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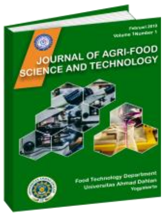

Comparison of Yam Composite Cookies Sensory Characteristic Between Sugar and Stevia Sweeteners

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ABSTRACT

Yam (Dioscorea alata L.) is one source of carbohydrates with a low glycemic index. It is useful for controlling blood glucose levels. Yam has high carbohydrate and protein content but low sugar content. This research contributed to compare the sensory characteristics of the yam composite cookies between sugar and stevia sweeteners. This research is a quasi-experimental study with a cross-sectional design. Purple yam tubers were made into yam flour. The composite was made from yam flour and green bean flour (F1=100:0; F2= 80:20; F3= 60:40; F4= 40:60; F5= 20:80) (%w/w). Composites were processed into cookies with sugar and stevia sweeteners. Cookies with sugar and stevia sweeteners tested sensory characteristics to 31 in healthy adults aged 25-35. The results showed that the sensory characteristics of shape, size, color, texture, sweet taste and umami taste of yam cookies with sugar sweetener were not better than stevia sweetener. In contrast, the sub-variables of aroma, taste, and overall sweet potato cake with sugar were better than stevia. This implies that yam composite cookies with stevia sweeteners are healthier, but less desirable.

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1. INTRODUCTION

Diabetes is a deadly and dangerous disease. According to data from the Ministry of Health's Sample Registration Survey in 2014, diabetes is the third leading cause of death in Indonesia, after stroke (21.1%) and coronary heart disease (12.9%). The prevalence of diabetes in Indonesia increased from 5.7% in 2007 to 6.9%, or about 9.1 million people, in 2013. According to the latest International Diabetes Federation (IDF) Atlas data in 2017, Indonesia ranks sixth in the world, with 10.3%. million people with diabetes. If not handled properly, the World Health Organization estimates that the number of people with diabetes in Indonesia will skyrocket to 21.3 million by 2030.

So far, pharmacological therapy with chemical drugs can cause side effects after application to treat Diabetes Mellitus. Herbal medicine in recent years has become increasingly popular because it has bioactive compounds found in plants that have been proven to have health benefits, one of which is from *Dioscorea sp. Uwi* yam (*Dioscorea alata L.*) is a type of tuber that is widely cultivated along with other forest plants. The color of the tubers such as purple, yellow, and white sweet potatoes. Bioactive compounds found in purple and yellow *uwi* tubers have the potential to have functional effects for health (Jiang et al., 2023). *Uwi* tubers contain bioactive compounds that are beneficial for health, such as water-soluble polysaccharides, dietary fiber, dioscorin, and diosgenin. Several studies have found food diversification by using local *uwi* tubers as instant noodle ingredients. Previous research successfully found that *uwi* tuber flour has a significant hypoglycemic effect on alloxan-induced diabetic Wistar rats. *Uwi* tubers have several polysaccharide contents such as water-soluble polysaccharides, resistant starch, and dietary fiber. The polysaccharide content has an influence in reducing blood glucose levels. Research on the hypoglycemic properties of tubers that have been done shows that purple *uwi* tuber decoction has a significant hypoglycemic effect on adolescents in a healthy condition (Naimah et al., 2023).

Dioscorea alata L., also known as *uwi* tuber or water yam, is an economically valuable crop that can be produced in drylands and has important nutritional resources as an alternative food ingredient that supports food security. *Uwi* are the third most important root crop after cassava and sweet potato. On a dry weight basis, *uwi*, have a higher vitamin C content than sweet potatoes and a higher protein content than cassava, with a range of protein content (0.2-1.8%). *Uwi* contain important sources of nutrients such as carbohydrates, proteins, fats, vitamins, and other important sources of nutrients. Based on this, *uwi* tubers can be a staple food as well as a reliable food source (Hornung et al., 2017; Jiang et al., 2023).

Uwi has the potential as a local food crop and can be used as a functional food source. Besides having a high carbohydrate content. *Uwi* tubers have a high protein content but low sugar content. The findings of this study are very beneficial for diabetic patients who have to limit their sugar intake. In addition, *uwi* tubers also contain vitamin C and can be used as a good source of minerals. Consumption of *uwi* is beneficial for gut microflora health and as an antioxidant. *Uwi* has an antioxidant content equal to or greater than 100 g of BHA (butyl hydroxyanisole) and -tocopherol. *Uwi* is a member of the *uwi-uwian* tribe (*Dioscorea spp.*) which is one of the world's 15 most important agricultural commodities, ranking fourth in the group of important root crops after potatoes, cassava, and sweet potatoes. *Dioscorea spp.* is grown on about five million hectares in 59 tropical and subtropical countries (Naimah et al., 2023; Zou et al., 2022).

