

FORMULATION OF BROWNIES COOKIES WITH THE ADDITION OF TEMPE FLOUR AND COFFEE GROUNDS AS FOOD PROCESSING

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Abstract

Brownie cookies are generally made using wheat flour as the main ingredient. Substituting wheat flour with tempeh flour has the potential to increase the nutritional value of the product because tempeh flour has a higher content of protein, essential amino acids, and dietary fiber. Coffee grounds are coffee processing waste that still contain bioactive compounds and fiber so they have the potential to be used as an additive that can affect aroma and sensory characteristics. This study aims to determine the effect of tempeh flour substitution and the addition of coffee grounds on the protein, fiber, carbohydrate content, and organoleptic quality of brownie cookies. The study used an experimental method with a factorial Completely Randomized Design (CRD), consisting of two factors: tempeh flour substitution (30%, 70%, 30%, 70%) and the addition of coffee grounds (6%, 6%, 9%, 9%). The parameters tested included protein content, fiber content, carbohydrate content, and organoleptic tests (color, aroma, taste, and texture). Proximate data were analyzed using ANOVA, while organoleptic data were analyzed using the Kruskal-Wallis test.

Keywords: *brownie cookies; tempeh flour; coffee grounds; protein; fiber; carbohydrates; organoleptic*

INTRODUCTION

The development of brownie products in Indonesia shows increasingly diverse variations over time, both in terms of shape, texture, color, taste, and variations of toppings used to increase consumer appeal. Brownies are known as chocolate-based bakery products with a generally square shape, sweet taste, and have a texture that tends to be soft and dense, so they are popular with various age groups, from children to adults (Putri, 2018). Based on the processing method, brownies are classified into two main types, namely steamed brownies and baked brownies (oven), each of which has different sensory characteristics (Putri, 2018). In general, brownies are made using wheat flour as the main ingredient. Wheat flour is the result of milling wheat grains and is widely used in the food industry, particularly in bread, noodles, and various cakes (Winarno, 2004). However, Indonesia's high dependence on wheat flour remains a problem because the raw material for wheat is entirely imported. This situation has prompted the need to develop food products based on locally sourced ingredients with high nutritional value to reduce dependence on imported food (Suhardjo, 2012).

One local food ingredient that has the potential to be used as a substitute for wheat flour is tempeh flour. Tempeh flour is produced through a process of drying fresh tempeh, which is then ground and sieved to obtain a fine powder. This flour has a relatively high vegetable protein content, so it has the potential to be used as a substitute ingredient in various food products, both wet and dry cakes (Syarif & Halid, 2014). The use of tempeh flour in brownies is expected to not only increase protein content but also support the optimization of the use of local food ingredients that are easily available in Indonesia (Hartati, 2019). Tempeh flour, coffee grounds also have the potential to be used as a functional food additive. Coffee grounds are the solid residue resulting from the process of brewing coffee grounds with hot water, which still contain bioactive compounds such as phenolic compounds that act as natural antioxidants, as well as caffeine in lower amounts than whole coffee grounds (Wijayanti, 2017; Santoso & Minantyo, 2022). Despite their potential nutritional value and unique sensory characteristics, the use of coffee grounds in food products is still relatively limited, and most are still discarded as waste (Yuliana, 2020).

Using tempeh flour as a source of vegetable protein and coffee grounds as a source of natural antioxidants in making brownies could be an innovative alternative in food product development. The combination of these two ingredients is expected to produce brownies with sensory characteristics that remain popular with consumers, while also offering improved nutritional value. Furthermore, the use of coffee grounds is also in line with the concept of sustainable food processing by reducing waste and increasing the added value of by-products from the coffee beverage industry (Haryati, 2021). Therefore, this research was conducted to formulate brownie cookies with the addition of tempeh flour and coffee grounds as a way to utilize local food ingredients and food waste. This research is expected to produce brownie cookies with higher nutritional content, particularly protein and antioxidant compounds, as well as an appealing flavor and aroma. In addition, the results of this research are expected to contribute to the development of local food diversification and support efforts to utilize coffee waste sustainably.

LITERATURE REVIEW

Brownies

Brownies are a chocolate-based cake that has a dense but soft texture, with a relatively dry top surface and a moist inside. This product is dark brown in color and has a distinctive chocolate aroma and flavor (Muliawaty, 2016; Suhardjito, 2006). Brownies are popular among the public because of their delicious taste, soft texture, relatively affordable price, and simple manufacturing process. Based on the processing method, brownies can be divided into two types: steamed brownies and oven-baked brownies. These differences in processing methods affect the moisture content, structure, and texture of the final brownie product (Ismayani, 2007). In general, the nutritional content of brownies per 100 grams includes 466 kcal of energy, 4.9 g of protein, 24.9 g of fat, 58 g of carbohydrates, and 39.1 g of sugar (USDA, 2020).

