

## ANALYSIS OF STUDENT PREFERENCES FOR FUDGY BROWNIES BASED ON DIFFERENCES IN WHEAT FLOUR PROTEIN TYPES

Gloria Uli Margareta Hutapea<sup>1</sup>, Naysiatul Aisyah<sup>2</sup>, Hanun Anindita Mayadah<sup>3</sup>,  
Dita Dwi Febiyanto<sup>4</sup>, Dimas Prayoga<sup>5</sup>, Gilang Fahreza<sup>6</sup>

Faculty of Economics and Business,

Bina Sarana Informatika University, Jakarta, Indonesia

Email: [51240014@bsi.ac.id](mailto:51240014@bsi.ac.id), [51240015@bsi.ac.id](mailto:51240015@bsi.ac.id), [51240016@bsi.ac.id](mailto:51240016@bsi.ac.id),  
[51240054@bsi.ac.id](mailto:51240054@bsi.ac.id), [51240058@bsi.ac.id](mailto:51240058@bsi.ac.id), [gilang.gfz@bsi.ac.id](mailto:gilang.gfz@bsi.ac.id)

### Abstrak

#### Keywords:

Fudgy Brownies,  
Preference,  
Texture,  
Wheat Flour,  
Protein,  
Google Form Survey.

*This study aims to analyze students' preferences for fudgy brownies made using wheat flour with different protein contents, namely high, medium, and low protein. Differences in flour protein content affect gluten formation, which directly influences the appearance or color, moisture, and texture of brownie products. The research method used was a quantitative descriptive survey through organoleptic testing of three fudgy brownie samples: Tester 1 made with high-protein wheat flour, Tester 2 made with medium-protein wheat flour, and Tester 3 made with low-protein wheat flour. The evaluation was conducted by 25 student respondents using a Google Form-based questionnaire with assessment parameters including appearance or color, fudgy texture, and moisture. The results showed that Tester 1 obtained the highest percentage scores across all evaluation parameters, with taste at 48%, appearance or color at 44%, fudgy texture and moisture at 44%, and texture at 52%. The level of respondent satisfaction indicated a very satisfying result of 66.7%. These findings demonstrate that differences in wheat flour protein content have a significant effect on consumer preference levels for fudgy brownies.*

*This is an open access article under the [CC BY-NC-SA 4.0](https://creativecommons.org/licenses/by-nc-sa/4.0/) license*



### INTRODUCTION

Brownies are one of the most well-known and widely favored food products among various groups, especially young people. This product has a distinctive chocolate flavor and a variety of textures that become its main attraction for consumers. In general, brownies are classified into two main types: cakey brownies and fudgy



brownies. Cakey brownies have a light structure similar to sponge cake, while fudgy brownies have a denser, moist texture and a richer chocolate flavor due to higher fat content and the use of less flour (Miranda & Rotua, 2023).

The fudgy texture of brownies can be strongly influenced by the composition of the ingredients, particularly the type of wheat flour used. Wheat flour contains main proteins in the form of gliadin and glutenin, which form gluten when reacting with water. High gluten formation produces a stronger and denser structure, while low gluten levels result in a more fragile and softer texture. Therefore, using wheat flour with different protein levels will produce different brownie texture characteristics (Organoleptic, 2022).

In addition to texture, consumer acceptance of brownies is also influenced by factors such as appearance or color, moisture, and texture of the product. Sensory evaluation or organoleptic testing is a commonly used method to assess the level of consumer preference for a food product. Based on this, this study was conducted to analyze student preferences toward three variants of fudgy brownies made using wheat flour with different protein levels, in order to determine which type of flour produces the highest preference level (Halim et al., 2016).

When someone decides whether they like a food product or not, their assessment is not focused on only one sensory aspect. Instead, it is a combination of what they see, how the texture feels, and how the taste is experienced in the mouth—all occurring simultaneously. The initial appearance of a product, especially its color and visual presentation, can influence expectations about texture even before tasting, which then affects the overall liking. Texture and moisture are also crucial in creating a pleasant eating experience, especially for products such as chocolate cakes. Therefore, when exploring what makes people like fudgy brownies, it is important to examine how these sensory aspects are interconnected. By doing so, researchers can obtain a more accurate and realistic description of what consumers truly perceive (Lawless, 1999; Cardello, 1996).

