Journal of Applied Food Technology

Home page: https://ejournal2.undip.ac.id/index.php/jaft

Sensory Characteristics and Nutritional Content of Dragon Fruit Peel Cookies with Stevia Substitution

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Abstract

Indonesia ranked 5th in the world for the highest number of diabetes sufferers in 2021 and continues to rise. One of the developments in low glycemic index food products that is safe for people with diabetes is dragon fruit peel flour cookies. The use of stevia in these products can further reduce the glycemic index. However, the use of stevia can affect the sensory characteristics of the product. This study aimed to determine the concentration of stevia that can be substituted in making dragon fruit peel cookies with mocaf flour, which potentially have a low glycemic index while still being favored by consumers. The study used five formulations of dragon fruit peel cookies, with stevia substitution of 0% (F0), 25% (F1), 50% (F2), 75% (F3), and 100% (F4). A Check-All-That-Apply (CATA), hedonic and ranking sensory tests were performed to determine consumer acceptance of the product. Nutritional composition was performed by comparing the selected formulation with the commercial product with low glycemic index claim. The data were analyzed using One-Way ANOVA (SPSS) and CATA Analysis tools (XLSTAT). The determination of CATA attributes was conducted through a Focus Group Discussion, and results showed that formula F1 was the closest to the ideal product characteristics, dominated by sweet aroma, and milky taste. The hedonic test results indicated that all parameters were quite different among the tested formulas. The ranking test results showed that sample F0 ranked first, followed by F1. The nutritional comparison showed that the only significant difference was the fiber content, which was seven times higher in the F1 cookies compared to the commercial product. Based on these results, the dragon fruit peel cookies with 25% stevia substitution are favored by the panelists and have the potential for a low glycemic index.

Article information:
Received: 16 November 2024
Accepted: 23 March 2025
Available online: 2 May 2025

Keywords:
CATA analysis
cookies gluten free
dragon fruit peel
low index glycemic
stevia

doi: 10.17728/jaft.25032

Introduction

Indonesia ranked 5th in the world for the highest number of diabetes patients in 2021, with 90% suffering from type 2 diabetes caused by excessive consumption of high glycemic index products. This was reported by the International Diabetes Federation (IDF), and it is predicted to continue increasing until 2045. Diabetes is a condition when a person's blood sugar levels are high due to pancreatic dysfunction in producing insulin or excessive consumption of high glycemic index products, leading to insulin resistance. Various efforts have been made to develop low glycemic index products to reduce the risk of diabetes and make them safe for diabetic patients to consume.

Cookies are one of the most popular bakery products. A previous study in 2023 successfully developed cookies using mocaf flour and dragon fruit peel flour at a 55:45 ratio that was favored by consumers (Adelina et al., 2024). The addition of dragon fruit peel flour aimed to utilize the abundant waste while enhancing the nutritional content and sensory characteristics of the product. Some of the nutritional improvements in that study included an increase in crude fiber to 2.29% and phenolic compounds to 5.67 mg GAE/g sample in cookies with 45% dragon fruit peel flour substitution. These two components could lower the glycemic index of the product by acting as enzyme inhibitors for alpha-amylase and amyloglucosidase (Wei et al., 2021; Zhang et al., 2022). However, the saponin content in dragon fruit peel resulted in a bitter taste (Putri et al., 2022), which require the addition of sweeteners to balance the flavor.

Various types of sweeteners could be used in the production of bakery products. A previous study used

three types of sweeteners, which were granulated sugar, brown sugar, and honey (Adelina et al., 2024). In addition to providing sweetness, sweeteners were also used to improve texture (softness and moisture), aroma (caramelization), and color (browning) in products (Arshad et al., 2022; Hutchings et al., 2019; Steindler, 2023; van der Sman et al., 2022). Each type of sweetener provided unique sensory characteristics, and combining several types of sweeteners could enhance the sensory qualities of a product. The cookie formula used in the previous study (Adelina et al., 2024) resulted in sensory evaluations where 73% of panelists agreed with its hardness, 60% agreed with its crunchiness, 60% agreed with its color appearance, and 40% agreed with its sweetness level. However, the carbohydrate content was relatively high at 64.60%, suggesting that the glycemic index might also be high (Di Cairano et al., 2020).