Cookies

Cookies are a popular snack among a wide range of people. They are generally made from wheat flour, sugar, butter, baking powder, and powdered milk, and have a crispy, dense texture (Mutmainna, 2013; Septiani, 2016). The cookie-making process involves mixing the ingredients, forming the dough, and baking until the desired texture is achieved (Rosida, 2008). Brownie cookies are an innovative blend of brownie and cookie characteristics, resulting in a product with a strong chocolate flavor and a crispier texture than conventional brownies. The nutritional content of brownie cookies per 100 grams includes 502 kcal of energy, 4.5 g of protein, 24.8 g of fat, 67.4 g of carbohydrates, and 5.2 g of dietary fiber (USDA, 2020).

Tempeh Flour

Tempeh flour is a processed product made from fresh tempeh, produced through several stages: slicing, steaming, drying, and grinding to produce a fine powder (Admojo, 2007; Faizah, 2012). Tempeh flour has a relatively high protein content, approximately 37.4%, and contains dietary fiber that is beneficial for health. Tempeh flour as a substitute for wheat flour in food products, both cakes and pastries, has the potential to increase the protein content of the final product. Furthermore, tempeh flour can be an alternative food ingredient for consumers with gluten intolerance (Sunardi, 2002; Oentoro, 2012). The use of tempeh flour in processed food products also supports the utilization of local food ingredients and food diversification (Bintanah *et al.*, 2014).

Coffee grounds

Coffee grounds are solid waste produced from the process of brewing coffee grounds with hot water. Despite their waste status, coffee grounds still contain bioactive compounds such as polyphenols, caffeine, fiber, protein, and antioxidants that have the potential to be used in food products (Wijayanti, 2017; Ramdani & Lestari, 2021). The use of coffee grounds in food products can provide the characteristic color, aroma, and taste of coffee, while increasing the nutritional value of the product. In addition, the use of coffee grounds also contributes to reducing food waste and supports the concept of sustainable food processing (Murthy & Naidu, 2012; Santoso & Minantyo, 2022; Haryati, 2021).

Ingredients for Making Brownies Cookies

a. Flour

Wheat flour functions as a structure and texture former and as a binder for other ingredients in the dough. Medium-protein wheat flour, with a protein content of around 10–11.5 % , is generally used in making brownies and cookies (Astawan, 2009; Sutomo, 2008).

b. Butter

Butter plays a role in providing a distinctive aroma, soft texture, and influences the melting point and crispness of the final product. The quality of the butter really determines the quality of the brownie cookies produced (Wahyuni et al., 1988; Farida et al., 2008).

c. Sugar

Granulated sugar functions as a sweet taste , texture maker, and plays a role in extending the product's shelf life (Sutomo, 2008; Syarbini & Husin, 2013).

d. Egg

Eggs function as structure formers, emulsifying agents, color formers, and enhancers of aroma and flavor of products (Astawan, 2009; Sugiyono et al., 2012).

e. Vanilla Essence

Vanilla essence is used to enhance the aroma of the product without changing the basic taste of brownie cookies, so that it can increase sensory acceptance (Towaha & Heryana, 2012; Wiranto, 2008).

f. Chocolate Bars and Chocolate Powder

Chocolate bars and cocoa powder are the main ingredients that play a role in providing the color, aroma, and distinctive chocolate taste to brownie cookies (Sutomo, 2008; Maulida & Estiasih, 2014).

Test Analysis

a. Analysis of Fiber, Protein, and Carbohydrate Content

This analysis was conducted to determine the nutritional content, quality of ingredients, and energy contribution of the resulting brownie cookies (Abdul et al., 2018; Andri & Pambudi, 2020).

b. Organoleptic Test

Organoleptic testing is used to assess the level of consumer acceptance of a product, including attributes of color, aroma, taste, and texture, involving trained, semi-trained, and untrained panelists (Gusnadi et al., 2021).

c. Effectiveness Test

Effectiveness testing aims to determine the best formulation based on nutritional and sensory parameters. The formulation with the highest score was declared the most effective treatment (Pratiwi & Rahmadhan, 2020; Aminah & Wulandari, 2021).

