

Sensory Evaluation and Antioxidant Activity of Fudgy Brownies With Purple Sweet Potato Substitution

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Abstract

This experiment aimed to analyze the effect of purple sweet potato substitution on fudgy brownies. This study used a Completely Randomized Design (CRD) with 3 formulations of wheat flour and sweet potato ratios F1 (75%, 25%), F2 (50%, 50%) and F3 (100% purple sweet potato). The three samples were tested using the hedonic method organoleptic test with a 9-point scale covering the assessment of color, aroma, taste, and texture attributes by 40 untrained panelists. Data were analyzed using the Kruskal-Wallis test because the results of the study showed that purple sweet potato substitution had no significant effect on all sensory attributes ($p > 0.05$) so that all formulations were still acceptable to the panelists. Formulation 2 was the best treatment based on the panelists' level of preference, with a composition of 50% wheat flour (14.5g) and 50% purple sweet potato (14.2g). The DPPH test results showed that formulation 2 had the best antioxidant activity with an average discoloration value of 38.992. This finding indicates that purple sweet potato has the potential to be used as a substitute for wheat flour in the development of fudgy brownies based on local food.

Keywords: organoleptic test, purple sweet potato, pastry, fudgy brownies, antioxidant activity

INTRODUCTION

Innovation in the food industry, particularly in the development of pastry products, is advancing at a rapid pace. Food innovation is not only focused on taste but also on nutritional value. In general, there is a growing preference for food products that use natural ingredients, have good nutritional content, and provide health benefits. This shift is driven by the trend toward healthy eating. Changing preferences align with increasing public awareness of healthy food.

The influence of social media content disseminated by influencers is accelerating changes in consumption patterns, thereby increasing interest in food purchasing decisions¹. This phenomenon is driving the industry and researchers to continue developing healthy products based on local ingredients². This trend is no exception for pastry products.

Pastries are products made from wheat flour, fat, and liquid ingredients processed using specific techniques,³ followed by a baking process. Examples of pastry products include various types such as

¹ Aqila Sintya and others, 'Analisis Statistika Pengaruh Sosial Media Terhadap Konsumsi Makanan Sehat Di Kalangan Remaja', *Jurnal Pendidikan Matematika*, 4.2 (2025), 208–18 <<https://doi.org/10.56916/jp.v4i2.1524>>.

² Aditiya Pratama. Daryana and others, 'Tren Healthy Fast Food: Analisis Model Bisnis Dan Potensi Pertumbuhan Di Era Gaya Hidup Sehat Di Kota Medan', *Jurnal Manajemen Dan Bisnis*, 25 (2025), 94–104.

³ Rr Cristiana Mayang Anggraeni Stj, Fristi Bellia Annishia, and Lu'luwatin Rosdiana Aprilia, 'Penyusunan Aset Modul Digital Inovasi Lokal Pastry Sebagai Sarana Publikasi Dikalangan

cakes, pies, cookies, and brownies. Brownies are square-shaped treats⁴ often referred to as “failed cakes” because they originated from a dense, hard batter from the United States in 1897⁵. Brownies have a sweet flavor made from wheat flour, eggs, fat, granulated sugar, and chocolate, baked in an oven⁶. However, as times have changed, variations in brownies have also evolved, ranging from the base ingredients used to the techniques employed. Emerging variations include steamed brownies, cookie brownies, crispy brownies, and fudgy brownies, which will continue to develop further.

Fudgy brownies are a variation of brownies that have a dense and moist texture due to a different preparation process and different formulation flour used. The texture of fudgy brownies depends on the preparation technique and the amount of flour used⁷. However, during the preparation process, the technique used to blend the eggs and sugar has a much greater impact on the texture and appearance of the final product than the amount of flour used. In the preparation process and require a longer egg-whisking time; these differences affect the final texture.

