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PHYSICOCHEMICAL AND SENSORY CHARACTERISTIC EVALUATION OF SAGO FLOUR COOKIES WITH STEVIA SUGAR (Stevia Rebaudiana) ADDITION

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Abstract

Cookies are a practical snack and are enjoyed by various age groups. Modifying sago flour cookies with stevia sugar not only has a crunchy texture and a preferred taste, but is also healthier. This study aims to determine the effect of various concentrations of sago flour with the addition of stevia sugar on cookies' physicochemical and sensory properties. This study used an experimental design with a quantitative approach and a Completely Randomized Design (CRD). The treatment consisted of four compositions: P1 (100% wheat flour: 0% sago flour) as a control, P2 (50% wheat flour: 50% sago flour), P3 (25% wheat flour: 75% sago flour), and P4 (0% wheat flour: 100% sago flour). Observations made were sensory tests, including: color, aroma, taste, texture, and crispness. Nutritional content tests included: water content, ash content, and fat content. Physical tests included: Hardness test. Respondents in the sensory test were 70 untrained panelists. Based on the research results, cookies substituted with 75% sago flour (P3) produced the highest acceptance of aroma, taste, texture, and crispness compared to other treatments, respectively, namely 3.86 (like), 3.66 (like), 3.87 (like), and 3.74 (like). The cookie hardness test found that the higher the proportion of sago flour, the more complex the cookies produced, namely P2 of 8.22 N/mm2, P3 of 8.4 N/mm2, and P4 of 11.5 N/mm2. Then, in the water content test, the more the proportion of sago flour, the more significant ($P<0.05$) the water content was, namely 4.42% (P2), 5.54% (P3), and 7.56% (P4). Meanwhile, the total ash and fat content decreased significantly ($P<0.05$), respectively, namely 0.88% (P2), 0.48% (P3), 0.30% (P4) ash content, and 29.09% (P2), 25.51% (P3), 21.04% (P4) fat content. The water, ash, and fat content in sago flour cookies meet the quality requirements of SNI 01-2973-2022 cookies except for the water content of the P4 treatment. Thus, the cookie formulation with 75% sago flour, 25% wheat flour, with the addition of stevia sugar (P3) produces the best product based on organoleptic acceptance and cookie quality requirements. However, it is necessary to identify the shelf life test of sago cookies to ensure the quality and safety of the product.

Keywords: Cookies, Stevia sugar, Physicochemical, Sago, Sensory

INTRODUCTION

Cookies are made primarily from wheat flour, sugar, eggs, and other additives such as margarine and baking powder. Wheat flour contributes to the structure of cookies through its gluten content, while sugar provides sweetness and influences color. However, commercial cookies made with regular wheat flour and sugar have several drawbacks, particularly from a health perspective. Wheat flour contains gluten, which can cause problems for people with gluten allergies or other sensitivities. At the same time, excessive consumption of granulated sugar can increase the risk of high blood sugar levels, obesity, and metabolic disorders (Mansur, 2022). Sago flour (Metroxylon sp.) is an alternative substitute for wheat flour in cookies for consumers avoiding gluten. It contains carbohydrates, fiber, calcium, iron, and (less) protein, making it gluten-free due to its low protein content. However, sago flour has a higher carbohydrate content than wheat flour, which can affect the quality of the cookie dough (Rahmawati et al., 2023). Meanwhile, as a sweetener, stevia sugar can be a calorie-free alternative to granulated sugar. Stevia sugar, derived from Stevia rebaudiana leaf extract, has a significantly higher sweetness level than granulated sugar, approximately 200-300 times greater. This calorie-free nature makes stevia sugar ideal

for individuals who need to control their sugar intake, such as those with diabetes, those on low-calorie diets, or those seeking to prevent the risk of obesity and metabolic disorders (Khairunnisa, 2022).
According to research by Sustriawan et al. (2021), granulated sugar (sucrose) can be replaced with other sweeteners such as stevia and crystallized coconut sugar to create cookies with a low glycemic index. Stevia has a low sugar content but provides a higher sweetness than regular sugar.