Consumer preferences for a specific food characteristic are influenced by individual sensitivity in perceiving texture and water content. Each individual has different tolerance limits toward the physical properties of a product; therefore, the same ingredient composition may result in varying levels of preference. In bakery products, understanding differences in consumer sensory responses becomes important to interpret liking test results more deeply. By considering individual perception differences, the analysis of student preferences toward fudgy brownies is expected to provide more accurate information regarding consumer acceptance trends related to variations in wheat flour composition (Meilgaard, Civille, & Carr, 2024; Meilgaard et al., 1999).

In food studies, selecting an appropriate sensory testing method is essential to ensure that the results regarding consumer preferences are reliable and representative. Hedonic testing, which involves untrained participants such as students, is often used in bakery product research because it can indicate how much consumers actually like a product. This method is considered appropriate for evaluating sensory characteristics such as color appearance, texture, and moisture level, especially for products targeted at the general public rather than experts. By involving consumers as panelists, researchers can obtain preference data that more closely reflects real market conditions. Therefore,

the results of this research can serve as a basis for developing products that match the preferences of the target consumers (Stone, Bleibaum, & Thomas, 2012).

## LITERATURE REVIEW

### 1. *The Specific Role of Flour Protein in Brownie Structure*

Wheat flour is the main structural component containing gliadin and glutenin proteins that form a gluten network when hydrated. Differences in protein levels in flour result in different texture characteristics in brownies. Analysis of the function of gliadin and glutenin shows that glutenin is strongly correlated with dough strength and elasticity, while gliadin contributes to dough extensibility (stretching ability). In fudgy brownies, which naturally contain high fat, the gluten network formed from high-protein flour (such as Tester 1) creates a sufficiently strong matrix to retain moisture and fat without fully developing a light cakey structure as in bread products. Gluten development control studies in dense chocolate-based bar products found that minimal mixing and high sugar and fat content (as used in fudgy brownie formulation) act as inhibitors of gluten development. This explains why, even when using high-protein flour, Tester 1 still maintains fudgy characteristics dense, moist, and slightly chewy rather than becoming completely hard (Welc et al., 2021).

### 2. *The Relationship Between the Maillard Reaction and Visual Quality*

The main chemical reaction occurring during baking is the Maillard Reaction, an interaction between reducing sugars and amino groups from proteins that produces brown color and a characteristic roasted aroma. It has been observed that baked products with higher protein content show darker brown surface intensity because more amino groups are available to participate in the Maillard Reaction. This finding supports the results of this research showing that Tester 1 (high protein) has a darker brown color and a glossy surface, contributing to the highest percentage of the most attractive appearance (Bou-maroun, 2025).

### 3. *Moisture and Water Holding Capacity*

Moist texture is an essential attribute of fudgy brownies. The ability of the protein matrix to hold water (water holding capacity) is crucial in high-moisture baked products. In Tester 3 (low protein), the weak gluten network causes the structure to be less capable of holding moisture and dough density, resulting in a more fragile and crumbly product. In contrast, the optimal protein structure in Tester 1 can trap water more effectively, making it the most preferred sample with the fudgiest and most moist texture (Johnson, 2007).

### 4. *Brief History of Wheat Flour*

Wheat flour comes from wheat grains cultivated by humans since around 10,000 years ago in the Fertile Crescent region (Iraq, Syria, and Turkey). Initially, wheat was processed by grinding stones into coarse powder. As civilization developed, humans began using water mills introduced by the Romans, making flour finer and easier to process. The word *terigu* in Indonesian is borrowed from Portuguese *trigo*, meaning wheat. Wheat flour contains a large amount of starch, a complex carbohydrate insoluble in water. Wheat flour also contains protein in the form of gluten, which determines the elasticity of foods made from wheat flour (Umum et al., 2009).