Uwi tubers have better flavor qualities than other species in the same genus (*Dioscorea spp*). In Indonesia, *uwi* tubers are still used in traditional food preparations (steamed, fried, grilled, and made into chips), and can be processed into flour. This processed form is beneficial in easier storage of *uwi* tubers, small volume, and flexibility for various processed food products. *Uwi* tuber flour can be used to make various food products such as noodles, pastries, cakes, steamed sponge cake, and other traditional snacks. Processed purple tubers are widely served as dessert in Taiwan's five-star restaurants. Purple tubers are widely used in the Philippines to make haleyang ube (jam), cakes, ice cream (halo-halo), and other traditional desserts. In West Africa, tuber flour is processed into amala (a type of African porridge/pasta). Purple tuber flour can also be made into edible paper. In the production of rice paper (wet spring roll skin), as a substitute for rice flour (Oliveira et al., 2021).

Several studies have been conducted to determine the nutritional value of *uwi* tubers, such as water content, ash, protein, fat, fiber, carbohydrate content, minerals, and vitamins. The tubers contain high resistant starch and inulin, which play a role (Oliveira et al., 2021). Cultivars of *uwi* tubers also contain polyphenols (anthocyanins), dioscorin, diosgenin (steroids), vitamins, inulin, and carotenoids. Anthocyanins and carotenoids play a role in giving purple color to purple tubers.

Dioscorin shows activity as an immunomodulator and antihypertensive. Diosgenin plays a role in controlling cholesterol levels and anti-tumor activity. Processing starch and flour from fresh tubers can affect its components such as proximate composition, inulin, diosgenin, and dioscotin (Logan et al., 2024).

Most people in Indonesia consume *uwi* tubers by boiling, steaming, and frying. This may be the reason why *uwi* tubers are still categorized as an unpopular food in Indonesia. This is due to inadequate food diversification and low knowledge of health benefits. Based on the research that has been done, further research is needed on food diversification from *uwi* tubers. This study contribution is to make food ingredients made from *uwi* tubers and test processed food products made from *uwi* tubers with a low glycemic index, so that it becomes a safe menu for people with diabetes mellitus.

2. MATERIALS AND METHODS

2.1. Materials

The materials used in this research are *uwi* tubers obtained from traditional market in Gamping, Yogyakarta, wheat flour (Segitiga Biru, Bogasari), margarine (Blue Band, PT Upfield Manufacturing), sugar (GulaKu, PT Sweet Indolampung), stevia sweetener (Tropicana Slim, PT Nutrifood Indonesia), and egg. The equipment used in this research are blender (Philips), oven (Signora), analytical balance (Ohaus Pioneer), furnace (Muffle Furnace), spectrophotometer UV-Vis, and glass ware.

2.2. Research Methods

2.2.1. Preparation of Flour

Fresh *uwi* tubers were peeled and cut into pieces of approximately 2-5 cm2 and dried in the sun for 6-8 hours from 9 am to 3 pm. Furthermore, the dried *uwi* tubers were pulverized using a blender (National Omega) and sieved with 80-mesh siever. The percentage yield of *uwi* tuber flour is calculated as equation (1).

$$Yield\ (\%) = \frac{flour\ weight\ (g)}{fresh\ tubers\ weight\ (g)} \times 100\% \tag{1}$$

2.2.2. Preparation of Yam Cookies

Treatment sample cookies were made from *uwi* tuber flour and mung bean flour. Commercial wheat flour (CWF) was used as a positive control. The cookie ingredients consisted of margarine, sweetener (sugar and stevia), milk, and whole egg (Table 1 and Table 2). Margarine and granulated sugar were mixed using a hand mixer for 3-7 minutes before flour was added and blended until a smooth dough was obtained. The smooth dough is rolled into thin sheets and molded using specific molds. Finally, the cake is baked at 180°C until golden brown.

Table 1. Formulation of *uwi* cookies with sugar sweetener.

Ingredients	Formulation (%)				
	G20	G40	G60	G80	G100
Uwi flour	20	40	60	80	100
Mung bean flour	80	60	40	20	0
Margarine	30.30	30.30	30.30	30.30	30.30
Egg	15.15	15.15	15.15	15.15	15.15
Milk	5.30	5.30	5.30	5.30	5.30
Sugar	11.35	11.35	11.35	11.35	11.35

Table 2. Formulation of *uwi* cookies with stevia sweetener.