Cookie products are being developed using sago flour, a gluten-free flour with positive health benefits. Sago flour in cookies, known as sago cookies, is already commercially available (Pari et al., 2024). Meanwhile, using stevia sugar has a low sugar content but provides a sweeter taste than regular sugar. Stevia is low in calories and suitable for diabetics, as well as safe for long-term use (Sustriawan et al., 2021). This study identified the effect of various concentrations of sago flour with added stevia sugar on cookie quality. The resulting cookies were evaluated through sensory testing, which measured acceptance of color, aroma, taste, texture, and crispness. Physical and chemical tests were also conducted to assess the texture characteristics of hardness, moisture content, ash content, and fat content. The results of this study can serve as a scientific reference source for the best formulation of sago cookies with added stevia sugar, based on the highest sensory acceptance and nutritional content that meets the requirements of SNI 01-2973-2022.

METHOD

Research Method

This study employed an experimental design with a quantitative approach. The research design used was a Completely Randomized Design (CRD) to test the effect of adding stevia sugar to sago flour-based cookies. The treatments tested included four experimental units as follows:

P1 = 1000 g wheat flour : 0 g sago flour
P2 = 500 g wheat flour: 500 g sago flour
P3 = 250 g wheat flour: 750 g sago flour
P4 = 0 g wheat flour: 1000 g sago flour

Subject Research

The subjects in this study were students at Teuku Umar University who were willing to participate as panelists to measure consumer preferences for cookie products. The organoleptic test was conducted with 70 untrained panelists as respondents. The variables observed in this study included organoleptic parameters such as color, taste, texture, aroma, and nutritional content of the cookie product. In this study, there were dependent and independent variables. The variables in this study are as follows:

Independent Variable: Concentration of sago flour with various concentrations, including 0%, 50%, 75%, and 100%. Dependent Variable: Physicochemical characteristics, including hardness, moisture content, fat content, and ash content, as well as sensory characteristics, including color, aroma, taste, and texture.

Location and time of research

This study was conducted at the Culinary Nutrition Laboratory and Agricultural Product Technology Laboratory of Teuku Umar University. The study was planned from January 20 to February 20, 2025.

Materials

The raw materials used in this research consisted of cookie ingredients and chemical analysis reagents. The cookie ingredients included sago flour, stevia sugar (Tropicana Slim), butter (Palmia), eggs, baking powder (Raja), vanilla (Harum), and water. The chemical analysis reagents included hexane (Merck).

Tools

The main tools for this study included cookie-making equipment, sensory testing equipment, and nutritional analysis. The cookie-making equipment included a Blender (Philips), Measuring cup (Waki), Analytical balance (Arashi), Oven (Kirin), and Dough mixer (Whisk). The tools used in the sensory testing included a form containing a rating table for appearance, color, aroma, taste, texture, and crispness. Meanwhile, the nutritional analysis equipment included an Oven (Memmert), Analytical balance (Fujitsu), Furnace (Snol), fat Soxhlet tester, desiccator, and Universal Testing Machine (UTM) (NL Scientific).

Procedures

Sensory Test

Sensory test referred to Salsabila et al. (2024). The parameters tested included color, taste, aroma, texture, and crunchiness using the hedonic method. The assessment was conducted using an organoleptic form with a scale of 1-5, namely: 1 = very dislike, 2 = dislike, 3 = slightly dislike, 4 = like, and 5 = very like

Proximate Analysis

The proximate analysis of cookies consists of moisture content, ash content, and fat content tests, referring to SNI 01-2891-1992 standard for food and beverages. The moisture content and ash content tests use the gravimetric method, while the fat content test uses the Soxhlet method.

Analysis physic of sago cookies

The physical analysis of sago cookies includes a hardness test using a Universal Testing Machine (UTM). The test involves placing the sago cookies on a sample holder, and then a needle or penetrator from the UTM is inserted into the center of the cookies to measure the hardness level of the product. The hardness level of the sago cookies is determined by the maximum force required by the UTM needle to penetrate the cookies until it reaches the base. An illustration of the hardness test of sago cookies is presented in Figure 1.