### 5. *Medieval Development*

In the Middle Ages, wheat flour became popular in Europe. Sifting techniques produced high-quality white flour, but it was only consumed by upper classes. During

this period, bread became a staple food because wheat flour produced softer bread textures compared to other grains. Wheat flour contains starch and gluten protein, which plays a role in determining chewiness (Pertanian & Mataram, 2018).

### **6. Industrial Revolution**

In the 19th century, modern milling machines enabled mass flour production with more stable quality. Wheat flour also began to be fortified with vitamins and minerals to increase its nutritional value. Wheat flour is unique because it contains gluten, a protein naturally found in cereals, insoluble in water, and elastic, allowing it to form a strong framework and chewy texture. Gluten contains protein components called peptides. Many people avoid gluten for health reasons, especially those with celiac disease. When flour is moistened during dough preparation, gluten binds some water and forms a net-like structure, which traps air and increases dough volume (Rumadana & Salu, 2020).

### **Types of Wheat Flour Today**

Today, wheat flour is differentiated based on protein levels and usage:

- **Cakra Kembar Flour:** High protein (12–14%), made from hard wheat. Suitable for bread, donuts, noodles, and puff pastry because it produces elastic dough and perfect rising.
- **Segitiga Biru Flour:** Medium protein (8–11%). Multipurpose, suitable for cakes, bread, and fried foods.
- **Kunci Biru Flour:** Low protein (8–9%), ideal for cookies, biscuits, and sponge cakes because it results in crispy texture and low elasticity.

## **RESEARCH METHOD**

This study uses a quantitative descriptive method with an organoleptic test approach to analyze student preferences for fudgy brownies based on differences in wheat flour protein levels. The study involved 25 student respondents as panelists. The objects of this study consisted of three samples. The only difference among the three samples was the type of flour used, while the other ingredients were made using the same composition.

### ***Brownie-Making Process as the Basis of Sensory Results***

#### ***Tools and Ingredients***

The tools used included a digital scale, pan, stove, mixing bowls, silicone spatula, manual whisk, sieve, three baking pans, baking paper, oven, knife, and cheese grater. All mixing was carried out manually without a mixer to control gluten formation so it would not be excessive.

All ingredients were weighed using a digital scale to ensure formulation accuracy. The ingredient composition used was measured for three baking pans representing one treatment of flour type. The ingredients consisted of 150 g dark cooking chocolate, 90 g butter, 2 eggs, 150 g powdered sugar, a pinch of salt, 35 g cocoa powder, and three types of wheat flour, each 100 g: high-protein flour (Tester 1), medium-protein flour (Tester 2), and low-protein flour (Tester 3). Cheese was used as topping. The brownie recipe in this study was taken from TikTok content by the account @cheekykiddo (2020), a culinary content creator (cheekykiddo, 2020).

### ***Steps for Making Fudgy Brownies***

The process began by melting dark cooking chocolate and butter directly in a pan over low heat while stirring until homogeneous, then cooling to room temperature. Eggs, powdered sugar, and salt were whisked manually until evenly mixed and slightly thickened. The chocolate-butter mixture was gradually added into the egg mixture while stirring until homogeneous. The batter was divided into three equal-weight portions, and each portion was mixed with a different flour type: high protein for Tester 1, medium protein for Tester 2, and low protein for Tester 3. Sifted cocoa powder was added into each batter and mixed evenly. Each batter was then poured into a lined baking pan, topped with cheese, and baked at 170–180°C for 25–30 minutes. After baking, brownies were cooled before cutting and conducting organoleptic testing. The flour type difference became the main variable influencing sensory outcomes.

### ***Data Collection Technique***

Data collection was conducted through a hedonic test by directly evaluating three fudgy brownie samples. Respondents assessed appearance (color), texture and moisture, and overall liking. The ratings were collected using a digital questionnaire via Google Forms as primary data.

### ***Data Analysis Technique***

Data collected from the questionnaire were processed using quantitative descriptive analysis in the form of percentages to describe respondents' preference levels for each brownie sample.

## **RESULT AND DISCUSSION**

Sensory testing results of the three fudgy brownie variants made using different flour protein levels showed variations in panelists' acceptance of taste attributes, visual appearance, fudgy texture, and moisture.