Ingredients	Formulation (%)				
	S20	S40	S60	S80	S100
Uwi flour	20	40	60	80	100
Mung bean flour	80	60	40	20	0
Margarine	30.30	30.30	30.30	30.30	30.30
Egg	15.15	15.15	15.15	15.15	15.15
Milk	5.30	5.30	5.30	5.30	5.30
Stevia	11.35	11.35	11.35	11.35	11.35

2.2.3. Water Content Analysis

The water content in *uwi* cookies was carried out using the gravimetry method (Salma et al., 2024). Specimens were measured, with a maximum weight of 2 grams, and placed inside a weighing container. Subsequently, the substance is subjected to dehydration by placing it in an oven set at a temperature of 105˚C for a duration of 24 hours. The specimen inside the weighing bottle is chilled using a desiccator for a duration of 15 minutes, after which it is weighed repeatedly until a consistent weight is achieved. This analysis was carried out with three repetitions. The water content of *uwi* cookies is calculated as equation (2), where A is weight of the empty weghing bottle (g), B is weight of the weghing bottle and sample (g), and C is weight of the weghing bottle and sample after drying (g).

$$Water\ content\ (\%) = \frac{B - C}{B - A} \times 100\% \tag{2}$$

2.2.4. Ash Content Analysis

For one hour at 105˚C, the cup was dried in an oven. After that, it was cooled in a desiccator for fifteen minutes, and then it was measured. Two grams of the sample were weighed out and put into a cup. After that, the cup was heated up to 600˚C and put in a burner for 6 hours, or until white ash formed. Following that, the cup was put into the desiccator for 15 minutes. Once it was cool, it was measured (AOAC, 2005). The ash content of *uwi* cookies is calculated as equation (3).

$$Ash\ content\ (\%) = \frac{Weight\ of\ ash\ (g)}{Weight\ of\ sample\ (g)} \times 100\% \tag{3}$$

2.2.5. Fat Content Analysis

Executing fat content analysis using the Soxhlet technique. The sample is processed in a blender or finely powdered and then analysed for fat content using the Soxhlet technique. The specimen is inserted into a sheath, weighed, and subsequently enveloped in cotton. Next, place it in the oven until it reaches a consistent weight. The subsequent procedure involves employing a Soxhlet apparatus for a duration of 6 hours, with 15 cycles of circulation. The extracted samples were subjected to oven drying until a stable weight was achieved, and then weighed (AOAC, 2005). The fat content of *uwi* cookies is calculated as equation (4), where a is weight of sample (g), b is weight before extraction (g), and c is weight after extraction (g).

$$Fat\ content\ (\%) = \frac{b - c}{a} \times 100\% \tag{4}$$

2.2.6. Protein Content Analysis

Perform protein content analysis using the Micro Kjeldahl technique. The pulverized sample was measured to weigh 0.2 g and then transferred into the Kjeldahl flask. Next, 0.7 grams of catalyst N, which consisted of 250 g of sodium (Na), was added. This was followed by the addition of K_2SO_4, 5 g of copper sulfate ($CuSO_4$), and 0.7 g of selenium/TiO_2. Finally, 4 ml of concentrated H_2SO_4 were added. Moreover, the destruction process was executed within a fume cupboard till the color transformed into a transparent green hue. Subsequently, the mixture was cooled and 10 ml of distilled water was added. For the distillation stage, 20 ml of NaOH-Tio (40% NaOH + $Na_2S_2O_3$ 5%) was added. The distillate was obtained by utilizing a 4% solution of H_3BO_3, which was supplemented with the BCG-MR indicator. The distillation process was continued until the volume of the distillate reached 60 ml, at which point the color transitioned from red to blue. Subsequently, the distillate underwent titration with a standard solution of 0.02 N HCl until a noticeable change in color to pink occurred. The recorded titration volume was used to compute the protein content (AOAC, 2005). The protein content of *uwi* cookies is calculated as equation (5 and 6).

$$Nitrogen\ content\ (\%) = \frac{V_{titration} \times N\ HCl\ \times weight\ of\ nitrogen\ atom}{weight\ of\ sample\ (mg)} \times 100\% \quad (5)$$

$$Protein\ content\ (\%) = \ nitrogen\ content \times 6.25 \quad (6)$$

2.2.7. Carbohydrate Content Analysis

Carbohydrate analysis was carried out using the by-different method. This method is carried out by calculating in equation (7).

$$Carbohydrate\ content\ (\%) = \ 100\% - (water\ content + \ ash\ content + fat\ content + protein\ content) \quad (7)$$