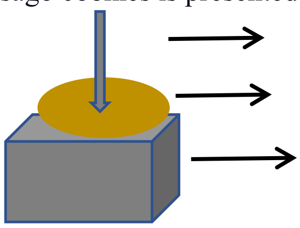

Figure 1. Illustration of Sago Cookie Hardness Test with UTM

Data Analysis

The data from this study were statistically analyzed using SPSS version 20. The evaluation of sensory parameters used the Kruskal-Wallis test, while the nutritional content analysis used Analysis of Variance (ANOVA). If significant differences were found between treatments, further tests were conducted using Duncan's test with a 5% confidence level or P<0.05.

RESULTS AND DISCUSSION

Sensory Test

This study thoroughly developed hypotheses and achieved the objectives by involving all relevant variables. The primary focus was on the physicochemical and sensory characteristics of sago flour cookies with the addition of stevia sugar. The acceptability analysis in this study included an organoleptic assessment involving crucial parameters such as color, taste, aroma, and texture. Each parameter plays a significant role in determining the sensory quality and the extent to which the panelists accept the product. The results of the acceptability analysis of sago flour cookies with the addition of stevia sugar are presented in Table 1.

Table 1. Acceptability analysis of sago flour cookies with the addition of stevia sugar.

Parameters	Treatments				
	P1	P2	P3	P4	P-value
Color	4,09±0,74^{ab}	3,97±066^{a}	3,90±0,85^{a}	3.59±0,91^{a}	0.05
Aroma	4,31±0,58^{b}	3,71±0,80^{a}	3,86±0,77^{ab}	3,21±1,10^{a}	0.00
Taste	4,27±0,68^{c}	3,57±0,97^{b}	3,66±0,87^{b}	2,97±1,17^{a}	0.01
Texture	3,96±0,77^{b}	3,84±0,86^{b}	3,87±0,72^{b}	3,37±1,02^{a}	0.00
Crunchiness	3,83±0,80^{a}	3,71±0,98^{a}	3,74±0,83^{a}	3,47±0,99^{a}	0.192

The data presented are mean ± standard deviation. Different letters in the same row or column indicate significant differences (P < 0.05).

Based on the color analysis results in Table 4, there was a significant difference between the use of stevia and regular sugar, with a p-value of 0.05. The average color values for cookies with stevia sugar were P2 (3.97), P3 (3.90), and P4 (3.59), while the control P1, which used granulated sugar, had a higher value of 4.09. It indicates that cookies using granulated sugar and 100% wheat flour (P1) were preferred in terms of color compared to cookies using a combination of stevia sugar and sago flour. The researchers assume that this difference is due to the chemical properties of each sweetener. Granulated sugar undergoes caramelization and the Maillard reaction during baking, resulting in the cookies' browning. In contrast, stevia does not undergo this process optimally, producing a paler color. It can be seen in Figure 2. Therefore, using stevia tends to reduce the color intensity of cookies compared to regular sugar. It is supported by research by Adelina et al. (2025), which found that dragon fruit skin cookies substituted with stevia sugar and cookies without stevia sugar produced brighter colors than those substituted with stevia sugar. It is because stevia sweeteners cannot make a caramel brown color compared to those containing granulated sugar (Adelina et al. 2025; Samuel et al. 2018). Furthermore, flour composition also influences color differences. In treatment P1, cookies were made using 100% wheat flour, while in treatments P2, P3, and P4, wheat flour was partially or wholly replaced with sago flour. Wheat flour contains protein (gluten) that can interact with the Maillard process, while sago flour is predominantly starch. It has a very low protein content, making it less conducive to color formation during baking. The results of this study are in line with Rahwamati's research (2023). Cookies made with a 70% substitution of sago flour produced the highest color preference acceptance compared to cookies without sago flour (0%) with 100% wheat as the main ingredient, namely 2.80 and 2.68, respectively.

