookie products. The taro flour cookie products consisted of 6 (six) treatments or formulas, namely F0 (control formula), F1 (60:40), F2 (50:50), F3 (40:60), F4 (25:75), and F5 (100).

Table 2. Hedonic Test Values

Sensory Attributes	Formula (100 g)						*p-value*
	F0 100:0	**F1 60:40**	**F2 50:50**	**F3 40:60**	**F4 25:75**	**F5 0:100**	
Color	3,85±0,83[c]	3,55±0,78[bc]	3,38±0,93[b]	3,50±0,93[bc]	2,90±0,81[a]	2,95±1,01[a]	0,000
Aroma	3,30±0,94[b]	3,58±0,93[b]	2,55±0,99[a]	3,58±0,98[b]	3,25±0,95[b]	3,48±0,96[b]	0,000
Taste	3,28±0,78[c]	3,70±0,88[d]	2,70±1,02[b]	3,25±0,93[c]	2,33±1,00[a]	2,83±1,01[b]	0,000
Texture	3,10±0,93[bc]	3,43±0,93[c]	2,90±0,98[b]	3,18±0,96[bc]	2,70±1,04[a]	2,65±1,05[a]	0,003

Note: Identical letter codes (a, b…) in the same column indicate no significant difference based on Duncan's test at a 5% significance level (α = 0.05). A p-value < 0.05 indicates a significant difference between treatments.
100:0 = 100 g wheat flour : 0 g taro flour
60:40 = 60 g wheat flour : 40 g taro flour
50:50 = 50 g wheat flour : 50 g taro flour
40:60 = 40 g wheat flour : 60 g taro flour
0:100 = 0 g wheat flour : 100 g taro flour

Color

Color is a very important factor in determining the quality or degree of acceptance of a food product (Jairani *et al.*, 2020). Based on the results of the hedonic color test, the statistical analysis showed that the p-value was < 0.05 (specifically 0.000), indicating a significant difference between the sample groups. These findings are consistent with the study by Qoshdina *et al.* (2024), which demonstrated that the use of taro flour in cookie products affects the color of the final product. The higher the proportion of taro flour used, the darker the cookies tend to become, due to phenolic compounds and browning reactions during baking. A color that is too dark can be associated with a burnt or bitter taste.

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Phenolic compounds and phenolase enzyme activity can result in a less good appearance and a reduction in the degree of whiteness due to the presence of dirt carried by tuber pigments, gum and mucus in the outer layer of tuber tissue (Ismail *et al*., 2023). Therefore, the brown color of F0 is likely at an ideal level of browning neither too pale nor too dark thereby providing a more familiar visual impression and meeting the panelists' expectations for cookies.

Aroma

Based on the results of the aroma hedonic test, the treatments had a significant effect on aroma ratings ($p<0.05$). The mean aroma scores differed significantly among the tested treatments. This indicates that variations in treatment were able to alter the panelists' perception of the product's aroma. According to Febriana *et al*. (2025), the aroma characteristics of cookie products are greatly influenced by ingredient composition and reactions during baking. The characteristic aroma of the substitute ingredient becomes more dominant as its concentration increases. However, if the concentration is too high, this characteristic aroma can become too strong and reduce the panelists' acceptance level. Conversely, if the concentration is too low, the intensity of the substitute ingredient becomes less noticeable. The results of this study are in line with research (Hidayati *et al*., 2022) which shows that the use of substitute ingredients in food products can affect the aroma of the product because each ingredient has different aroma characteristics.

Taste

Based on the results of the ANOVA test for the taste parameter, a significance value of 0.000 ($p < 0.05$) was obtained. This finding indicates that the treatments applied had a significant effect on taste ratings. Therefore, it can be concluded that variations in treatment resulted in differences in the panelists' preference levels regarding the product's taste. According to Febriana *et al*. (2025), sensory characteristics such as taste are greatly influenced by ingredient composition and the level of substitution. Increasing the amount of substitute ingredients can enhance the distinctive flavor profile; however, if the concentration is too high, it may result in a taste that is overly dominant or unbalanced. In this study, formulations with an appropriate proportion

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of ingredients tended to yield better sensory acceptance compared to formulations with excessively high concentrations.