2.2.8. Crude Fibre Analysis

The specimen is pulverized until it can be sieved and must be fat- and oil-free. At least 1 g of material is placed in an erlenmeyer flask. After adding 200 ml of 1.25% H_2SO_4, the liquid was heated in a water bath at 100°C for 30 minutes. Next, strain the mixture using filter paper and rinse with hot water until it achieves a neutral pH, which litmus paper can check. The residual material was transferred to an Erlenmeyer flask and washed with 200 ml of 1.25% sodium hydroxide. Next, the mixture is heated in a 100°C water bath for 30 minutes with stirring. Use predetermined-weight filter paper for filtering. Washing the sample with 15 ml of 96% ethanol followed. Rinse with hot water until litmus paper shows the solution is neutral. The residue-covered filter paper was oven-dried at 100°C and weighed (Sudarmadji & Haryono, 2010). The crude fibre content of *uwi* cookies is calculated as equation (8).

$$Crude\ fibre\ (\%) = \frac{Filter\ paper\ sample\ (g) - Blank\ filter\ paper\ (g)}{Weight\ of\ sample\ (g)} \times 100\% \quad (8)$$

2.2.9. Antioxidant Analysis

Observation of antioxidant activity was carried out using DPPH based on the (Itagi et al., 2023) method.

2.2.10. Sensory Characteristic

Sensory analysis of *uwi* cookies was carried out to determine the panellists' preference profiles. The characterization of panellist described at Table 3 and the scale used for sensory measurements is presented in Table 4. The sensory parameter preference test consists of shape, size, color, aroma, texture, taste, sweetness, umami and overall taste.

Table 3. Respondents' characteristic.

No	Characteristic	Amount	Percentage (%)
1	Age (year)	29.03 ± 3.50	
2	Gender		
	a. Male	7	22.58
	b. Female	24	77.42
3	Education		
	a. Middle school	1	3.22
	b. 3rd Diploma	2	6.45
	c. Strata 1	21	67.74
	d. Strata 2	7	22.58

Table 4. Sensory parameter scale.

Scale	Sensory parameter								
	Shape	Size	Colour	Aroma	Texture	Taste	Sweet taste	Umami flavour	Overall
1	Strongly dislike	Strongly dislike	White	Very unscented	Very non-sandy	Strongly unpleasant	Not too sweet	Not very savory	Strongly dislike
2	Dislike	Dislike	Slightly brownish	Unscented	Non-sandy	Unpleasant	Not sweet	Not savory	Dislike
3	Somewhat like	Somewhat like	Light brown	Slightly scented	Somewhat sandy	Somewhat tasty	Slightly sweet	Slightly savory	Somewhat like
4	Like	Like	Brown	Scented	Sandy	Tasty	Sweet	Savory	Like
5	Strongly like	Strongly like	Dark brown	Strongly scented	Extremely sandy	Very tasty	Very sweet	Extremely savory	Strongly like

2.2.11. Statistical Analysis

The experiment was conducted using a completely randomized design for physicochemical properties between the weight of *uwi* flour and mungbean flour. Results are presented as mean ± SD (standard deviation). All experiments were conducted three times. Furthermore, the difference between the means was calculated by paired sample T-test with a significance level of 95% ($p<0.05$) using IBM SPSS Statistics 23 software.

3. RESULT AND DISCUSSION

The resulting *uwi* cookies are in Figure 1 and it can be seen the difference in color visually. Cookies with the addition of stevia sweetener have a darker color than cookies with sugar. The composition of cassava flour and mung beans also influences the color change in the cookies produced.

Itagi et al., (2023)'s research revealed that the flour and sweetener had significant and intricate impacts on the color formulation of the cookies. The Maillard reaction, a chemical reaction that takes place when baking, is an additional factor that influences the ultimate color of cooked food items. The interaction between reducing sugars and proteins could lead to the formation of reddish-brown hues, which could account for the decreased lightness value seen in this process (Giuberti et al., 2017; Itagi et al., 2023).