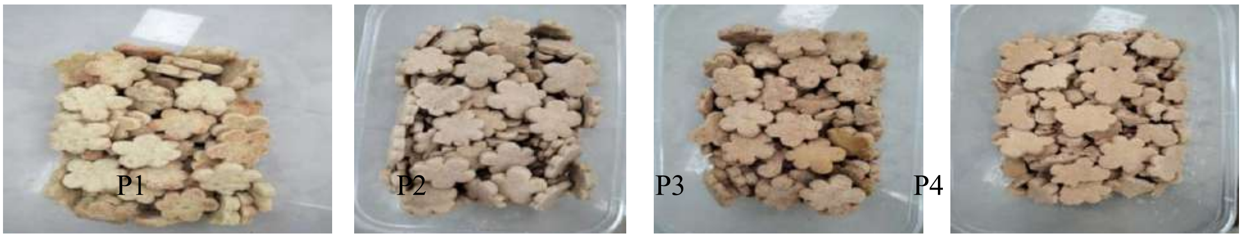

Figure 2. Sago flour cookies product added stevia sugar

Based on the aroma analysis results in Table 4, there was a significant difference between the use of stevia and granulated sugar, with a p-value of 0.00. The average aroma scores for cookies with stevia sugar were P2 (3.71), P3 (3.86), and P4 (3.21), while the control P1, which used regular sugar, had a higher value of 4.31. It indicates that cookies using granulated sugar and wheat flour (P1) were preferred in terms of aroma compared to cookies using a combination of stevia sugar and sago flour. Researchers assume this difference in aroma is due to the type of sugar used. Granulated sugar produces a distinctive aroma because it optimally undergoes the Maillard reaction and caramelization, resulting in a stronger and more appealing aroma. Conversely, stevia also does not undergo this reaction, resulting in a less intense aroma. Furthermore, the type of flour also affects aroma. Wheat flour contains gluten proteins that support the Maillard reaction and aroma formation, while sago flour is primarily starch and contains little protein.The results of this study align with Adelina et al (2025) research, dragon fruit skin cookies substituted with stevia sugar and without stevia (granulated sugar) produced the highest acceptance of aroma preferences in cookies without stevia. Cookies given granulated sugar produced a sweet aroma and a caramel aroma compared to cookies substituted with stevia 0.50 g, 0.75 g, and 1 g. Then the results of this study, also strengthened by Rahmawati et al (2023), reported that cookies with sago flour substitution (0%) with the main ingredient of 100% wheat flour produced the highest acceptance of aroma preferences compared to 50% and 60% sago flour substitution.

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starch and contains little protein. The results of this study align with Adelina et al (2025) research, dragon fruit skin cookies substituted with stevia sugar and without stevia (granulated sugar) produced the highest acceptance of aroma preferences in cookies without stevia. Cookies given granulated sugar produced a sweet aroma and a caramel aroma compared to cookies substituted with stevia 0.50 g, 0.75 g, and 1 g. Then the results of this study, also strengthened by Rahmawati et al (2023), reported that cookies with sago flour substitution (0%) with the main ingredient of 100% wheat flour produced the highest acceptance of aroma preferences compared to 50% and 60% sago flour substitution. Based on the taste analysis results in Table 4, there was a significant difference between the use of stevia sugar and regular sugar, with a p-value of 0.01. The average taste scores for cookies with stevia sugar were P2 (3.57), P3 (3.66), and P4 (2.97), while the control P1, which used granulated sugar, had a higher value of 4.27. It indicates that cookies using granulated sugar and 100% wheat flour (P1) were more preferred in terms of taste than cookies using stevia sugar and sago flour. Cookies made with the stevia sugar and sago flour mixture had a lower taste preference. The researchers assumed this was due to the characteristic bitter taste of stevia, which was less preferred by panelists. In contrast, granulated sugar provides a more familiar and sensorially acceptable sweetness. Therefore, the use of stevia tended to decrease the level of taste preference for cookies. Furthermore, the type of flour also influenced taste acceptance. In treatment P1, 100% wheat flour was used, while in P2, P3, and P4, wheat flour was partially or wholly replaced with sago flour. Wheat flour contains gluten, which helps form a soft texture and reasonable structure, thus supporting a more pleasant and desirable taste perception. The results of this study align with those of Adelina et al. (2025), who found that dragon fruit skin cookies without stevia in F0 were preferred over those substituted with 0.50 g, 0.75 g, and 1 g of stevia. Cookies with granulated sugar (without stevia) produced a milky and sweet taste, while those with stevia tended to have a bitter aftertaste. These results were further supported by Rahmawati et al. (2023), who also explained that cookies with sago flour substitution (0%) with 100% wheat flour as the main ingredient produced the highest taste acceptance compared to those substituted with 50%, 60%, and 70% sago flour.