**(Tester 3)**



**(Tester 2)**



**(Tester 1)**



### ***Differences in Color and Appearance***



Tester 1 was assessed as having a darker brown color, glossy surface, and dense form. This darker color was suspected to be influenced by a more intense Maillard reaction due to interaction between protein and sugar during baking. Tester 2 had an attractive visual with evenly distributed brown color, but its surface was not as glossy as Tester 1. Tester 3 had a paler color and less dense surface, likely related to low protein levels, resulting in weaker structure than the other testers. This visual appearance strongly influenced respondents' initial perception of product quality.

### ***Differences in Fudgy Texture and Moisture***



effectively

Tester 1 was considered to have the densest, most moist, and slightly chewy texture, matching ideal fudgy brownies. This texture was formed due to a gluten network strong enough to retain fat and moisture without making the product hard. Tester 2 had fairly moist texture and was not too crumbly, but its chewiness was still below Tester 1. Tester 3 had a more fragile, less dense, and more crumbly texture. Low protein levels caused a very weak gluten network, so the brownie structure could not retain moisture and dough density

### ***Differences in Appearance Among the Three Testers***



Tester 1 was considered to have the most attractive appearance, with a darker, richer, and more evenly distributed brown color, as well as a brownie surface that looked dense and compact. This characteristic is assumed to be influenced by the use of flour with a higher protein content, which produces a more stable batter structure, causing the brown color to appear more intense and less pale. Tester 2 showed a fairly good appearance; however, the product color appeared slightly lighter and less uniform compared to Tester 1. Meanwhile, Tester 3 tended to have a paler appearance with a surface structure that was less dense and more fragile. These differences indicate that variations in wheat flour protein levels affect the visual characteristics of the product, particularly color intensity, structural density, and the overall visual impression of the brownies.

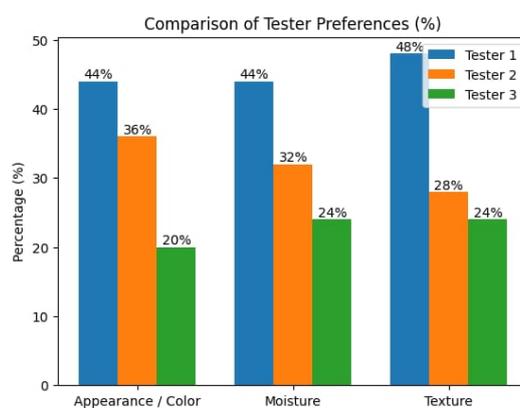
### ***Organoleptic Test Results of Fudgy Brownies***

Based on the appearance or color parameter, Tester 1 obtained the highest percentage score of 44%, followed by Tester 2 at 36%, and Tester 3 at 20%. This result shows that brownies made using high-protein wheat flour had a more attractive

appearance to respondents compared to brownies made with medium- and low-protein flour. The resulting color tended to be more even and visually appealing.

For the moisture parameter, Tester 1 again showed the highest score with a percentage of 44%, while Tester 2 obtained 32% and Tester 3 obtained 24%. The high preference level for moisture in Tester 1 indicates that higher protein content contributes to the formation of a gluten structure capable of retaining water content in the brownies, resulting in a moister texture.

Furthermore, for the texture parameter, Tester 1 obtained the highest percentage score of 48%, followed by Tester 2 at 28%, and Tester 3 at 24%. This difference indicates that brownies made with high-protein wheat flour produced the most preferred fudgy texture among respondents. The higher protein content allows a better structural formation, making the brownies softer and less likely to crumble.



## CONCLUSION

Based on the research results and discussion, it can be concluded that differences in wheat flour protein levels significantly affect the sensory quality of fudgy brownies and student preference levels. Fudgy brownies made with high-protein wheat flour produced the best results in terms of appearance and color, fudgy texture, and moisture. High-protein flour formed a more optimal gluten network, producing brownies with a denser structure, higher moisture, slightly chewy texture, and darker brown color with a more attractive surface appearance due to a more intense Maillard reaction.