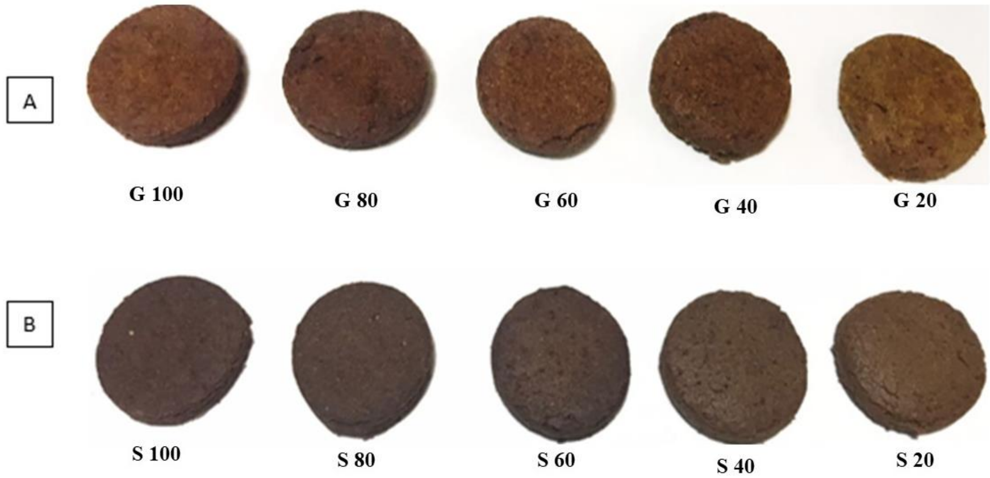

Figure 1. *Uwi* cookies with sugar sweetener (A) and stevia sweetener (B).

3.1. Water Content of *Uwi* Cookies

The water content of *UWI* cookies has been recorded in Table 5 for the sugar sweetener and Table 6 for the stevia sweetener. The results indicate that the water content of the *uwi* cookies with sugar sweetener increased in proportion to the quantity of *uwi* flour. Concurrently, the water content of stevia sweetener declines. This demonstrates that the inclusion of different types of sweeteners can have an impact on the moisture level of cookies. According to a study by (Salazar et al., 2018), cookies sweetened with stevia contain more water than cookies sweetened with sucrose.

The reason for this differentiation can be attributed to the hygroscopic nature of sugar and the existence of mineral ions in stevia (de Andrade et al., 2024; Rao & Singh, 2022). Reducing the amount of water in the final product is essential for prolonging its shelf life and minimizing the likelihood of foodborne diseases. Furthermore, it is imperative to utilize suitable packing materials to ensure the preservation of quality and prolong the shelf-life (Lamdande et al., 2018; Yildiz & Gocmen, 2021).

Table 5. Proximate test results of *uwi* cookies with sugar sweetener.

Sample	Water content (%)	Ash content (%)	Fat content (%)	Protein content (%)	Carbohydrate content (%)
G20	3.80 ± 0.03	2.55 ± 0.08	27.74 ± 0.03	10.91 ± 0.12	49.07 ± 0.16
G40	3.95 ± 0.05	2.63 ± 0.05	28.38 ± 0.09	9.50 ± 0.03	48.17 ± 0.03
G60	3.71 ± 0.28	2.56 ± 0.10	27.50 ± 0.02	9.52 ± 0.07	46.12 ± 0.22
G80	3.11 ± 0.00	2.51 ± 0.15	28.63 ± 0.47	6.88 ± 0.01	49.36 ± 0.22
G100	4.29 ± 0.15	2.46 ± 0.08	28.72 ± 0.25	6.56 ± 0.29	45.83 ± 0.06

Table 6. Proximate test results of *uwi* cookies with stevia sweetener.

Sample	Water content (%)	Ash content (%)	Fat content (%)	Protein content (%)	Carbohydrate content (%)
S20	6.26 ± 0.06	2.85 ± 0.00	28.36 ± 0.01	12.53 ± 0.13	47.45 ± 0.31
S40	5.67 ± 0.00	2.86 ± 0.03	28.88 ± 0.14	10.97 ± 0.04	47.92 ± 0.40
S60	3.18 ± 0.08	2.67 ± 0.11	30.89 ± 0.02	9.68 ± 0.14	52.24 ± 0.40
S80	3.65 ± 0.07	2.88 ± 0.07	30.34 ± 0.02	7.45 ± 0.05	41.80 ± 0.18
S100	3.60 ± 0.13	2.53 ± 0.52	30.59 ± 0.29	6.55 ± 0.05	44.41 ± 0.13

3.2. Ash Content of *Uwi* Cookies

The lowest ash content is found at UG100, while the highest ash content is at US80 (Table 5 and Table 6). The ash content of *uwi* cookies with the addition of sugar sweetener has a lower value than *uwi* cookies with stevia sweetener. The mineral content contained in sweeteners can affect the ash content value in cookies (Itagi et al., 2023). In addition to containing sweet glycosides, stevia is also a rich source of vitamins and minerals. An examination of the leaves using atomic absorption spectrophotometry revealed increased levels of potassium, phosphorus, calcium, magnesium, sulfur, and sodium, as well as small amounts of iron, copper, cobalt, manganese, zinc, selenium, and molybdenum (Ahmad et al., 2020; Wölwer-Rieck, 2012). According to the report, white sugar has an ash value of around 0.015%. The ash content indicates the presence of minerals, fiber, and inorganic substances that remain in the sample after it has been subjected to intense heat, eliminating moisture, volatile substances, and organic molecules (Altındağ et al., 2015; Itagi et al., 2023; McKee et al., 2015).