The use of wheat flour in making fudgy brownies serves as the foundation for a sturdy dough structure because it contains gluten proteins composed of gliadin and glutenin⁸. However, fudgy brownies could not be consumed by those who allergy to gluten. and The growing interest in healthy lifestyles has led to innovations in replacing wheat flour with alternative ingredients that do not contain gluten, such as purple sweet potatoes.

Purple sweet potatoes (*Ipomoea batatas* L) are a readily available local food source and a substitute for wheat flour. Purple sweet potatoes are a source of complex carbohydrates rich in fiber and vitamins, with relatively lowfat content and high anthocyanin levels⁹. The anthocyanins in purple sweet potatoes give them their purple or deep purple color¹⁰ and act as natural antioxidants that help neutralize free radicals¹¹. Additionally, purple sweet potatoes help prevent hypertension, type 2

Mahasiswa Seni Kuliner Polimedia', *Jurnal Ilmiah Jurusan Penerbitan*, 12.2 (2024) <<https://doi.org/10.46961/jip.v12i2.1524>>.

⁴ I Wayan Hendra Aditya and I Gede Dirga Surya Arya Widhyandanta, 'Pembuatan Brownies Dengan Tepung Bebas Gluten Making Brownies with Gluten Free Flour', *Jurnal Pariwisata Dan Bisnis*, 04.3 (2025), 2176–82 <<https://doi.org/10.22334/paris.v4i3.950>>.

⁵ Rochiyat Setiawan and Tri Yuni Susilowati, 'Pemanfaatan Hasil Bumi Biji Nangka Untuk Pembuatan Brownies Ooleh Masyarakat Desa Kebon Hui Bandung Barat', *Jurnal of Social Science*, 8.2 (2024), 2807–5358 <<https://doi.org/10.70157/e.v8i2.2623>>.

⁶ Mathilda Saulia Deborah Harianja, 'Pengaruh Subtitusi Tepung Kacang Arab Terhadap Kulaitas Kue Brownies Sebagai Alternatif Snack Gluten-Free', *Jurnal Mahasiswa Pariwisata Dan Bisnis*, 01.05 (2022), 1169–88 <<https://doi.org/10.22334/paris.v1i5.82>>.

⁷ Kelli Foster, 'What's the Difference Between Fudgy, Chewy, and Cakey Brownies?', *The Kitchn*, 2022 <<https://www.thekitchn.com/difference-between-fudgy-chewy-and-cakey-brownies-265966>> [accessed 12 January 2026].

⁸ Suyatno, Dasir, and Khairuissa BR Tamba, 'Pengaruh Perbandingan Tepung Tapioka Dan Tepung', *Jurnal Penelitian Ilmu-Ilmu Teknologi Pangan (Jedb)*, 14.1 (2025), 6–11 <<https://doi.org/10.32502/jedb.v14i1.9988>>.

⁹ Eni Sumarliyah and others, 'Pemanfaatan Ubi Jalar Ungu Sebagai Makanan Alternatif Bagi Pasien Diabetes Mellitus Di RS Siti Khadijah Sepanjang', *Prosiding Conference of Elementary Studies (CES)*, 2023 <<https://doi.org/10.30651/pc.v1i1.25336>>.

¹⁰ Siti Rahmah Kurnia. Ramdan and Vivit. Fitriah, 'Optimasi Fase Gerak Pada Isolasi Dan Identifikasi Antosianin Ubi Jalar Ungu (*Ipomea Batatas* L)', *Pharmacy Genius*, 02 (2023), 135–44 <<https://doi.org/10.56359/pharmgen.v2i2.280>>.

¹¹ Siti Farida and others, *Potensi Ubi Jalar Ungu Analisis Kandungan Antosianin*, 1st edn (Kota Malang: PT. Literasi Nusantara Abadi Grup, 2024),1-118.

diabetes, and have anti-cancer properties¹². They are particularly recommended for people with diabetes because they lower blood glucose levels, making them suitable as a rice substitute and a snack alternative to wheat flour¹³.