Some artificial sweeteners (aspartame, cyclamate, saccharin) were alternatives for low-calorie sweetener substitution to produce products with a low glycemic index. However, several studies had shown that consuming artificial sweeteners in high amounts correlates positively with the potential to cause cancer (Steindler, 2023). Therefore, natural sweeteners like stevia, extracted from the leaves of *Stevia rebaudiana*, were still widely used. In addition to having very few calories, making it beneficial for preventing obesity, stevia was also rich in fiber and contains various bioactive components such as steviol glycosides (stevioside, rebaudioside, steviobioside), phytochemical compounds (flavonol and flavone), and various other phenolic components that can lower the glycemic index of products (Ahmad et al., 2018; Góngora Salazar et al., 2018). The Food and Agriculture Organization (FAO) had also declared stevia safe for use in food products, categorizing it as Generally Recognized as Safe (GRAS).

Several previous studies successfully substituted stevia in various products, including tomato velva (Astuti et al., 2021), yogurt (Harismah, 2017), and tea (Apriliapatni et al., 2023) which were favored by consumers. The use of stevia was widely applied in liquid products (Chughtai et al., 2020) because stevia did not contribute to the texture, viscosity, mouthfeel of food products (specifically in baked product) as natural sweeteners like granulated sugar or brown sugar. Additionally, stevia imparted a bitter aftertaste if not balanced with other ingredients that can mask its bitterness. Therefore, the use of stevia as a sweetener substitute in cookies still requires further study to produce cookies with a low glycemic index while being well-accepted by consumers for sensory qualities. Previous study needed to add bulking agent such as maltodextrin, sugar alcohol, or fiber in baked food product with stevia to promote the formation of texture that mimic the characteristic of sugar (Samuel et al., 2018). Therefore, the substitution of stevia in cookies with dragon fruit peel, which has a high fiber content based on the previous research (Adelina et al., 2024), could be done for producing cookies with low glycemic index and good sensory.

This study aimed to determine the optimal concentration of stevia that can be used as a substitute sweetener, which is acceptable to panelists, and to analyze the nutritional content of the selected formula compared to commercial products with low glycemic index claims. Additionally, sensory testing using the Check-All-That-Apply (CATA) method was conducted to determine the sensory profile of the product, which can later be used for product development. This research offered an alternative cookie formulation utilizing dragon fruit peel, with sensory qualities favored by panelists and a low glycemic index, making it safe for individuals with diabetes. The production of these cookies could also serve as a functional food product by utilizing abundant waste while providing various nutrients, including bioactive compounds and high fiber content.

Materials and Methods

Materials

The materials used for making dragon fruit peel flour were obtained from Jus Kode, a juice restaurant in the Bendungan Hilir area, Central Jakarta. The ingredients for making cookies were purchased from supermarkets and included mocaf flour (Ladang Lima), butter (Anchor), stevia sugar (Stevia), brown sugar powder (Ricoman), granulated sugar (Gulaku), eggs, vanilla extract, honey, baking soda, baking powder, and salt. The equipment required for making dragon fruit peel flour and cookies included a 60-mesh sieve, blender (Philips), food dehydrator (Lock&Lock), mixer (Philips), and oven (Italina).

Preparation of Dragon Fruit Peel Flour

The preparation of dragon fruit peel flour followed a previous study (Qalbi et al., 2023). Fresh dragon fruit peels that were red and undamaged were used. The peels were washed to remove dirt and blanched at 80°C for 1 minute to kill microbes and inactivate enzymes, preserving the red color. After draining, the peels were ground into smaller pieces using a blender and dried in a food dehydrator at 60°C for 5 hours.

Cookies Preparation

The cookies were prepared using the best formula from a previous study (Adelina et al., 2024), consisting of mocaf flour and dragon fruit peel flour at a 55:45 ratio. Sweeteners were substituted with stevia at 25% (F1), 50% (F2), 75% (F3), and 100% (F4), with a control formulation (F0) included. The formulation and cookie preparation process used in this study are presented in Table 1. First step butter, granulated sugar and brown sugar were mixed for 5 mins by mixer. Then, honey, eggs, and vanilla extract were added and mixed for another 2 mins. Next baking soda, baking powder, salt, flour, and flax seeds were added and mixed for 10 mins. The dough was then shaped into circle with the thickness 8 mm and diameter 25 mm. The last step, the cookie dough was baked with oven 180 °C for 10 mins.