Oatmeal cookies that use stevia as a sweetener have an ash content of 1.63 ± 0.03, while those that use sucrose are 1.19 ± 0.02 (Salazar et al., 2018). This is in line with this research which also shows that cookies sweetened with stevia have higher ash content. However, apart from sweeteners, the type of flour can also affect the mineral content in food products (Islam et al., 2012; Lamdande et al., 2018).

3.3. Fat Content of *Uwi* Cookies

The fat content of *uwi* cookies was highest at US100 and lowest at UG 60 (Table 5 and Table 6). Based on the analysis results, the stevia sweetener used in *uwi* cookies can increase the fat content of the cookies. These results are in accordance with research (Ramaroson, 2024) which states that biscuits sweetened with stevia have a higher fat content than biscuits with sugar. Oatmeal cookies sweetened with stevia also contain a significant amount of fat, specifically 21.37 ± 0.12%, compared to sugar-sweetened cookies which have only 12.45 ± 0.05% fat (Adeyanju et al., 2021; Salazar et al., 2018).

3.4. Protein Content of *Uwi* Cookies

The protein content of *uwi* cookies is displayed in Table 5 and Table 6. The protein content of *Uwi* cookies varied from 6.55 ± 0.05 to 12.53 ± 0.13, with the greatest quantity seen at US20. Adding stevia as a sweetener enhances the protein content of cookies. In addition, using mung bean flour into the cookies also enhances their protein value. This occurs because mung beans belong to the legume family and possess a high protein content (Ervina, 2023).

Oatmeal cookies using stevia have higher protein content (21.37 ± 0.12) compared to those using sugar (12.45 ± 0.05) (Salazar et al., 2018). The result of that research are in line with this research. *Stevia rebaudiana* contains 9.8–20.4% protein, so its use can increase the protein content of food products (Abou-Arab et al., 2010; Gökçe et al., 2023). Furthermore, differences in protein and lipid content may account for variations in carbohydrate concentration of flour (Oppong et al., 2021; Ramaroson, 2024).

3.5. Carbohydrate Content of *Uwi* Cookies

The carbohydrate content of *uwi* cookies varies from 41.80 ± 0.18% to 52.24 ± 0.40% (Table 5 and Table 6). Carbohydrate content is analyzed using the by different method, so the results depend on the values of water, ash, fat and protein content. Oatmeal cookies which sweetened with stevia have lower value of carbohydrate than sugar sweetened (Salazar et al., 2018). In addition to being impacted by the amount of sugar, the carbohydrate level in cookies is also affected by the raw material used, specifically flour (Fitriyah et al., 2021; Liu et al., 2020; Melese & Keyata, 2022).

3.6. Crude Fibre of *Uwi* Cookies

Table 7 and Table 8 show the results of the analysis of crude fiber of *uwi* cookies. The use of stevia overall increases the value of crude fiber in *uwi* cookies. The highest crude fiber value is US80 and the lowest is UG80.

Table 7. Crude fibre of *uwi* cookies with sugar sweetener.

Sample	Crude fibre (%)
G20	7.54 ± 0.11
G40	7.36 ± 0.14
G60	8.79 ± 0.18
G80	6.64 ± 0.22
G100	8.59 ± 0.41

Table 8. Crude fibre of *uwi* cookies with stevia sweetener.

Sample	Crude fibre (%)
S20	8.19 ± 0.09
S40	7.20 ± 0.09
S60	7.47 ± 0.13
S80	9.86 ± 0.12
S100	7.67 ± 0.12

Uwi flour contains some amount of dietary fibre, but it is generally lower in fibre compared to other high-fibre ingredients. The variation in crude fibre content with *uwi* flour addition can be influenced by the specific variety and processing method of the *uwi* used. As *uwi* flour is added to the cookie formulation, the crude fibre content can increase due to the natural fibre present in the *uwi*. However, because *uwi* flour typically has a lower fibre content, the increase might be moderate (Chinma et al., 2021; Polat et al., 2020).

Mung bean flour is rich in dietary fibre. Increasing the proportion of mung bean flour in the cookie formulation would likely increase the crude fibre content significantly due to its high fibre concentration. Mung beans are known for their high soluble and insoluble fibre content, which would directly affect the overall fibre content of the cookies when included in higher amounts (Altındağ et al., 2015; Mudgil et al., 2017).