Based on the texture analysis results in Table 4, there was a significant difference between the use of stevia and granulated sugar, with a p-value of 0.00. The average texture scores for cookies with stevia sugar were P2 (3.84), P3 (3.87), and P4 (3.37), while the control P1, which used regular sugar, had a slightly higher value, at 3.96. It indicates that cookies using regular sugar and 100% wheat flour (P1) were preferred in terms of texture compared to cookies using stevia sugar and a mixture of sago flour. The researchers assume this difference is due to granulated sugar's ability to influence structure and texture formation during baking. Granulated sugar can help form a crispy structure through Maillard reactions and caramelization, which contribute to color and texture. Conversely, stevia does not make the same physical contribution to the dough structure, resulting in cookies that tend to be less crispy than cookies with granulated sugar. Furthermore, the flour composition also influences the final texture of the product. In P1, 100% wheat flour was used, while in P2, P3, and P4, wheat flour was gradually replaced by sago flour until it reached 100% in P4. Wheat flour contains gluten, crucial in providing elasticity and structure to the dough. Meanwhile, sago flour contains high amounts of starch but almost no gluten, making it unable to maintain the cookie structure well. Consequently, the higher the proportion of sago flour, the more brittle the cookie texture becomes and the less preferred it becomes. The results of this study align with those of Adelina et al. (2025), who found that dragon fruit peel cookies substituted with stevia sugar produced a denser or harder texture, thus decreasing texture acceptance. A similar finding was also reported by Astuti et al. (2021), who reported a decrease in texture preference due to the substitution of stevia sweetener in their "tomato velvet" product. The research results were also strengthened by Rahmawati et al. (2023), who used sago flour substitution, obtained cookies with sago flour substitution (0%) with the main ingredient of 100% wheat flour, resulting in the highest texture preference acceptance compared to 70% sago flour.

Based on the crispiness analysis results in Table 4, there was no significant difference between the use of stevia and granulated sugar, with a p-value of 0.192. The average crispness values for cookies with stevia sugar were P2 (3.71), P3 (3.74), and P4 (3.47), while the control value for P1, which used regular sugar, was slightly higher at 3.83. It indicates that both cookies with stevia and granulated sugar had similar crispness levels. The researchers assumed that the similar crispness values between cookies with stevia sugar and regular sugar were due to the sweetener's role in the dough's physical structure, which is not very dominant in creating crispness. Crispiness was more influenced by fat content, water content, and the baking process. Furthermore, flour composition also influenced crispness. In treatment P1, 100% wheat flour was used, while in P2, P3, and P4, wheat flour was partially or wholly replaced with sago flour. Sago flour, rich in starch and low in gluten, tends to produce a more brittle and dry texture, which can enhance the crunchiness. Meanwhile, wheat flour with gluten content provides a denser and chewier texture. Research by Akbar (2023) confirms that the crispiness of cookies depends on the ingredients used and the water content in the dough. The right water content creates the right crispiness. This study showed that a mixture of 15% wheat flour, mung bean flour, and 35% sago flour had the highest scores compared to a mixture of 35% wheat flour, mung bean flour, and 15% sago flour, with scores of 4.457 (suitable for crispness) and 3.571 (sufficiently crispy), respectively.

Nutritional Content

The results of the water content analysis of sago flour-based cookies are shown in Figure 3. The test was conducted on four treatments, namely P1, P2, P3, and P4, with variations in the use of sago flour ranging from 0% to 100%. The results show that the water content of the cookie products experienced quite clear changes between treatments. In P1 (without sago flour), the water content was recorded at 5.85%. This value decreased in P2 to 4.42%, then increased again in P3 with a water content of 5.54%. The highest increase occurred in P4, which used 100% sago flour, with a water content of 7.56%.