RESEARCH METHODS

This research is planned to be carried out for one month, namely October to November 2025, at the Food Technology Chemistry Laboratory of the Faculty of Agriculture, Dr. Soetomo University, Surabaya. The research uses a laboratory experimental method to systematically analyze the nutritional content of brownie cookies, including protein, fiber, and carbohydrate levels (Kerlinger, 1973; Wimmer, 2006). The tools used include baking pans, ovens, digital scales, mixers, measuring cups, Kjeldahl flasks, burettes, Erlenmeyer flasks, volumetric pipettes, hot plates, drying ovens, desiccators, furnaces, and other laboratory equipment, while the main ingredients of the research are tempeh flour and coffee grounds, with supporting materials such as wheat flour, butter, granulated sugar, eggs, vanilla essence, cornstarch, chocolate bars, and chocolate powder, as well as chemicals for analysis such as sulfuric acid, sodium hydroxide, and distilled water.

The experimental design used a Completely Randomized Design (CRD) with one factor, namely the concentration of tempeh flour substitution (A) to wheat flour and the addition of coffee grounds (B) at various treatment levels: A1 (30% tempeh, 64% wheat flour, 6% coffee), A2 (70% tempeh, 24% wheat flour, 6% coffee), A3 (30% tempeh, 62% wheat flour, 9% coffee), and A4 (70% tempeh, 21% wheat flour, 9% coffee). Replications were carried out 3 times per treatment, so that 12 experimental units were obtained (Hanafiah, 2000). The stages of making brownie cookies include preparing ingredients according to the formulation, mixing the dough using the mix method and mixing melted ingredients such as butter and chocolate bars, molding and baking at 180°C for 10 minutes, and cooling and storing the samples before being analyzed chemically and organoleptically. Observation variables are divided into chemical variables, namely protein content (%) analyzed using the Kjeldahl method,

fiber content (%) using the acid and base reflux method, and carbohydrate content (%) by difference (Abdul et al., 2018; Andri & Pambudi, 2020; Pratiwi & Hidayat, 2020; Ramdani & Lestari, 2021; Sudarmadji et al., 2007), and organoleptic variables including color, aroma, texture, and taste assessed by ordinary panelists using a hedonic scale of 1–5 (Gusnadi et al., 2021). Data were analyzed using ANOVA with the help of SPSS version 23. If the difference between treatments was significant ($p < 0.05$), further tests were carried out using BNT, BNJ, or Duncan's test depending on the value of the Coefficient of Diversity (Akbar et al., 2022). Meanwhile, non-parametric data from the organoleptic test were analyzed using the Kruskal-Wallis test to determine the effect of treatment on the level of panelist preference.

RESULTS AND DISCUSSION

1. Chemical Test

Protein Content

The results of the protein content test *on brownie cookies* made from tempeh flour and coffee grounds with each different treatment have an effect on the protein content *of brownie cookies*.

Table 1. Average Protein Content Results for Brownies Cookies

Treatment	Fiber Content (%)
F1 (tempeh flour 30%, coffee grounds 6%)	0.79 ^a
F2 (tempeh flour 70, coffee grounds 6%)	1.0 ^a
F3 (30% tempeh flour, 9% coffee grounds)	1.3 ^b
F4 (70% tempeh flour, 9% coffee grounds)	1.45 ^b

Increasing the proportion of tempeh flour in the brownie cookie formulation has been shown to increase the product's protein content, while decreasing the proportion of coffee grounds tends to decrease the resulting protein content. The highest protein content was obtained in the treatment with a 70% tempeh flour substitution and 9% coffee grounds addition, reaching 11.24%. Conversely, the lowest protein content of 8.54% was found in the treatment with a lower proportion of tempeh flour. Increase in protein content is closely related to the characteristics of the raw materials used. Tempeh flour is known to have a relatively high protein content, around 18.3%, while coffee grounds also contain protein, albeit in lower amounts, around 13.5% (Omosebi, 2013; Putri & Hidayat, 2019). Therefore, the higher the proportion of tempeh flour used, the greater the protein contribution to the final product.

The results of this study align with the findings of Wulandari et al. (2018) on biscuit products, which reported that increasing the use of tempeh flour significantly positively affected the product's protein content. These findings indicate that tempeh flour has the potential to be a source of vegetable protein in the development of wheat flour-based food products. Overall, the protein content of the brownie cookies produced in this study still meets the biscuit quality standards based on SNI 2973:1992, which is a minimum of 0.9%. This indicates that brownie cookies with tempeh flour substitution and coffee grounds addition are not only nutritionally sound but also have the potential to be developed as a functional food product with higher protein value.

Fiber Content

The results of the fiber content test for dahlia cookies made from tempeh flour and coffee grounds with each different treatment had an effect on the fiber content of dahlia cookies.