Sensory Evaluation

Sensory evaluation was conducted on the five cookie formulations using the Check-All-That-Apply (CATA), hedonic test, and rank test. The CATA test followed the methodology of previous methods (Hunaefi and Farhan, 2021; Nurlela et al., 2023). This

Table 1. Dragon fruit peel flour cookie formulations with stevia substitution

Formulation	F0	F1	F2	F3	F4
Butter (gram)	40.00	40.00	40.00	40.00	40.00
Brown sugar (gram)	10.00	7.50	5.00	2.50	-
Replacing brown sugar with stevia (gram)	-	0.25	0.50	0.75	1.00
Granulated sugar (gram)	30.00	22.50	15.00	7.50	-
Replacing granulated sugar with stevia (gram)	-	0.75	1.50	2.25	3.00
Eggs (gram)	13.50	13.50	13.50	13.50	13.50
Vanilla extract (gram)	5.00	5.00	5.00	5.00	5.00
Honey (gram)	6.00	4.50	3.00	1.50	-
Replacing honey with stevia (gram)	-	0.15	0.30	0.45	0.60
Total stevia (gram)	-	1.15	2.30	3.45	4.60
Baking powder (gram)	1.00	1.00	1.00	1.00	1.00
Baking soda (gram)	1.00	1.00	1.00	1.00	1.00
Salt (gram)	0.20	0.20	0.20	0.20	0.20
Flax seeds (gram)	10.00	10.00	10.00	10.00	10.00
Mocaf flour (gram)	34.00	34.00	34.00	34.00	34.00
Dragon fruit peel flour (gram)	30.00	30.00	30.00	30.00	30.00

Note: the use of the stevia formula refers to previous research, where 1 gram of stevia is equivalent to 10 grams of other sweeteners

testidentified the sensory profile of the cookies, beginning with a Focus Group Discussion (FGD) involving 15 panelists to determine sensory attributes present in the cookies. Subsequently, 30 panelists were asked to evaluate whether these sensory attributes were perceived in the tested products.

The hedonic test followed the method described by Machado (2021) and involved semi-trained panelists aged 18–35 years. The sensory parameters included taste, aroma, texture, color, and overall acceptability on a 7-point hedonic scale. The rank test was also conducted to rank the sample based on their preferences.

Nutritional Composition

The chemical tests performed included the proximate content of the cookies, which covers moisture, ash, fat, protein, and dietary fiber content according to the AOAC 2005 method (AOAC, 2005). The carbohydrate content was determined by the difference method, subtracting moisture, ash, fat, and protein content. The chemical content of the cookies from the selected formulation based on the hedonic test would be compared with the chemical content of commercially available cookies with a low glycemic index claim.

Statistical Analysis

This study used a Completely Randomized Design with one factor and five formulations. The data obtained were analyzed for variance using Analysis of Variance (ANOVA) at a significance level of $\alpha = 0.05$ using SPSS Statistics V17.0, followed by Duncan's Multiple Range Test (DMRT) for post-hoc analysis at a significance level of $\alpha = 0.05$. CATA data were processed using the CATA Analysis tool in XLSTAT with Cochran's Q test and create the biplot map by the data obtained from CATA.

Results and Discussion

Preparation of Flour and Cookies

The research process began with the preparation of dragon fruit peel flour as the raw material for making cookies, as shown in Figure 1. The best cookie formulation used mocaf flour and dragon fruit peel flour, based on the selected formula from previous research in terms of sensory parameters and chemical content, was the formula with 55% mocaf flour and 45% dragon fruit peel flour (Adelina et al., 2024). This study substituted the sweeteners used in the previous formula (granulated sugar, brown sugar, and honey) with stevia at concentrations of 0% (F0), 25% (F1), 50% (F2), 75% (F3), and 100% (F4), as shown in Figure 3.

Figure 1. Dragon fruit peel flour

Check All That Apply (CATA) test

The sensory attributes used for the CATA test were obtained from a Focus Group Discussion (FGD) involving 15 panelists (who consumed cookies 1-2 times a week), as presented in Table 2. The attributes included 9 tastes, 7 textures, and 4 aromas. The determination of the cookie sensory profile began with the Cochran's Q test calculation to determine the significantly different attributes in the tested formulas, as shown in Table 3. A p-value of <0.05 indicated significant differences in the attributes of the tested formula. All attributes showed significant differences except for fruit taste, caramelized taste, hard texture, chewy texture, vanilla aroma, and cinnamon aroma. This proved that the substitution of stevia as a sweetener in the cookies led to significant differences in 6 tastes (with the most significant differences in sweet taste and milky taste), 5 textures

(with the most significant differences in soft texture and crispy texture), and 2 aromas (with the most significant difference in sweet aroma).