Texture

Based on the results of the ANOVA test on texture parameters, a significance value of 0.03 (p<0.05) was obtained, indicating that the treatment had a significant effect on product texture. In the acceptability test, treatment F1 which contained the lowest proportion of taro flour received the highest score for texture (3.43), falling into the "fairly crisp" category. This indicates that panelists preferred a crispier cookie texture compared to formulations with a higher taro flour substitution. As explained in the study (Febriana *et al*., 2025), moisture content and the interaction between protein and starch also influence the product's hardness and brittleness. The higher the water content bound in the starch, the less crisp the sensation will be. Additionally, a study (Fitri, 2025) also explains that the composition of ingredients in cookie formulations can affect a product's crispness level because it relates to moisture content and dough structure.

Table 3. Hedonic Quality Test Table

Sensory Attributes	Formula (100g)						*p-value*
	F0 100:0	F1 60:40	F2 50:50	F3 40:60	F4 25:75	F5 0:100	
Color	4,60±0,63[d]	3,48±1,01[c]	3,63±1,00[c]	2,53±1,13[b]	2,00±1,11[a]	2,23±1,21[b]	0,000
Aroma	2,83±0,96[a]	3,08±0,89[a]	3,35±1,10[a]	3,25±0,90[a]	3,20±0,94[a]	3,18±1,01[a]	0,224
Taste	2,63±0,95[a]	2,90±0,96[ab]	3,13±1,02[bc]	3,43±0,87[c]	3,33±1,23[c]	3,33±1,00[a]	0,003
Texture	2,25±0,95[a]	2,40±0,98[a]	1,90±1,08[a]	2,53±0,96[a]	2,28±1,22[a]	2,30±1,04[a]	0,157

Note: Identical letter codes (a, b…) in the same column indicate no significant difference based on Duncan's test at a 5% significance level (α = 0.05). A p-value <0.05 for the aroma and texture parameters indicates no significant difference, while a p-value >0.05 for the color and taste parameters indicates a significant difference between treatments.

Color

The ANOVA results showed a significance value of 0.000 (p<0.05), indicating a significant difference among treatments in terms of product color quality. The scoring categories for the hedonic quality test of color quality were: 1 = dark brown; 2 = grayish brown; 3 = brown; 4 = light brown; 5 = yellowish brown. Based on the results of the color quality test, different mean values were obtained for each treatment. Treatment F0 had the highest mean

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score, namely 4.60, indicating a yellowish brown color.

According to Iskandar *et al.* (2018), color changes in taro-based products during the heating process occur due to browning reactions, particularly the Maillard reaction between reducing sugars and proteins, as well as the gelatinization of starch, which triggers the formation of brown pigments. The intensity of the brown color increases with the duration of heating or processing. The optimally formed yellowish-brown color tends to be preferred by panelists because it indicates a good level of doneness without appearing burnt. In treatments resulting in a grayish-brown color, there is a likelihood of a more dominant mixture of taro's natural pigments, leading to a less bright and less appealing appearance. A grayish color is often perceived as a product that is undercooked or lacks freshness. Meanwhile, a dark brown color may indicate a higher intensity of the browning reaction, which could be perceived as overbaking or a more bitter taste due to an overly advanced Maillard reaction. The results of this study are also in line with research (Yuliatmoko *et al.*, 2012) taro flour formulation has a significant effect on color cookies. The higher the taro flour content, the darker the cookies, due to the Maillard reaction. Color is a crucial factor in food. The first impression a food makes is its color. Color is a characteristic that determines consumer acceptance of a product (Yuliatmoko *et al.*, 2012).

Aroma

The results of the ANOVA test showed that the treatment had no significant effect on the level of aroma preference, with a significance value of 0.224 ($p > 0.05$). The scoring categories for the hedonic quality test of aroma quality were as follows: 1 = no taro aroma; 2 = weak taro aroma; 3 = moderate taro aroma; 4 = strong taro aroma; 5 = very strong taro aroma. From the results of the hedonic test on the aroma parameter, the average likability score of the panelists for each treatment ranged from 2.83 to 3.35. Treatment F2 had the highest average score of 3.35, followed by F3 at 3.25 and F4 at 3.20, while the lowest was F0 at 2.83.