Based on proximate analysis, purple sweet potatoes contain 1.5–2.2% protein, 27–30% carbohydrates, 3–4% fat, and 100–210 mg of anthocyanins per 100 g of purple sweet potato¹⁴. Meanwhile, the nutritional content of purple sweet potato flour depends on the particle size of the flour; 100 µm is the most optimal size based on antioxidant indicators,¹⁵ as well as how the drying process of the purple sweet potato affects the nutritional content¹⁶.

Therefore, the use of purple sweet potato puree as an alternative to purple sweet potato flour in fudgy brownie formulations holds greater potential. Substituting purple sweet potato puree can reduce reliance on wheat flour. Additionally, the anthocyanin content in purple sweet potatoes remains relatively stable even after heat processing,¹⁷ although the phenolic content of purple sweet potatoes increases due to the heating process¹⁸.

Several studies on the use of purple sweet potatoes have been conducted. It was found that substituting purple sweet potatoes in the production of healthy snacks such as milk pie results in a product containing 7,679 mg/ml of antioxidants¹⁹. Additionally, the use of purple sweet potatoes in ice cream production yields a product with a protein content of 2.59 g and a fat content of 1.66 g per 100 g²⁰. Purple sweet potatoes can also be used in the production of snack bars, where increased use of

¹² Ainun Sakinah Adiningsih and others, 'Manfaat Ubi Jalar Ungu (Ipomea Batatas. L) Sebagai Pengobatan Penyakit Tidak Menular', *Fakumi Medical Journal*, 04 (2024), 746–58 <<https://doi.org/10.33096/fmj.v4i11.511>>.

¹³ Sutrisno and others, 'Pengaruh Pemberian Ubi Jalar Ungu (Ipomoea Batatas Poirlet) Terhadap Penurunan Kadar Glukosa Darah Pada Pasien Diabetes Mellitus Di Wilayah Kerja Puskesmas Peniangan Lampung Timur', *Jurnal Gizi Aisyah*, 5 (2022), 35–44 <<https://doi.org/10.30604/jnf.v5i1.553>>.

¹⁴ Lovro Sinkovič and others, 'Scientia Horticulturae Variations in the Nutritional Profile and Colour Parameters of Sweet Potato Varieties with Different Flesh Colours: Effects of Cropping System, Mulching and Growing Season', *Scientia Horticulturae*, 338 (2024), 113807 <<https://doi.org/10.1016/j.scienta.2024.113807>>.

¹⁵ Muhammad Azeem and others, 'Isolation, Identification and Quantification of Phenolic Acids, Flavonoids and Anthocyanins Based on Different Particle Fractions of Purple-Fleshed Sweet Potato Flour for Utilization as Industrial Applications', *Food Chemistry: X*, 33 (2026) <<https://doi.org/10.1016/j.fochx.2025.103410>>.

¹⁶ Zhen Peng and others, 'Effect of Carriers on Physicochemical Properties, Antioxidant Activities and Biological Components of Spray-Dried Purple Sweet Potato Flours', *LWT - Food Science and Technology*, 51 (2013), 348–55 <<https://doi.org/10.1016/j.lwt.2012.09.022>>.

¹⁷ Ngouana Moffo A. Ivane and others, 'Harnessing the Health Benefits of Purple and Yellow-Fleshed Sweet Potatoes: Phytochemical Composition, Stabilization Methods, and Industrial Utilization- A Review', *Food Chemistry: X*, 23 (2024), 101462 <<https://doi.org/10.1016/j.fochx.2024.101462>>.

¹⁸ Afsheen Zehra and others, 'Unraveling Anthocyanin Accumulation in Sweet Potatoes with Integrated Omics', *Scientia Horticulturae*, 350 (2025) <<https://doi.org/10.1016/j.scienta.2025.114293>>.

¹⁹ Bahriyatul Ma'rifah, Erna Tri Astuti, and Dewi Kusumawati, 'Pie Tepung Ubi Ungu Dan Kacang Merah Alternatif Makanan Selingan Bagi Penderita DM Tipe 2', *Jurnal Riset Gizi*, 12.2 (2024), 170–82 <<https://doi.org/10.31983/jrg.v12i2.11766>>.