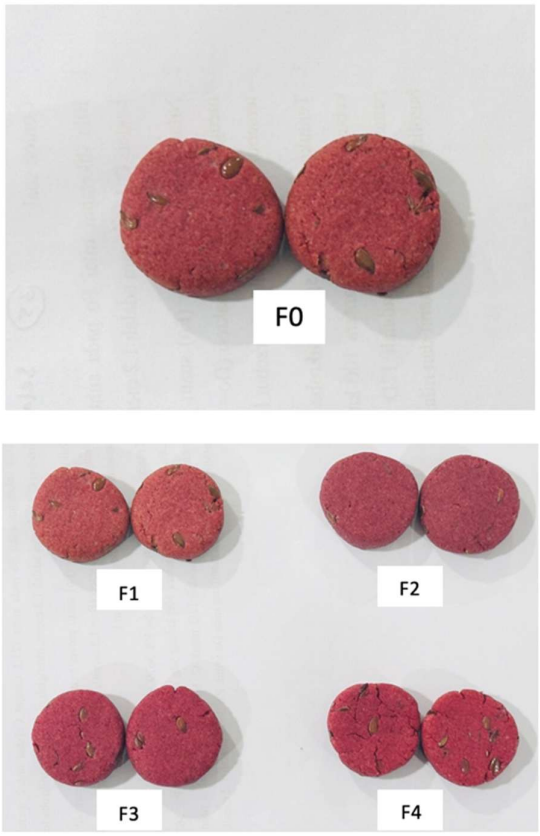

Figure 2. Cookies made from mocaf flour and dragon fruit peel flour with stevia substitution (F0) 0%, (F1) 25%, (F2) 50%, (F3) 75%, and (F4) 100%

The next analysis represented the ideal product and the tested cookie formulas in a biplot map according to the sensory attributes tested in the CATA test, as shown in Figure 3. The ideal product was described as having sensory attributes related to a dominant sweet aroma. The ideal product also had a sensory profile of sweet aroma, vanilla taste, and milky taste. Previous research stated that beside the sweet taste, buttery taste, buttery aroma, and crunchy texture were closely associated with ideal product for cookies made with wheat flour (Ervina, 2023). Other study also reported that panelist would prefer cookies with the sweet aroma, sweet taste, and crunchy texture to be consumed (Lee and Ju, 2024). Based on Figure 3, no formula tested was in the same quadrant as the ideal product. However, formula F1 (25% stevia substitution) was the closest to the ideal product, with dominant attributes of sweet aroma and milky taste. The other formula that was not far from the ideal product was F4 (100% stevia substitution), with dominant sensory attributes of soft texture, buttery texture, and moist texture. Meanwhile, formulas F2 (50% stevia substitution) and F3 (75% stevia substitution) were the farthest from the ideal product, characterized by salty taste and bitter taste. This may have occurred because the higher amount of stevia substituted in the samples increased the perception of bitter aftertaste.

Hedonic and Ranking Tests

The hedonic and ranking sensory tests were performed on 4 cookie formulas and 1 control formula. The results of the hedonic test for all the parameters tested (taste, aroma, texture, color, and overall) showed significant differences across all formulas (Table 4). The panelists rated the taste between 4.23-5.93 (neutral-like), aroma between 4.27-5.50 (netral-slightly like), texture between 3.73-6.07 (slightly dislike-like), color between 4.07-5.67 (neutral-slightly like), and overall between 3.90-5.97 (neutral-like). The lowest scores for all parameters were dominated by formula F3 (75% stevia substitution). This may be due to the higher amount of stevia substituted, which caused a characteristic aftertaste and reduced the typical texture and aroma that would result from using sweeteners like granulated sugar, brown sugar, and honey (Samuel et al., 2018). Formula F4 (100% stevia substitution) had scores that were not significantly different from F3, in terms of taste, aroma, texture, and overall, but there was a significant difference in color, where F4 scored higher than F3. This could be due to the stevia sweetener not producing the caramelized brown color seen in products made with sugars, which led to a brighter product color and an increased color score (Samuel et al., 2018).