According to Iskandar *et al.* (2018), the heating process causes changes in the chemical components of the ingredients that can create a distinctive aroma through reactions between sugars and proteins (the

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Maillard reaction) as well as changes in volatile compounds during processing. Aroma intensity is influenced by heating duration and ingredient composition. A well-balanced aroma is more likely to be accepted by panelists because it conveys the product's distinctive character without causing off-notes. An aroma that is too weak or undetectable can make the product seem lacking in character, so that panelists do not perceive the distinctive identity of the substitute ingredient used. Conversely, an overly strong taro aroma has the potential to create a musty or overly dominant impression, which can lower the level of acceptability because not all panelists are accustomed to the distinctive aroma of taro tubers. Therefore, aromas of moderate intensity tend to be preferred because they provide a balance between the distinctive aroma of taro and the general aroma of cookies.

Taste

Taste is the most important factor in a consumer's decision to accept or reject a food (Amalia *et al*., 2021). The ANOVA results showed that the treatment had a significant effect on taste preference, with a significance value of 0.003 ($p<0.05$). The scoring categories for the hedonic quality test of taste were 1 = no taste; 2 = weak taro taste; 3 = moderate taro taste; 4 = strong taro taste; 5 = very strong taro taste.

According to research (Qoshdina *et al*., 2024), increasing the substitution of taro flour in food products can affect sensory characteristics, particularly taste. Substitution at a certain level can improve panelist acceptance because it provides a distinct and appealing flavor profile. However, if the concentration of taro flour is too high, the characteristic tuber flavor may become overly dominant and potentially create an off-putting, musty impression. Conversely, if the amount of taro flour is too low, the characteristic taro flavor becomes less pronounced, causing the product to lose its identity as a taro-based food.

Texture

The ANOVA results showed that the treatment had no significant effect on texture acceptability, with a significance value of 0.157 ($p > 0.05$). The hedonic quality test scores for texture were categorized as follows: 1 = soft texture; 2 = not very crisp texture; 3 = moderately crisp texture; 4 =

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crisp texture; 5 = very crisp texture. Treatment F3 obtained the highest mean score, namely 2.53, while treatment F2 showed the lowest mean score of 1.90. Meanwhile, the other treatments, such as F0, F1, F4, and F5, had mean scores that were quite close, ranging from 2.25 to 2.40.

According to Febriana *et al*. (2025), the texture of cookies is greatly influenced by the composition of the flour and its protein and starch content. Taro flour has a high amylopectin content, causing it to gelatinize easily during baking. The starch gelatinization process causes starch granules to absorb water, expand, and form a softer structure after baking. This structure can reduce the crispness of the product because the dough matrix becomes less dry and less brittle compared to cookies made with all-purpose flour. Additionally, an increase in protein content from the substitute ingredient can increase the product's hardness, but it may also affect its brittleness and crumb characteristics.

Table 4. Proximate Analysis Values

Parameter	**Cookies Formula**					***p-value***
	F0	**F1 60:40**	**F2 50:50**	**F3 40:60**	**F4 25:75**	
Moisture content (%)	19,79±0,30^{c}	19,97±0,16^{c}	16,56±0,15^{b}	19,30±0,61^{c}	15,85±0,32^{a}	0,000
Ash content (%)	1,62±0,37^{a}	1,76±0,11^{b}	2,36±0,09^{e}	2,23±0,01^{d}	2,00±0,08^{c}	0,000
Protein (%)	9,87±0,12^{e}	8,27±0,16^{d}	6,44±0,24^{b}	6,18±0,34^{a}	6,64±0,17^{c}	0,000
Fat (%)	16,23±0,09^{a}	26,14±1,47^{b}	29,01±0,32^{c}	29,46±0,49^{c}	33,34±0,24^{d}	0,000
Carbohydrates (%)	52,48±0,23^{e}	43,85±1,24^{c}	45,61±0,79^{d}	42,81±0,84^{b}	42,15±0,72^{a}	0,000