²⁰ Natasya Pratima Asti Fauzia and Rita Ismawati, 'Tingkat Kesukaan Dan Kandungan Gizi Es Krim Susu Kedelai Ubi Ungu Untuk Penderita Diabetes Mellitus', *Jurnal Gizi Universitas Negeri Surabaya*, 3 (2023), 399–408.

purple sweet potatoes results in products with higher antioxidant content²¹.

Based on this description, an innovation was implemented in fudgy brownies by substituting wheat flour with purple sweet potatoes as the raw material. This innovation is expected to reduce dependence on wheat flour by replacing it with local food ingredients. Therefore, this study examined the effect of purple sweet potato substitution on the antioxidant content, sensory quality, and acceptability of fudgy brownies through organoleptic testing using the hedonic test method. Statistical analysis was performed using the Kruskal-Wallis test.

METHOD

The research method used was an experimental method with a completely randomized design (CRD) involving three formulations. The formulations applied involved varying the ratio of wheat flour to purple sweet potato in each formula: F1 with 7.2 g (25%) purple sweet potato substitution, F2 with 14.5 g (50%) substitution, and F3 with 29 g (100%) substitution. The raw materials for making brownies²² are based on the formulations presented in Table 1:

Ingredients	Weight of Ingredients (g)		
	F1	F2	F3
Flour	21.7	14.5	0
Purple sweet potato	7.2	14.5	29
Dark chocolate	105	105	105
Margarine	45	45	45
Eggs	56	56	56
Brown sugar	36	36	36
Sugar	16	16	16
Cocoa powder	9	9	9
Vanilla	2	2	2
Salt	2	2	2

The process of making brownies started by preparing the tools and ingredients, washing them, and drying them. The process was started by washing the sweet potatoes, then steamed them for 20 minutes until they are soft. Next, the sweet potatoes here blended to form a paste.

The margarine was melted first, then cocoa powder, dark chocolate, and salt were added and mixed well, then let it cool to room temperature. The light brown sugar, sugar, vanilla, and eggs using a mixer on medium speed for 3 minutes using the bain-marie method²³ until the sugar dissolves.

The sugar and eggs were mixed again using a mixer for 1 minute on low speed. The melted chocolate was then added to the egg mixture and stirred with a spatula. After that, the sweet potato paste and flour were added gradually and mixed again until well combined. The batter was baked in the oven for 5 minutes at 250°C, followed by 20 minutes at 170°C.

The study was conducted at the laboratory of the Department of Culinary Education, Faculty of Engineering, UNNES in January. The testing was performed by 40 untrained panelists using an

²¹ Fitriana Mustikaningrum, Hilda Carella, and Anggraini Wulandari, 'Kadar Antisianin, Amilosa Dan Organoleptik Snack Bar Kacang Merah Pratana Dan Ubi Ungu Sebagai Alternatif Makanan Bagi Penyandang Diabetes Mellitus', *Jurnal Gipis*, 5 (2021), 35–47.

²² Joels cuisine, 'Chocolate Fudgy Brownie', *Instagram*, 2025 <<https://www.instagram.com/reel/DRmt6zIAezZ/?igsh=bGZrenBnMGh4cXdP>> [accessed 28 February 2026].

²³ Tatik Sriwulandari, Nisa Rahmadiyah Utami, and Saleha, 'Culinary Sustainability : Exploring The Potential Of Manihot Esculenta In Innovative Production Using The Au Bain Marie Technique', *Jurnal Sejarah, Pendidikan Dan Humaniora*, 8 (2024), 2103 <<https://doi.org/10.36526/js.v3i2.>>.

organoleptic test with the hedonic method²⁴. Evaluations were conducted on several sensory attributes, including taste, aroma, texture, color, and product appearance, as well as the antioxidant content of the product.