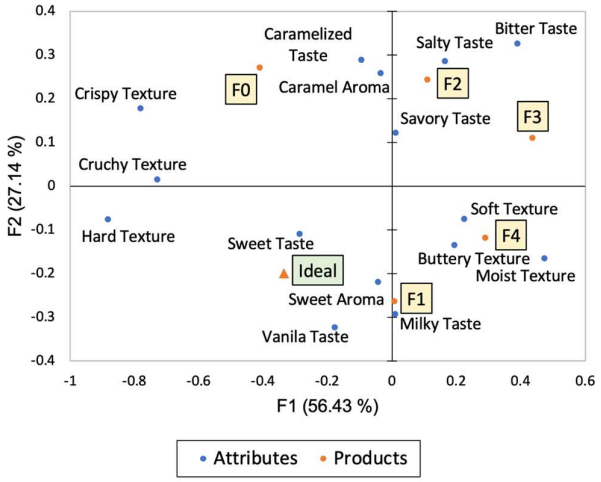

Figure 3. Symmetric plot representation of the sensory profile of cookies dragon fruit peel flour with stevia substitution (F0) 0%, (F1) 25%, (F2) 50%, (F3) 75%, and (F4) 100%

The highest taste scores were achieved by F0 (without stevia) and F1 (25% stevia substitution), for aroma by F0, F1, and F2, for texture by F0, for color by F0 and F1, and for overall by F0 and F1. In general, F0 and F1 had the highest scores across all parameters, with no significant differences between them in all parameters except for texture. This was because the stevia substitution reduced the texture, decreased the moisture content, and affected the hardness of the cookies. A reduction in texture preference due to stevia substitution was also found in previous research on stevia-sweetened tomato velvets (Astuti et al., 2021). Previous study also reported that the higher substitution

Table 2. Sensorial attributes of dragon fruit peel flour cookies with stevia substitution determined from the Focus Group Discussion (FGD)

Attribute	Description
Sweet Taste	Sweet taste is the sensation produced by sugar
Savory Taste	Savory taste is the sensation produced by the content of salt or ingredients rich in fat or protein
Bitter Taste	Bitter taste is the sensation produced by certain chemical compounds, such as alkaloids or tannins
Milky Taste	Milk taste is the sensation produced by dairy products
Buttery Taste	Butter taste is the sensation produced by butter
Fruity Taste	Fruity taste is the sensation produced by fresh fruits or fruit products that contain high amounts of natural sugars
Caramelized Taste	Caramelized taste is the sensation produced by sugar heated until it develops the color and aroma of caramel
Vanilla Taste	Vanilla taste is the sensation produced by vanilla beans or ingredients containing vanilla extract
Salty Taste	Salty taste is the sensation produced by the content of salt or other ingredients that have a salty characteristic
Soft Texture	The texture feels light in the mouth
Hard Texture	Hard texture refers to a dense and solid texture that requires more effort to bite or chew
Crunchy Texture	Solid food texture that is chewed with molar teeth, producing a loud or crisp sound
Chewy Texture	Chewy texture refers to a texture that is elastic and pliable when chewed
Crispy Texture	Food texture that is hard but breaks easily when bitten with the front teeth. It usually produces a loud sound.
Buttery Texture	Butter-like texture refers to a soft and smooth texture, similar to butter at room temperature, which is soft and easy to manipulate
Moist Texture	Moist texture refers to a wet, soft, and somewhat slippery texture when bitten
Caramel Aroma	Caramel aroma describes a sweet, warm, and rich scent similar to burnt sugar
Sweet Aroma	Sweet aroma is a pleasant and delightful scent, similar to the fragrance of sugar or honey
Vanilla Aroma	Vanilla aroma is a sweet, soft, and floral scent produced by vanilla beans
Cinnamon Aroma	Cinnamon aroma is a warm, sweet, and spicy scent produced by cinnamon spices

of sucrose with stevia increased the firmness of the muffin, led to the less aerated cake and more dense structure (Karp et al., 2017). Other study also stated that using 50% of stevia could give bitter aftertaste for the cookies (Raharjo and Ekantari, 2023). Therefore, other researcher studied about the combination of stevia with caloric and non-caloric sweetener to reduce bitter aftertaste of stevia-sweetened products (Gao et al., 2016).