In contrast, medium-protein flour produced fairly good quality but remained below high-protein flour, particularly in chewiness and moisture. Low-protein flour produced fudgy brownies with more fragile texture, less density, lower moisture, and less attractive appearance. Thus, high-protein wheat flour can be concluded as the most optimal choice to produce fudgy brownies with the most preferred color, appearance, fudgy texture, and moisture among student consumers.

Overall, this study shows that selecting wheat flour with the appropriate protein level greatly affects the quality of fudgy brownies. Flour with optimal protein content can help produce brownies with softer, more moist, and fudgy textures, as well as a more attractive and preferred appearance. Therefore, the results of this study can serve as a reference for students, bakery businesses, and other parties who want to develop better-quality fudgy brownie products. This study is also expected to add insight regarding the importance of raw material selection in bakery product processing. For further research, it is recommended to add other variables, such as fat ratio, types of

chocolate used, and different baking techniques, so that future results can be more complete, in-depth, and innovative.

## BIBLIOGRAPHY

- Bou-maroun, E. (2025). *Maillard Reaction : Mechanism , Influencing Parameters , Advantages , Disadvantages , and Food Industrial Applications : A Review*. 1–43.
- Cardello, A. V. (1996). *The role of the human senses in food acceptance*. 1–2.
- cheekykiddo. (2020). *Simple Fudgy Brownies*. <https://vt.tiktok.com/ZSfJy5FNf/>
- Halim, J. F., Studi, P., Interior, D., Petra, U. K., & Siwalankerto, J. (2016). *Implementasi Konsep Addiction in Catchiness pada Perancangan Interior “ Rumah Cokelat ” di Surabaya*. 4(2), 339–351.
- Johnson, L. A. (2007). *Evaluation of Water-Holding Capacity for Wheat – Soy Flour Blends*. 151–155. <https://doi.org/10.1007/s11746-006-1018-0>
- Lawless, H. T. (1999). *SENSORY EVALUATION OF FOOD PRINCIPLES AND PRACTICES*.
- Meilgaard, M., Civille, G. V., & Carr, B. T. (2024).
- Meilgaard, M., Sc, D., Civille, G. V., & Carr, B. T. (1999). *SENSORY EVALUATION TECHNIQUES*.
- Miranda, M., & Rotua, M. (2023). *Formulasi Brownies Berbasis Tepung Kacang Hijau dan Puree Kulit Pisang Raja Sebagai Makanan Selingan Tinggi Kalium Formulation of Brownies Green Flour and Planan Skin Puree As High Potassium Food Menurut WHO ( World Health Organization ) tahun 2018 , hipe*. 3(1), 21–28.
- Organoleptik, U. (2022). *PERBANDINGAN KUALITAS BROWNIES QUALITY COMPARISON OF CHOCOLATE*. 01(04), 1008–1029.
- Pertanian, H., & Mataram, U. M. (2018). *Substitusi tepung terigu dengan tepung mocaf dalam pembuatan kue kering*. 5(1), 73–77.
- Rumadana, I. M., & Salu, A. A. (2020). *Uji Organoleptik Spritz Cookies ( Kue Semprit ) dengan Tepung Mocaf sebagai Substitusi sebagian Tepung Terigu*. 8(1), 32–40. <https://doi.org/10.52352/jgi.v8i1.548>
- Stone, H., Bleibaum, R. N., & Thomas, H. A. (2012). *Sensory evaluation practices (4th ed.)*. Heather A. Thomas. <https://doi.org/https://books.google.co.id/books?>
- Umum, G., Tepung, I., Di, T., Dan, I., Umum, G., Tepung, I., Di, T., & Tepung, P. (2009). *Triticum spp.* ). 34–79.
- Welc, R., Fornal, E., & Nawrocka, A. (2021). *Effects of Physical and Chemical Factors on the Structure of Gluten , Gliadins and Glutenins as Studied with Spectroscopic Methods 2 . Biochemistry and Structure of Gluten Network and Gluten Proteins 3 . Spectroscopic Methods Used in the Study of Gluten Structure 4 . Factors Affecting Structure of Gluten Network , Gliadins and Glutenins 5 . Application of Spectroscopic Methods in Wheat Products Technology*. <https://doi.org/10.1002/jrs.4648>.