Note: Identical letter codes (a, b, …) indicate no significant difference at the One-Way ANOVA test level, followed by Duncan's test at a 5% significance level (α = 0.05). If the p-value is < 0.05, this indicates a significant difference between treatments.
Taro flour cookie formulation:
F0 = 100 g wheat flour
F1 = 60 g wheat flour : 40 g taro flour
F2 = 50 g wheat flour : 50 g taro flour
F3 = 40 g wheat flour : 60 g taro flour
F4 = 25 g wheat flour : 75 g taro flour

Moisture content

Water content is a parameter that has a big role in the stability of the quality of a product (Astuti *et al*., 2023). The ANOVA results indicate that the treatments had a significant effect on moisture content ($p < 0.05$). Treatment F1 had the highest moisture content with a ratio of 60 g wheat flour to 40 g taro flour at 19.97%, while treatment F4 had the lowest moisture content with a ratio of 25 g wheat flour to 75 g taro flour at 15.85%. According to the quality

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requirements for cookies in SNI 2973.2022, the maximum moisture content for cookies is 5%. Amar *et al*. (2021) added that high water content is caused by the high water content of the raw materials, shape, size, thickness, time, and baking temperature of the cookies. If the water content of cookies is above the maximum limit of 5% according to SNI quality requirements, this will increase water activity in the cookies, making the product more susceptible to microbial growth, which leads to a shorter shelf life. High water content can accelerate quality changes during storage. Based on the test results, the cookies do not meet the quality requirements, as the moisture content in each formulation exceeds 5%. This is likely due to the taro flour, which has a high water-binding capacity due to its starch and dietary fiber content, causing the product's moisture content to increase.

In a study (Febrianti *et al*., 2025), it was noted that high moisture content is caused by the high water content of the raw materials, as well as the shape, size, thickness, baking time, and temperature of the cookies. If the moisture content of the cookies exceeds the maximum limit of 5% as specified by SNI quality standards, this will increase the water activity within the cookies, making the product more susceptible to microbial growth and resulting in a shorter shelf life. High moisture content can accelerate quality deterioration during storage. Cookies are hygroscopic food products, meaning they easily absorb water vapor from the environment. High humidity during cooling can lead to an increase in moisture content. These conditions can cause the moisture content to exceed established standards.

Ash content

Ash content is an indicator of the mineral content of a food product. The higher the ash content, the higher the mineral content (Kartika, 2014). The ANOVA results showed a significance value of 0.000 ($p < 0.05$). These results indicate that the treatments had a highly significant effect on the ash content of the samples. Thus, differences in treatment led to differences in the mineral content of the tested products. The test results show that the highest ash content was found in treatment F2 with an average value of 2.37%, while the lowest ash content was found in treatment F0 at 1.62%.

According to Abdi *et al*. (2025), it is explained that taro flour contains

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approximately 1.1% minerals as well as various micronutrients such as calcium, potassium, and phosphorus. This indicates that the use of local food ingredients like taro flour is not only intended as a wheat flour substitute but also to enhance nutritional value, particularly the micronutrient content in cookies. Thus, the ash content in taro flour cookies can indicate the extent of the mineral contribution from this substitute ingredient. The higher the proportion of mineral-rich ingredients like taro, the higher the ash content tends to be. In addition to indicating mineral content, ash content is also important as a parameter of quality and purity of the ingredient. An appropriate ash content value indicates that the raw material is clean and free from contamination by foreign inorganic substances.

Protein

The ANOVA results showed a significance value of 0.000 ($p < 0.05$). This indicates that there was a highly significant difference among the treatments in terms of the samples' protein content. The highest mean protein content was found in treatment F0 at 9.87%, while the lowest was found in treatment F3 at 6.18%. The other treatments, namely F1, F2, and F4, had protein contents of 8.27%, 6.44%, and 6.65%, respectively. According to the biscuit quality requirements in SNI 2011, the minimum protein content for biscuits is 5%.

This is consistent with a study (Qoshdina *et al*., 2024), which found that substituting non-wheat ingredients in baked goods leads to changes in chemical composition, including a decrease in protein content when the substitute has a lower protein content than wheat flour. The study explains that changes in ingredient formulation directly affect the nutrient content of the final product, particularly protein and carbohydrates. It is concluded that taro flour contains protein but in low amounts; the higher the taro flour substitution, the more the product's protein content tends to decrease. This occurs because taro contains little protein its protein content is lower than that of wheat flour so the total protein in the formulation becomes smaller when wheat flour is reduced. The high protein content of wheat flour is related to the presence of prolamins, glutelins, globulins, and albumins. These components play a role in forming a strong gluten structure, making wheat flour widely used in

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food products such as noodles, bread, and cookies (D.K Khamdamova, 2024).