A ranking test was also performed on 5 samples and presented in Table 5. The ranking test results showed the highest rank for F0 (without stevia), followed by F1 (25% stevia substitution), and the lowest rank for F3 (75% stevia substitution). These results align with the hedonic test findings, where the preference levels across several parameters were similar. Based on the hedonic test results for the parameters, F0 and F1 had the highest scores and were not significantly different. The same results were observed in the CATA test, where sample F1 had attributes closest to the ideal sample as rated by the panelists, dominated by sweet aroma and milky taste. Based on the results from the CATA test, hedonic test, and ranking test, formula F1 was selected as the preferred formula and continued for the chemical composition testing.

Nutritional composition

Nutritional composition testing was conducted on the selected formula (F1), including tests for moisture content, ash content, fat, protein, carbohydrates, and dietary fiber. This test was performed to compare the nutritional content of the selected formula with a commercial product that claims to have a low glycemic index. The nutritional content is displayed according to the Nutrition Facts as presented on the commercial product packaging, per serving size of 20 grams. Table 6 presented the nutritional content of the selected formula cookies and the commercial product per serving size.

Moisture content is one of the chemical components of cookies that influences the shelf life of the product. Table 6 showed that the moisture content of formula F1 is 1.65 grams per 20 grams, or approximately 8.24%. This result exceeded the maximum moisture content requirement set by SNI-2973-2011 for cookies, which is 5%. This could be influenced by the relatively high use of dragon fruit peel (45%), as the higher pectin content in the peel may bind more water (Dyah Kumalasari and Devira, 2024). The addition of stevia may also bind more water, leading to a higher moisture content in the product (Pranyusha et al., 2020). In addition affecting the shelf life, moisture content also influences the texture of the product. A higher moisture content results in cookies with a softer texture, but it reduces the crispiness of the cookies. In previous research, a product with a moisture content of 8.37% achieved a crunchiness score that aligned with the panelists' preference in the Just About Right (JAR) test, with 73% of panelists rating the texture as ideal (Adelina et al., 2024). Thus, it can be said that the moisture

Table 3. Cochran's Q test for the sensory attributes of dragon fruit peel flour cookies with stevia substitution

Atttibute	*p-values*	F0	F1	F2	F3	F4
Sweet Taste	0.000	0.633 (b)	0.667 (b)	0.433 (ab)	0.267 (a)	0.333 (a)
Savory Taste	0.014	0.400 (ab)	0.500 (ab)	0.567 (b)	0.400 (ab)	0.200 (a)
Bitter Taste	0.005	0.367 (ab)	0.167 (a)	0.533 (b)	0.467 (ab)	0.600 (b)
Milky Taste	0.000	0.300 (a)	0.733 (b)	0.233 (a)	0.400 (ab)	0.367 (a)
Fruity Taste	0.236	0.133 (a)	0.033 (a)	0.033 (a)	0.033 (a)	0.033 (a)
Caramelized Taste	0.081	0.467 (a)	0.167 (a)	0.333 (a)	0.267 (a)	0.267 (a)
Vanila Taste	0.049	0.167 (a)	0.267 (a)	0.167 (a)	0.033 (a)	0.300 (a)
Salty Taste	0.011	0.433 (ab)	0.333 (ab)	0.533 (ab)	0.600 (b)	0.233 (a)
Soft Texture	<0.0001	0.333 (a)	0.700 (b)	0.733 (b)	0.767 (b)	0.800 (b)
Hard Texture	0.092	0.100 (a)	0.067 (a)	0 (a)	0 (a)	0 (a)
Cruchy Texture	0.000	0.400 (b)	0.167 (ab)	0.167 (ab)	0 (a)	0.067 (a)
Chewy Texture	0.866	0.133 (a)	0.067 (a)	0.067 (a)	0.100 (a)	0.100 (a)
Crispy Texture	<0.0001	0.567 (b)	0.133 (a)	0.167 (a)	0 (a)	0.100 (a)
Buttery Texture	0.001	0.300 (a)	0.533 (ab)	0.433 (ab)	0.667 (b)	0.700 (b)
Moist Texture	0.000	0.100 (a)	0.433 (bc)	0.233 (ab)	0.567 (c)	0.500 (bc)
Caramel Aroma	0.005	0.733 (b)	0.400 (a)	0.633 (ab)	0.567 (ab)	0.367 (a)
Sweet Aroma	0.003	0.433 (ab)	0.667 (b)	0.367 (ab)	0.333 (a)	0.633 (ab)
Vanila Aroma	0.303	0.233 (a)	0.367 (a)	0.367 (a)	0.333 (a)	0.467 (a)
Cinnamon Aroma	0.346	0.133 (a)	0.200 (a)	0.267 (a)	0.300 (a)	0.200 (a)