RESULTS AND DISCUSSION

This study aimed to determine the effect of substituting purple sweet potato puree on the sensory characteristics of fudgy brownies. Three formulations were tested: 25%, 50%, and 100% substitution of wheat flour with purple sweet potato. The evaluation focused on the attributes of sweetness, chocolate flavor, sweet potato flavor, chocolate aroma, sweet potato aroma, texture, color, and overall impression. The evaluation was conducted using a 9-point hedonic scale by 40 untrained panelists. Data analysis was performed using the Kruskal-Wallis test with SPSS 27.

Data Analysis

The results of the normality test for the fudgy sweet potato brownies data, using the Kolmogorov-Smirnov method, indicated that the data were not normally distributed because the p-value was < 0.05 ; this indicates that the data are not normally distributed across all aspects. Furthermore, the homogeneity test for the fudgy sweet potato brownie data showed that the data is homogeneous. Therefore, the non-parametric test chosen was the Kruskal-Wallis test as a substitute for the one-way ANOVA²⁵. Kruskal-Wallis analysis data in Table 2.

Table 2. Results of the Kruskal-Wallis Test

Aspects	P<0.05		Description
	Sig.	0.05	
Sweet taste	0.820	0.05	No difference
Chocolate flavor	0.501	0.05	No difference
Sweet potato flavor	0.355	0.05	No difference
Chocolate aroma	0.901	0.05	No difference
Sweet potato aroma	0.531	0.05	No difference
Soft texture	0.371	0.05	No difference
Color	0.399	0.05	No difference
Overall	0.107	0.05	No difference

Based on the results of the Kruskal-Wallis test, all evaluation indicators showed significance levels greater than 0.05 ($p > 0.05$); therefore, it can be concluded that there were no significant differences among the levels of purple sweet potato substitution for all indicators tested. These results indicate that variations in the substitution level of purple sweet potato in the fudgy brownie formulation do not significantly affect the product's sensory characteristics; thus, increasing the proportion of purple sweet potato up to the highest substitution level remains acceptable to the panelists without causing significant differences in perception across the tested indicators.

Sample Preference Level

The level of preference is an important parameter in the acceptance of a product. The aim is to determine the extent to which substituting purple sweet potatoes in the production of fudgy brownies affects panelists' preferences regarding the sensory attributes being tested and to identify the most preferred formulation.

Preference ratings were conducted using a hedonic test with a 9-point scale. The higher the score given, the greater the panelists' acceptance and preference for the sample. The test compared the formulations of the three substitution samples—Formula 1 with 25% purple sweet potato, Formula 2 with 50%, and Formula 3 using 100% purple sweet potato—by calculating the average scores from 40

²⁴ Winiati P Rahayu, Siti Nurosiyah, and Rachmat Widyanto, *Evaluasi Sensori*, 2nd edn (Tangerang: Universitas Terbuka, 2019) <<https://id.scribd.com/document/511716996/buku-evaluasi-sensoris-lengkap>>.

²⁵ Shorihatul Inayah and others, *Statistika Non Parametrik*, ed. by Alfauzain, Cetakan Pe (Kota Padang: U ME Publishing, 2024) <https://www.researchgate.net/profile/Shorihatul-Inayah/publication/392631089_STATISTIKA_NON_PARAMETRIK/links/684baecf5e99ec1951ca09e2/STATISTIKA-NON-PARAMETRIK.pdf>.

panelists. The average sample data are presented in Table 3.

Formula:

$$\bar{x} = \frac{\sum x}{n}$$

Notes:

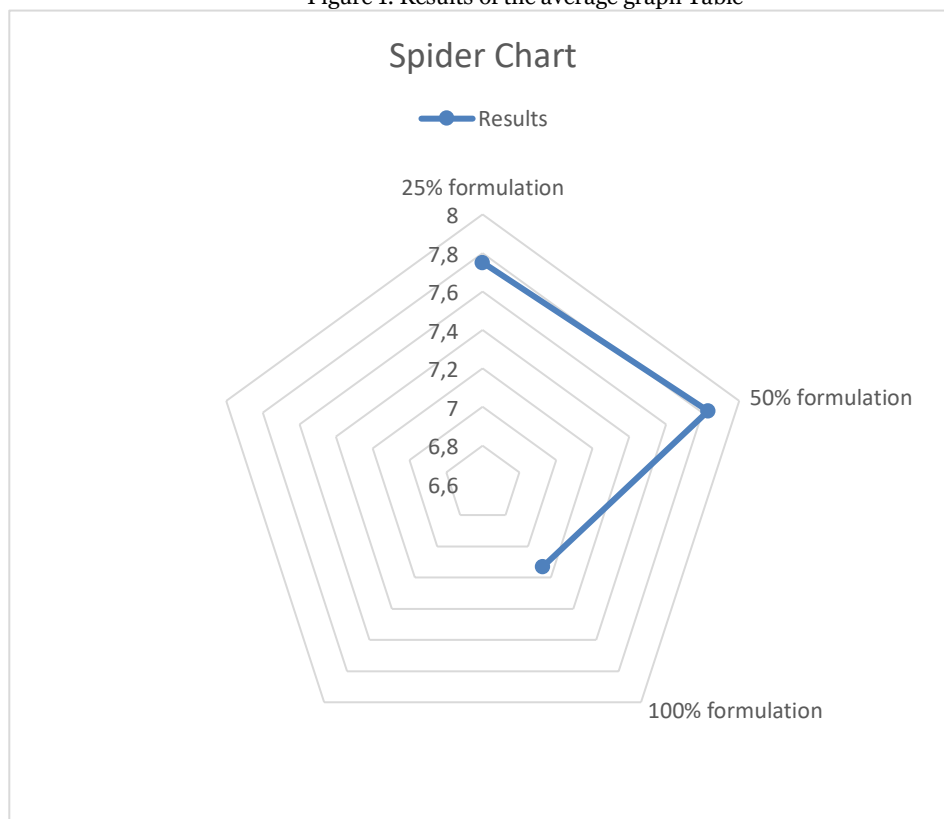
- $\sum x$ = sum of panelists' scores
- n = number of panelists

Table 3. Sample Average

Sweet Potato Formulation	Total score	Average
25% Formulation	309	7.73
50% Formulation	313	7.83
100% Formulation	285	7.13

Based on the results of the average score calculation, the 25% substitution treatment with sample code 245 showed the highest score of 7.83 compared to the 50% substitution and the 100% formulation. This indicates that the formulation with 25% substitution was the sample most preferred by the panelists. The mean values for each sample are then presented in the form of a spider chart in Figure 1.

Figure 1. Results of the average graph Table



The Effect of Substitution on Product Texture and Structure

Based on the results of sensory testing and statistical analysis of texture acceptability, the purple sweet potato substitute showed no significant differences in texture attributes ($p > 0.05$), indicating that the texture of all three purple sweet potato formulations was still acceptable to the panelists.

In theory, reducing the amount of wheat flour can decrease the formation of gluten networks,

which play a crucial role in the product's structure²⁶. In the production of fudgy brownies, very little wheat flour is used because fudgy brownies are characterized by a dense and moist texture; however, when wheat flour is completely removed from fudgy brownies and replaced with sweet potato puree, the texture becomes excessively moist and too soft. The use of sweet potato puree can alter the texture because sweet potatoes contain a significant amount of water, and there is nothing to absorb that moisture since the wheat flour has been removed during production²⁷.

Implications for color and aroma

The results of sensory testing and statistical analysis of the acceptability of the sweet potato aroma, chocolate aroma, and color did not show significant differences ($p > 0.05$). This indicates that the formulation substituting purple sweet potato in fudgy brownies was well-accepted by the panelists, suggesting that the dominant chocolate aroma from dark compound chocolate and cocoa powder is the primary characteristic of the product.