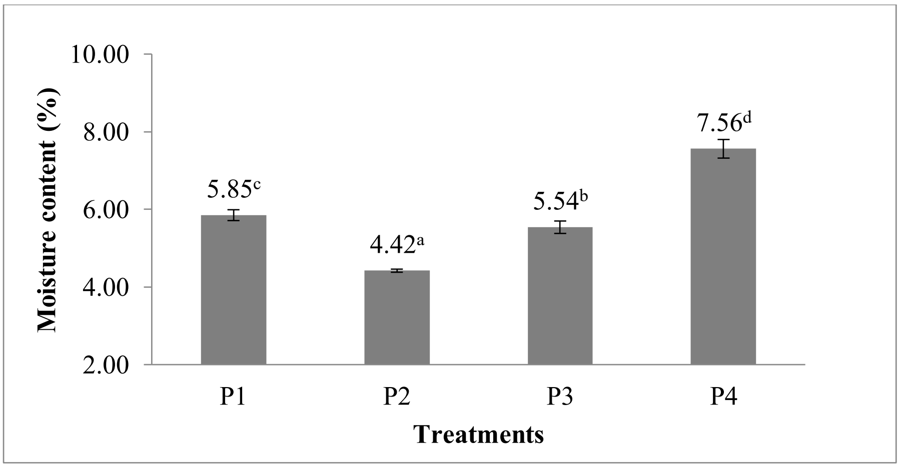

Figure 3. Moisture content sago flour cookies. Different letters in the graph each showed a significant differences (P < 0.05).

The results of the moisture content analysis of sago flour-based cookies are shown in Figure 3. The results indicate that the moisture content of the cookies varied significantly between treatments. Treatment P4, which used 100% sago flour, had the highest moisture content at 7.56%, followed by P3 (5.44%) with 75% sago flour, and P2 (4.42%) with 50% sago flour. The higher the proportion of sago flour used, the higher the moisture content of the cookies. Treatment P1, which used 100% wheat flour and granulated sugar, had a moisture content of 5.85%. The researchers assumed that the higher the proportion of sago flour used, the higher the moisture content of the cookies. It is due to the characteristics of sago flour, which is high in starch but low in protein, especially gluten, making it unable to form a strong and stable dough structure that binds water during the baking process. These results are in line with those reported by Tahir et al (2018), cookies with a sago flour: blondo ratio of 65 and 35 g, as well as a ratio of 60 and 40 g, produced the highest water content in cookies with a sago flour proportion of 65 g. In addition, the addition of stevia can affect the increase in water content in sago flour cookies. It is suspected that stevia can bind more water, thus causing an increase in water content in the product. Pranyusha et al (2020) state that stevia sweetener can bind a certain amount of water in the dough, thus causing an increase in water content in the product. It is also the reason why the water content in cookies with a sago flour proportion of 75% (P3) and 100% (P4) contains water content that exceeds the SNI 01-2891-1992 standard of 5% with the analysis results being 5.44% and 7.56%, respectively. The results of the ash content analysis of sago flour-based cookies are shown in Figure 4. Based on the ash content analysis, cookies using a combination of sago flour and stevia showed variations in ash content. Treatment P2, which used 50% sago flour and stevia, had the highest ash content at 0.88%, followed by P3 (0.48%) with 75% sago flour, and P4 (0.30%) with 100% sago flour. Meanwhile, treatment P1, the control, which used 100% wheat flour and regular sugar, had an ash content of 0.71%.