Note : The results showed different letters indicated significant differences within the same attribute ($p<0.05$) based on Duncan's post hoc test.

content achieved in this study is still favored by the panelists. However, for the commercial product, the moisture content is not specified in the Nutrition Facts provided on the packaging.

The ash content in a food product can be related to the mineral content of the product. The ash content of the selected formula F1 was 1.12 grams per 20 grams or approximately 5.62%, as shown in Table 6. This result was similar to the cookies in a previous study that used 38% wheat flour, 47% dragon fruit peel flour, and 15% mung bean flour (Dyah Kumalasari and Devira, 2024). This is because dragon fruit peel flour itself has a high mineral content of 13.13%, mainly composed of calcium and phosphorus (Qalbi et al., 2023). The addition of stevia also contributes to the increase in mineral content, which is calcium, potassium, magnesium, iron, copper, manganese, zinc and sodium (Chughtai et al., 2020). As same as the moisture content, the commercial product also does not provide the ash content in the nutrition information on the packaging.

Fat was one of the nutritional components that contributed to the soft texture of the cookies. The higher fat content in cookies, the softer the texture would be. In this study, the fat content in the cookies was relatively high, at 5.09 grams per 20 grams, or approximately 25.46%. The cookies in this study were categorized as soft cookies, with a high fat content primarily derived from the use of butter (Prasetyo and Atmaka, 2021). However, dragon fruit peel flour also contained a significant amount of fat, which is 20% (Qalbi et al., 2023). Other studies on cookie production with substituted flours also showed similar fat content to this study, such as with mung bean flour and dragon fruit peel flour, which had a fat content of 24.95% (Dyah Kumalasari and Devira, 2024) and with coconut flour, which had a fat content of 28.61% (Kumalasari and Aurisa, 2023). However, other studies using defatted flours from grains such as wheat, chia, sesame, flax, and poppy showed much lower fat content, ranging from 4.29% to 14.11% (Martínez et al., 2021). The commercial product compared in this study contained 6 grams of fat per 20 grams, which was equivalent to 30%. This indicated that the cookies with the selected formula had a lower fat content compared to the commercial product.

The protein content in the selected cookie formula was relatively low, at 0.76 grams per serving, or 3.81%. The protein in the cookies could be derived from the use of eggs and flaxseeds. However, the amounts used were not significant enough to produce a higher protein content. The dragon fruit peel flour used also had

Table 4. Sensory evaluation of 5 formulations of dragon fruit peel flour cookies with stevia substitution

Attribute	F0	F1	F2	F3	F4
Taste	$5.87^{a} \pm 1.41$	$5.93^{a} \pm 0.83$	$3.83^{b} \pm 1.50$	$3.57^{b} \pm 1.12$	$4.23^{b} \pm 1.45$
Aroma	$5.50^{a} \pm 1.80$	$5.50^{a} \pm 1.53$	$4.87^{ab} \pm 1.22$	$4.27^{b} \pm 1.46$	$4.37^{b} \pm 1.33$
Texture	$6.07^{a} \pm 1.34$	$5.07^{b} \pm 1.31$	$4.80^{b} \pm 1.40$	$3.80^{c} \pm 1.54$	$3.73^{c} \pm 1.41$
Color	$5.30^{a} \pm 1.53$	$5.67^{a} \pm 1.32$	$4.20^{bc} \pm 1.49$	$4.07^{c} \pm 1.28$	$4.90^{ab} \pm 1.54$
Overall	$5.97^{a} \pm 1.27$	$5.63^{a} \pm 1.13$	$4.40^{b} \pm 1.61$	$4.00^{b} \pm 1.53$	$3.90^{b} \pm 1.30$