Fat

Based on the results of the proximate analysis of fat content, different average fat content values were obtained for each treatment. The ANOVA results showed a significance value of 0.000 ($p < 0.05$). These results indicate that the treatments had a highly significant effect on the fat content of the samples. The test results showed that the highest fat content was found in treatment F4 with an average value of 33.35%, while the lowest fat content was found in treatment F0 at 16.24%. The other treatments showed varying fat contents, namely F3 at 29.46%, F2 at 29.01%, and F1 at 26.14%.

Based on the proximate analysis results, the highest fat content was found in F4 at 33.34%, with a formulation of 25 g wheat flour to 75 g taro flour. The increase in fat content in F4 was likely not due to the high proportion of taro flour, but rather influenced by the contribution of other high-fat ingredients, presumably due to variations in ingredient composition, including the use of almonds in the formulation. Differences in the amount of almonds across formulations likely contribute to the product's fat content because almonds contain fat. Therefore, variations in ingredient formulations can affect the fat content of the cookies. In terms of composition, taro flour is not a high-fat ingredient; taro generally contains only a very small amount of fat, around 0.21%. Therefore, increasing the amount of taro flour does not significantly increase the fat content of the product. Almonds are known as one of the nuts with a high fat content, but most of it is unsaturated fat, specifically 30 g of monounsaturated fat and 12 g of polyunsaturated fat (Pada *et al*., 2022).The fat content in these cookies meets the requirements of SNI-01-2973-1992, which stipulates that the minimum fat content in cookie products is 9.5%. Therefore, it can be concluded that the highest fat content in F4, at 33.34%, is likely due to the dominance of high-fat ingredients such as almonds, rather than the high use of taro flour.

Carbohydrates

The ANOVA results showed a significance value of 0.000 ($p < 0.05$). This indicates that the treatments had a highly significant effect on the carbohydrate content of the resulting cookies. Based on the

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proximate analysis of carbohydrate content, different average carbohydrate levels were obtained for each treatment. Treatment F0 showed the highest carbohydrate content, at 52.48%, while the lowest carbohydrate content was found in treatment F4, at 42.15%. The other treatments, namely F2, F1, and F3, had carbohydrate contents of 45.61%, 43.85%, and 42.82%, respectively.

According to Qoshdina *et al. (*2024), changes in the formulation of raw materials in cookie products result in changes in chemical composition, including carbohydrate content. Substituting non-wheat ingredients will affect the nutrient content of the final product because each ingredient has a different proximate composition. This is consistent with the results of previous studies, which found that when the proportion of wheat flour is higher, the product's carbohydrate content tends to be higher because wheat flour is the primary source of starch in the formulation. Thus, the difference in carbohydrate content between wheat flour and taro can be explained by the differences in the properties of the raw materials and their chemical composition, and is supported by research (Qoshdina et al., 2024), which states that variations in ingredient formulation directly affect the chemical composition of the product. Differences in carbohydrate content are influenced not only by ingredient composition but also by moisture and fat content. This is because carbohydrate content is calculated using the "by difference" method; thus, an increase in moisture or fat content can reduce the calculated carbohydrate value. Additionally, the use of taro flour in bakery products is known to affect the product's chemical and physical characteristics. (Nurilmala *et al*., 2024) state that substituting taro flour in cakes affects the nutritional value, texture, and physical properties of the product because taro flour has a relatively high starch and dietary fiber content. These properties indicate that taro flour has the potential to be developed as a functional food ingredient in baked goods.

CONCLUSION

The addition of taro flour had a significant effect on the organoleptic characteristics and proximate composition of the cookies. In terms of proximate composition, formulation F4 with a ratio of 25 g wheat flour to 75 g taro flour had the

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lowest carbohydrate content, making it a suitable healthy snack alternative for individuals with prediabetes.

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