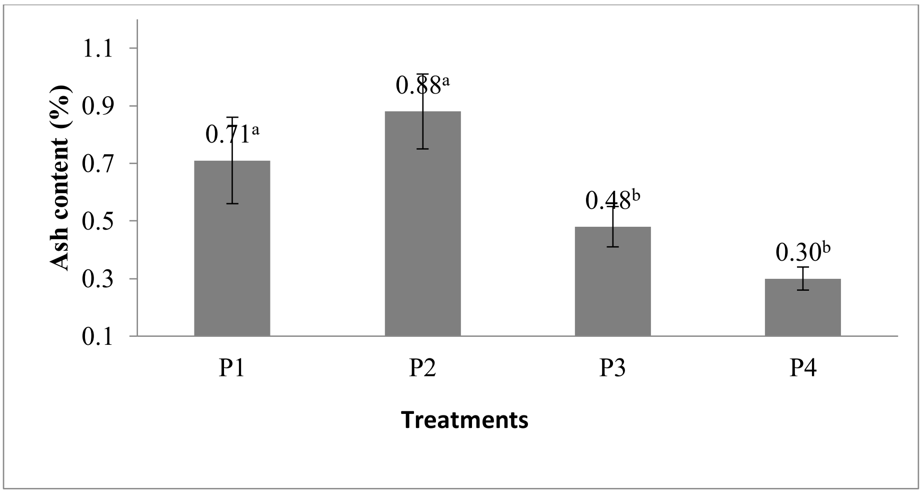

Figure 4. Ash content of sago flour cookies. Different letters in the graph each showed a significant differences (P < 0.05).

The researchers hypothesized that the combination of sago flour and stevia, particularly in treatment P2, tends to increase the ash content of the product. It may be due to interactions between the components in stevia and other additives that increase the mineral content or inorganic residue after baking. Conversely, the higher the proportion of sago flour used, the lower the ash content, as seen in cases of P3 and P4. Sago flour is known to have a lower mineral content than wheat flour, so its use in large quantities lowers the overall ash content. These results align with research by Tahir et al. (2018), who found that cookies with sago flour:blondo ratios of 65 and 35 g and 60 and 40 g produced lower ash content than cookies with a sago flour proportion of 65 g. Meanwhile, in P1 (100% wheat flour) and P2 (50% sago and 50% wheat), the highest ash content was found in P2, at 0.88% and 0.71%, respectively. The high ash content in cookies with 50% sago flour is thought to be due to the addition of stevia sweetener in the P2 treatment. Stevia has been reported to increase the mineral content of products, including calcium, potassium, iron, magnesium, zinc, sodium, and copper (Chughtai et al., 2020). The results of the fat content analysis in sago flour-based cookies are shown in Figure 5. The results indicate that the fat content in the cookies experienced significant changes between treatments. Treatment P2 showed the highest fat content at 29.09%, followed by P3 with a fat content of 25.51%, and P4 with the lowest fat content at 21.04%. Meanwhile, the control treatment P1, which used 100% wheat flour and regular sugar, had a fat content of 26.18%.

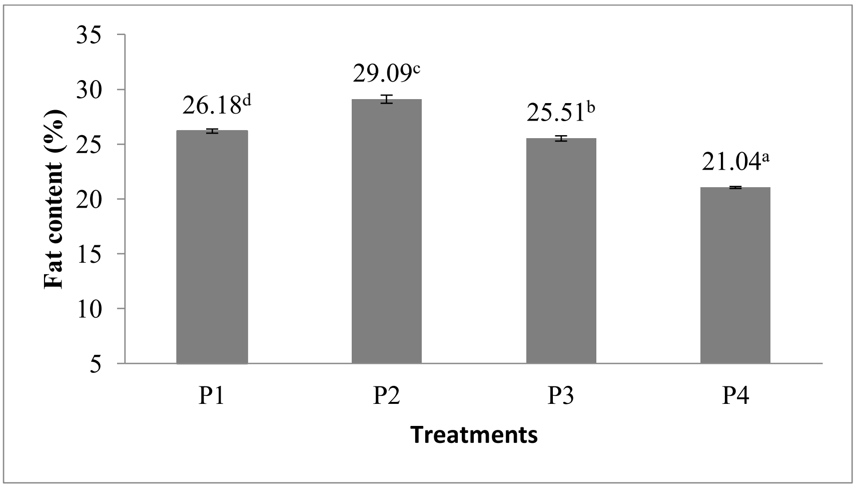

Figure 5. Fat content of sago flour cookies Different letters in the graph each showed a significant differences (P < 0.05).