Note : Formulation of cookies made from mocaf flour and dragon fruit peel flour with stevia substitution (F0) 0%, (F1) 25%, (F2) 50%, (F4) 100% with scores (1) strongly dislike, (2) dislike, (3) slightly dislike, (4) neutral, (5) slightly like, (6) like, (7) strongly like. Numbers followed by different letter notations indicated significant differences between treatments ($p<0.05$) based on Duncan's post hoc test.

a low protein content, at 12.44% (Qalbi et al., 2023). This result was still below the protein content requirement set by SNI 2973-2011 for cookies, which require a minimum protein content of 5%. The use of legumes, which are rich in protein, could be considered to increase the protein content in the cookies. The compared commercial product also had a similar protein content of 1 gram per serving.

Table 5. Ranking test of 5 formulations of dragon fruit peel flour cookies with stevia substitution

Sampel	Rank Value	Rank
F0	$4.23^{a} \pm 1.28$	1
F1	$3.90^{b} \pm 1.03$	2
F2	$2.73^{c} \pm 1.14$	3
F3	$1.83^{e} \pm 0.75$	5
F4	$2.30^{d} \pm 1.18$	4

Note : Formulation of cookies made from mocaf flour and dragon fruit peel flour with stevia substitution (F0) 0%, (F1) 25%, (F2) 50%, (F4) 100%

Carbohydrates were determined using the by-difference method. The selected formula cookies contained 11.38 grams per serving, or 56.88%. The carbohydrate content greatly influences the glycemic index of the product. However, it is essential to first determine the available carbohydrate by subtracting the fiber content from the total carbohydrate. The use of stevia reduces the carbohydrate content because natural sweeteners like sugar, brown sugar, and honey result in higher carbohydrates (Góngora Salazar et al., 2018). The commercial product contained 12 grams of carbohydrates per serving, slightly higher than the selected formula product.

Tabel 6. Nutritional composition cookies dragon fruit peel with stevia substitution and commercial product

Nutrition composition (gram per serving size of 20 gram)	Cookies with 25% stevia substitution (F1)	Commercial product with low glycemic index claim
Moisture content	1.65	-
Ash content	1.12	-
Fat	5.09	6.00
Protein	0.76	1.00
Carbohydrate	11.38	12.00
Dietary fiber	7.55	1.00

Dietary fiber plays a crucial role in determining the glycemic index of a product. High fiber content can inhibit the action of digestive enzymes like alpha-amylase and amyloglucosidase, which are responsible for breaking down starch granules into absorbable nutrients, thus reducing the rise in blood sugar levels (Di Cairano et al., 2020; Reshmi et al., 2017). The selected formula had a relatively high fiber content of 7.55 grams per serving, or 37.76%. This exceeds the BPOM's regulation (Regulation No. 1, 2022) regarding claims on food labels, which requires a food product to contain at least 6% fiber to make a "high in fiber" claim. High-fiber foods are also recommended for diabetes patients to help control blood sugar levels (Öztürk et al., 2017). However, the higher dietary fiber could increase the hardness of cookies. As also provided in Table 4, F1 had score 5 for texture (slightly like), but still acceptable by panelist. Other study also reported that the higher fiber content, the higher firmness of the muffin (Karp et al., 2017). The commercial product with a low glycemic index claim contained only 1 gram of fiber per serving, much lower than the selected dragon fruit peel cookie formula. Based on this nutritional analysis, the dragon fruit peel cookies with 25% stevia substitution have the potential for a low glycemic index and are suitable for consumption by people with diabetes.

Conclusion

Based on the CATA sensory test results, formula F1 (25% stevia substitution) had characteristics most closely to the ideal product, with dominant attributes of sweet aroma and milky taste. The hedonic sensory test showed that stevia substitution caused significant differences in all tested attributes. The F0 (without stevia) and F1 samples had the highest scores for all attributes, ranging from 5 to 6 (slightly like to like). The ranking test results showed that sample F0 ranked first, followed by F1. Formula F1 became the selected formula and was compared to the nutritional content of the commercial product with a low glycemic index claim. The nutritional comparison showed that the only quite difference was the fiber content, which was seven times higher in the F1 cookies compared to the commercial product. Based on these results, the dragon fruit peel cookies with 25% stevia substitution are favored by the panelists and have the potential for a low glycemic index.

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