The use of pure sweet potato results in an aroma with relatively lower intensity compared to the strong and complex aroma of dark compound chocolate and cocoa powder, a difference²⁸ also influenced by the lower proportion of purple sweet potato used relative to dark compound chocolate and cocoa powder. Therefore, increasing the substitution of purple sweet potato does not drastically alter the panelists' perception of aroma and color.

Product Results

The results are presented visually to illustrate the differences in the physical characteristics of the three fudgy brownie formulations with varying levels of purple sweet potato substitution. The three samples have a relatively similar appearance, but there are differences in color, surface texture, and overall texture. The Visual result of the product are presented in Table 4.

Table 4. Visual presentation of fudgy brownies

Formulation	Image
Formula 1 (25% sweet potato, 75% wheat flour)	

²⁶ Negasi Tsegay and others, 'Nutritional and Functional Potentials of Wheat , Cowpea , and Yam Composite Flours on Bread Formulations: Effect of Blending Ratio and Baking Parameters', *Journal of Agriculture and Food Research*, 18 (2024), 1 <<https://doi.org/10.1016/j.jafr.2024.101294>>.

²⁷ Logeswary Selvakumaran and others, 'Orange Sweet Potato (Ipomoea Batatas) Puree Improved Physicochemical Properties and Sensory Acceptance of Brownies', *Journal of the Saudi Society of Agricultural Sciences*, 18 (2019), 4 <<https://doi.org/10.1016/j.jssas.2017.09.006>>.

²⁸ Camila Araújo Costa Lira and others, 'Sensory Acceptance Testing and Rheological Parameter Analysis of a Plant-Based Cocoa (Theobroma Cacao l .) Dessert Formulated with Chickpeas (Cicer Arietinum L .), Quinoa (Chenopodium Quinoa Willd .), Sweet Potatoes (Ipomoea Batatas L .), and Rice (O', *Food Chemistry Advances*, 8, July 2024 (2025), 4–5 <<https://doi.org/10.1016/j.focha.2025.101068>>.

Formula 2 (50% sweet potato, 50% wheat flour)	
Formula 3 (100% sweet potato)	

Laboratory Test Results on Antioxidant Content

Testing of the fudgy sweet potato brownies for antioxidant activity was conducted at the laboratory of Soegijapranata Catholic University in Semarang using the DPPH method with discoloration spectrophotometry. UV-VIS (ultraviolet-visible) spectrophotometry is a tool used to measure antioxidant activity and total phenolic content.²⁹

The discoloration value indicates the percentage change in solution color from purple to yellow due to the antioxidant compounds in the sample capturing free radicals.³⁰ A discoloration value above 70% is considered good, 50–70% is considered good, 30–50% is moderate, and below 30% indicates low antioxidant activity.³¹ The laboratory test result are presented in Table 5.

Code	Antioxidant Activity (% discoloration)	Mean	Stdev
F 1	23.817	23.262	0.887
F 1	23.731		
F 1	22.239		
F 2	39.112	38.992	0.112
F 2	38.889		
F 2	38.975		
F 3	27.984	27.955	0.065
F 3	28.001		
F 3	27.881		

Based on the results of the antioxidant activity laboratory tests, it was found that the highest level of free radical scavenging activity (% discoloration) among the three fudgy sweet potato brownie samples was observed in formulation 2, which contained a 50% substitution of purple sweet potato, with the highest average value of 38.992% compared to formulations 1 and 3. A higher antioxidant activity value indicates better antioxidant potential.

Formulation 3 had the highest amount of purple sweet potato added and should have had the

²⁹ Lucrezia Angeli and others, 'Comparative Analysis of Antioxidant Activity and Capacity in Apple Varieties: Insights from Stopped Flow DPPH • Kinetics, Mass Spectrometry and Electrochemistry', *Food Bioscience*, 58 (2024), 103729 <<https://doi.org/10.1016/j.fbio.2024.103729>>.

³⁰ Philip Molyneux, 'The Use of the Stable Free Radical Diphenylpicryl- Hydrazyl (DPPH) for Estimating Antioxidant Activity', *Songklanakarin Journal of Science and Technology*, 26 (2004), 211–19.