The composition of *uwi* and mung bean flours varies based on their source and processing. Differences in the fibre content of these flours can impact the final crude fibre percentage in cookies. The exact ratios of *uwi* and mung bean flour can significantly influence the crude fibre content. For instance, higher ratios of mung bean flour are likely to result in a higher fibre content. The variations in crude fibre content across the different cookie samples are influenced by the amounts and types of *uwi* and mung bean flour used. Increased mung bean flour generally boosts the fibre content, while processing and blending inconsistencies can affect the final measurements (Ezegbe et al., 2023; Silva et al., 2018).

Table 8 indicates that the crude fiber content of the cookies varies based on the formulation, with US80 showing the highest crude fiber content and US40 showing the lowest. This variation is likely due to changes in the proportions of *uwi* and mung bean flour. Variations in the crude fiber content in cookies are influenced by the amount and type of *uwi* and mung bean flour used. Mung bean flour has a more significant effect on increasing crude fiber content compared to *uwi* flour. Sugar and stevia do not affect the crude fiber content directly but can influence the texture and sweetness of the cookies.

3.7. Antioxidant of *Uwi* Cookies

The antioxidant activity of *uwi* cookies is detailed in Table 9 and Table 10. The investigation revealed that cookies sweetened with stevia had non-linear values. Nevertheless, the utilization of sugar sweetener leads to a significant rise in the outcomes. The addition of sugar sweetener to *uwi* cookies results in the maximum antioxidant activity value, specifically 55.34 ± 0.30%, which is achieved with UG100. Meanwhile, in the case of *uwi* cookies with stevia sweetener, the antioxidant activity value reached a maximum of US100, specifically 45.80 ± 0.10%.

Table 9. Antioxidant activity and pH of *uwi* cookies with sugar sweetener.

Sample	Antioxidants (%)
G20	33.33 ± 0.20
G40	37.68 ± 0.10
G60	38.11 ± 0.10
G80	41.45 ± 0.20
G100	55.34 ± 0.30

Table 10. Antioxidant activity and pH of *uwi* cookies with stevia sweetener.

Sample	Antioxidants (%)
S20	25.86 ± 0.10
S40	40.95 ± 0.10
S60	27.28 ± 0.10
S80	36.40 ± 0.10
S100	45.80 ± 0.10

As the proportion of *uwi* flour increases, the antioxidant content of the cookies generally increases. This is evident from the increasing antioxidant activity with higher amounts of *uwi* flour in both formulations (sugar and stevia). Mung bean flour is known for its antioxidant properties due to its rich content of polyphenols and flavonoids. The inclusion of mung bean flour would contribute significantly to the antioxidant content of the cookies. Therefore, higher amounts of mung bean flour would result in higher antioxidant activity, as seen in the higher values in samples with more *uwi* flour, which might also include mung bean flour (Diniyah et al., 2020).

Sugar does not contain antioxidants. Its addition primarily affects the sweetness and texture of the cookies without contributing to antioxidant levels. The higher antioxidant content in the sugar-sweetened cookies (UG80 and UG100) is attributed to the higher proportion of *uwi* and potentially mung bean flour, not the sugar (Carocho et al., 2017). Stevia is also free of antioxidants. It provides sweetness without calories and does not directly impact the antioxidant content of the cookies. Variations in antioxidant activity in the stevia-sweetened cookies (US40 and US100) are likely due to differences in the formulation of *uwi* and mung bean flour, not the stevia itself (de Andrade et al., 2024; Simlat et al., 2016).

3.8. Sensory Characteristic of *Uwi* Cookies

Based on the statistical analysis of paired samples T test, the favorability test of sugar-sweetened *uwi* cookies (UG) compared to Stevia-sweetened *uwi* cookies (US) obtained different significance values. In the subvariable shape of UG *uwi* cookies compared to US *uwi* cookies, a significance value of 0.133 was obtained which means greater than the probability of 0.05 (> 0.05). This shows that the shape of UG *uwi* cookies is not better than US *uwi* cookies.