The researchers assumed that the high fat content in P2 was due to the mixture of wheat flour and sago flour, each containing 50% of each. The higher fat content likely occurred due to the interaction between the flour components, which made the fat more easily retained or absorbed in the cookies. These results align with those reported by Tahir et al. (2018), who found that cookies with sago flour:blondo ratios of 65 and 35 g and 60 and 40 g produced lower fat content than cookies with a sago flour proportion of 65 g. Meanwhile, in P1 (100% wheat flour) and P2 (50% sago flour and 50% wheat flour), the highest fat content was found in P2, at 29.09% and P1 at 26.18%. The high fat content in cookies containing 50% sago flour is thought to be due to differences in the starch composition of the two flours, wheat flour and sago flour. This finding is supported by research by Hemeto et al. (2021), which explains that high starch content can absorb water well during the cookie-making and baking process, thus affecting texture and fat content. The results of the texture analysis of sago flour-based cookies are shown in Figure 6. Treatment P4 showed the highest hardness level, at 11.5 N/mm2, followed by P3 with a hardness level of 8.4 N/mm2, and P2 with a hardness level of 8.22%. Meanwhile, the control treatment P1, which used 100% wheat flour and granulated sugar, had a hardness level of 5.67 N/mm2.

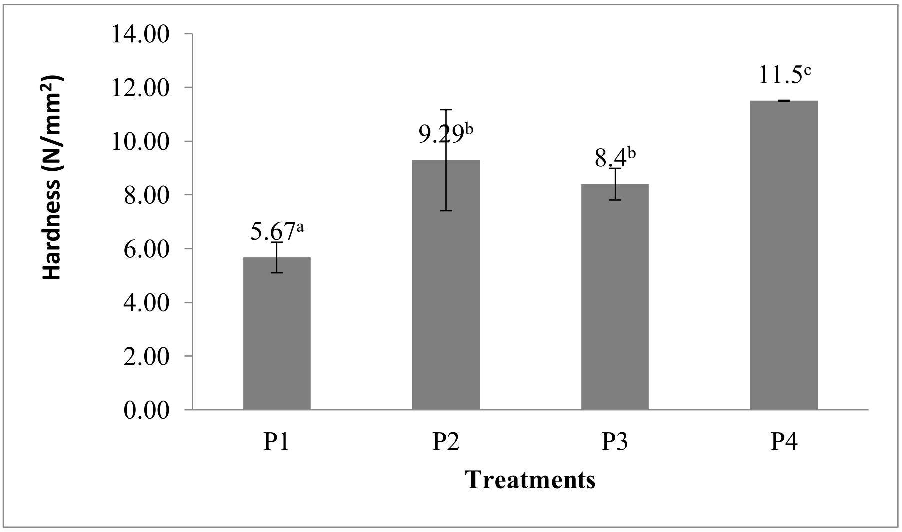

Figure 6. Hardness of sago flour cookies. Different letters in the graph each showed A significant differences (P < 0.05).

The researchers assumed that the high hardness in P4 could be due to using 100% sago flour, which has a denser and stiffer texture than wheat flour and does not contain gluten, maintaining the product's softness. This is evidenced by the research results by Qoshdina et al. (2024), which found that cookies using a higher proportion of sago flour produced higher hardness levels, ranging from 6.18 to 15.53 N/mm2. Furthermore, using stevia as a sweetener did not provide the softening effect of granulated sugar, resulting in a more complex cookie structure. Adelina et al.'s (2025) statement that stevia sugar can affect the hardness of cookies supports this. Similar results were also reported by Astuti et al. (2021) in a "velvet tomato" product where stevia was added, resulting in a firmer product.

CONCLUSION

The best formulation was obtained in P3 (75% sago flour: 25% wheat flour), which showed the highest level of acceptance in aroma, taste, texture, and crispness, and met the SNI 01-2973-2022 quality standards for water, ash, and fat content, except for the water content in treatment P4. Increasing the proportion of sago flour tended to increase water content and hardness, but decreased ash and fat content. A shelf life test is required for these sago flour-based cookies to ensure product quality and safety during storage.

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