³¹ Olamide E Adebiyi and others, 'In Vitro Antioxidant Activity, Total Phenolic and Flavonoid Contents of Ethanol Extract of Stem and Leaf of Grewia Carpinifolia', *Beni-Suef University Journal of Basic and Applied Sciences*, 6 (2017), 10–14.

highest antioxidant activity,³² the absence of added flour caused a decrease due to thermal degradation resulting from the heating temperature during baking.³³

The wheat flour in formulation 2 serves to protect against the decline in antioxidant activity caused by thermal heating because it contains gluten. The gluten content forms a protective protein matrix that helps retain water and shield antioxidant compounds from the high oven temperatures during baking.³⁴. Therefore, formulation 2 tends to be more stable compared to formulation 3, which does not use flour.

CONCLUSION

This study aimed to analyze the effect of purple sweet potato substitution on the sensory acceptance of fudgy brownies. The results indicated that the substitution formulation did not have a significant effect on the attributes of taste, aroma, texture, color, and overall impression. This suggests that the fudgy brownie formulation exhibits a high degree of flexibility regarding the use of tuber-based substitute ingredients without compromising sensory quality.

Formulation 2, with a 50% substitution of purple sweet potato and 50% wheat flour, showed higher consumer preference compared to Formulations 1 and 3. This was influenced by the resulting flavor profile, where the combination of purple sweet potato and other ingredients blended more harmoniously than in the other formulations. In Formulation 1, the purple sweet potato content was too low, so the sweet potato flavor was not noticeable, and in Formulation 3, which contained purple sweet potato without wheat flour, the purple sweet potato flavor came through fully; however, the absence of flour caused the sugar in the batter to burn quickly, resulting in a slightly bitter taste and a sticky sensation on the teeth after eating.

Based on the results of laboratory tests on the antioxidant activity of formulation 2, which substituted 50% purple sweet potato and 50% wheat flour, it had a high average value of 38.992% compared to formulations 1 and 3. In formulation 1, the use of purple sweet potato was too small, resulting in the lowest value among the other formulations; however, in formulation 3, although the use of purple sweet potato was the highest, the value showed a decrease. This was because formulation 3 did not use wheat flour. Wheat flour contains gluten, which functions to form a more stable protein matrix, thereby protecting the moisture content and antioxidant compounds during the baking process. Purple sweet potatoes have the potential to be used as a substitute ingredient in the development of pastry products, particularly fudgy brownies, to support food diversification based on local ingredients and reduce reliance on wheat flour.

Further research is recommended to conduct a more in-depth analysis of the nutritional composition, moisture content, and physicochemical characteristics of the product in order to enhance its functional value and support its development as an innovative food product based on local ingredients.

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³² Purwanti Fadiah Kusuma Sari Subianto, Apri Dwi Anggoro, and Putut Har Riyadi, 'Pengaruh Substitusi Tepung Ubi Jalar Ungu (*Ipomea Batatas* L.) Terhadap Aktivitas Antioksidan Dan Tensile Strength Kwetiau Ikan Kurisi (*Nemipterus* Sp.)', *Jurnal Ilmu Dan Teknologi Perikanan*, 5 (2023), 64.

³³ Fadilah Husnun and others, 'Sifat Kimia Dan Kinetika Degradasi Termal Antioksidan Jus Melon (*Cucumis Melo* L.) Kultivar Gama Melon Parfum', *Jurnal Pertanian Andalas*, 6 (2022), 74 <<https://doi.org/10.25077/jtpa.26.1.71-83.2022>>.

³⁴ Saima Perveen and others, 'Comparison of Nutritional, Antioxidant, Physicochemical, and Rheological Characteristics of Whole and Sprouted Wheat Flour', *LWT- Food Science and Technology*, 2024, 116679 <<https://doi.org/10.1016/j.lwt.2024.116679>>.

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The authors state that there is no conflict of interest in the publication of this article

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