In the subvariable size of UG *uwi* cookies compared to US *uwi* cookies, the significance value is 0.757 which means greater than the probability of 0.05 (> 0.05). This shows that the size of UG *uwi* cookies is not better than US *uwi* cookies. In the color subvariable of UG *uwi* cookies compared to US *uwi* cookies, the significance value is 0.227 which means greater than the probability of 0.05 (> 0.05). This shows that the color of UG *uwi* cookies is not better than US *uwi* cookies. In the aroma subvariable of UG *uwi* cookies compared to US *uwi* cookies, the significance value is 0.000 which means less than the probability of 0.05 (> 0.05). This shows the aroma of UG *uwi* cookies is better than US *uwi* cookies. In the texture subvariable of UG *uwi* cookies compared to US *uwi* cookies, a significance value of 0.593 was obtained which means greater than the probability of 0.05 (> 0.05). This shows that the texture of UG *uwi* cookies is not better than US *uwi* cookies. In the subvariable taste of UG *uwi* cookies compared to US *uwi* cookies, the significance value is 0.030 which means it is smaller than the probability of 0.05 (> 0.05). This shows that the taste of UG *uwi* cookies is better than US *uwi* cookies. In the subvariable sweetness of UG *uwi* cookies compared to US *uwi* cookies, the significance value is 0.058 which means greater than the probability of 0.05 (> 0.05). This shows that the sweetness of UG *uwi* cookies is not better than US *uwi* cookies. In the umami flavor subvariable of UG *uwi* cookies compared to US *uwi* cookies, the significance value is 0.226 which means greater than the probability of 0.05 (> 0.05). This shows that the umami flavor of UG *uwi* cookies is not better than US *uwi* cookies. In the overall subvariable of UG *uwi* cookies compared to US *uwi* cookies, the significance value is 0.034 which is smaller than the probability of 0.05 (> 0.05). This indicates that the overall UG *uwi* cookies are not better than US *uwi* cookies.

Table 11. Sensory test result of *uwi* cookies with sugar sweetener in healthy adult respondents.

Characteristic	G20	G40	G60	G80	G100
Shape	3.77 ± 0.99	3.45 ± 0.85	3.16 ± 0.82	3.10 ± 0.98	3.65 ± 0.98
Size	3.68 ± 0.83	3.68 ± 0.79	3.61 ± 0.76	3,61 ± 0.80	3.77 ± 0.67
Colour	3.55 ± 0.77	3.71 ± 0.74	3.94 ± 0.73	3.90 ± 0.91	4.03 ± 0.75
Aroma	3.10 ± 1.04	2.77 ± 0.92	3.23 ± 0.84	3.16 ± 0.82	3.13 ± 0.88
Texture	2.87 ± 1.06	3.13 ± 0.92	3.29 ± 0.82	3.16 ± 1.07	3.26 ± 1.03
Flavour	2.84 ± 1.00	2.61 ± 0.67	2.97 ± 0.84	2.65 ± 0.75	2.58 ± 0.76
Sweetness	2.48 ± 0.89	2.52 ± 0.57	2.55 ± 0.68	2.50 ± 0.78	2.10 ± 0.79
Umaminess	2.71 ± 0.86	2.65 ± 0.66	2.87 ± 0.67	2.74 ± 0.86	2.52 ± 0.72
Overall	2.77 ± 1.04	2.50 ± 0.82	2.90 ± 0.88	2.63 ± 0.89	2.37 ± 0.76

Table 12. Sensory test result of *uwi* cookies with stevia sweetener in healthy adult respondents.

Characteristic	S20	S40	S60	S80	S100
Shape	3.81 ± 0.95	3.65 ± 0.95	3.68 ± 0.87	3.52 ± 1.03	3.16 ± 1.16
Size	3.74 ±0.96	3.74 ± 0.73	3.65 ± 0.80	3.68 ± 0.87	3.45 ± 0.96
Colour	3.74 ± 0.77	3.74 ± 0.73	4.00 ± 0.82	4.16 ± 0.93	3.87 ± 1.12
Aroma	2.71 ± 0.97	2.55 ± 0.93	2.81 ± 0.98	2.55 ± 0.93	2.68 ± 0.94
Texture	2.77 ± 0.99	3.00 ± 1.10	3.42 ± 0.85	3.32 ± 0.98	3.45 ± 0.93
Flavour	2.71 ± 0.86	2.45 ± 0.85	2.39 ± 0.80	2.52 ± 0.89	2.61 ± 0.88
Sweetness	2.39 ± 0.92	2.10 ± 0.79	1.97 ± 0.80	2.26 ± 0.77	2.68 ± 0.91
Umaminess	2.45 ± 0.85	2.55 ± 0.89	2.55 ± 0.81	2.61 ± 0.88	2.84 ± 0.78
Overall	2.63 ± 0.89	2.30 ± 0.92	2.37 ± 0.85	2.27 ± 0.69	2.67 ± 0.88

4. CONCLUSIONS

The use of *uwi* and mung bean flour affects the chemical and organoleptic properties of cookies. Variations in the addition of sweeteners also affect the chemical and organoleptic properties. The use of stevia increases chemical values such as water, ash, protein, and fat content but the antioxidant content is lower than cookies with sugar sweeteners.

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