Table 2. Average fiber content of brownie cookies

Treatment	Fiber Content (%)
F1 (tempeh flour 30%, coffee grounds 6%)	0.79 ^a
F2 (tempeh flour 70, coffee grounds 6%)	1.0 ^a
F3 (30% tempeh flour, 9% coffee grounds)	1.3 ^b
F4 (70% tempeh flour, 9% coffee grounds)	1.45 ^b

The analysis results showed that increasing the proportion of tempeh flour and coffee grounds in the brownie cookie formulation had a positive effect on the product's fiber content. The higher the use of tempeh flour

and coffee grounds, the resulting fiber content tended to increase. The highest fiber content was obtained in the treatment with a 70% tempeh flour substitution and 9% coffee grounds addition, namely 1.45 % . Conversely, the lowest fiber content of 0.79 % was found in the treatment with a lower proportion of tempeh flour. The increase in fiber content is related to the characteristics of the raw materials used. Tempeh flour is known to have an average fiber content of 7.2 % , while coffee grounds contain much higher fiber, around 45.3% (Maulina, 2015; Putri & Hidayat, 2020). Therefore, the combination of increasing the proportions of these two ingredients significantly contributes to the increase in fiber content of brownie cookies.

The results of this study align with the findings of Wulandari *et al.* (2019) on biscuit products, which found that increasing the use of tempeh flour significantly increased the fiber content of the product. This suggests that tempeh flour has the potential to be a source of dietary fiber in the development of bakery products based on wheat flour as a substitute. Overall, the fiber content of the brownie cookies produced in this study met the biscuit quality requirements based on SNI 2973:1992, which is a minimum of 0.5 % . Therefore, brownie cookies with the addition of tempeh flour and coffee grounds not only have better nutritional value but also have the potential to be developed as a high-fiber food product.

Carbohydrate Content

H test results Carbohydrate *brownie cookies* made from tempeh flour and coffee grounds with each different treatment having an effect on the carbohydrate content of *brownie cookies* .

Table 3. Average carbohydrate content of brownie cookies

Treatment	Carbohydrate Content (%)
F1 (tempeh flour 30%, coffee grounds 6%)	54.45 ^a
F2 (tempeh flour 70, coffee grounds 6%)	52.66 ^a
F3 (30% tempeh flour, 9% coffee grounds)	51.26 ^b
F4 (70% tempeh flour, 9% coffee grounds)	50.74 ^b

The results showed that varying the proportions of tempeh flour and coffee grounds in the brownie cookie formulation significantly affected the protein, fiber, and carbohydrate content of the product. Increasing the proportion of tempeh flour tended to increase protein and fiber content, while decreasing carbohydrate content. Conversely, the addition of coffee grounds contributed to an increase in fiber content but tended to decrease the protein and carbohydrate content of the product. The highest protein content was obtained in the formulation with 70% tempeh flour substitution and 9% coffee grounds addition, which was 11.24%, while the lowest protein content of 8.54% was found in the formulation with a lower proportion of tempeh flour. A similar pattern was also seen in the fiber content, where the formulation with 70% tempeh flour and 9% coffee grounds produced the highest fiber content of 1.45 % , while the lowest fiber content of 0.79% was obtained in the formulation with the lower use of tempeh flour.

Conversely, the highest carbohydrate content, at 54.45%, was found in the formulation with a low proportion of tempeh flour, while the lowest content, at 50.74%, was found in the formulation with 70% tempeh flour and 9% coffee grounds. This decrease in carbohydrate content was related to the increase in protein and fiber fractions due to the substitution of tempeh flour and the addition of coffee grounds. The results of this study align with previous findings that tempeh flour is a high source of protein and fiber (Omosebi, 2013; Maulina, 2015; Wulandari *et al.*, 2018; Wulandari *et al.*, 2019). Furthermore, coffee grounds are known to contain protein, fiber, and carbohydrates, which contribute to the nutritional composition of the product (Putri & Hidayat, 2019; Putri & Hidayat, 2020). A decrease in carbohydrate content with increasing use of tempeh flour was also reported by Hermawan *et al.* (2020) and Wulandari *et al.* (2018) on biscuit products. Overall, the protein, fiber, and carbohydrate content of the brownie cookies produced in this study still meets the biscuit quality requirements based on SNI 2973:1992, namely a minimum protein content of 0.9 % , a minimum fiber content of 0.5%, and carbohydrates in accordance with the established standards.

2. Organoleptic Test

Color

The results of the color content test of *brownie cookies* made from tempeh flour and coffee grounds with each different treatment have an effect on the color content of *brownie cookies*.

Table 4. Average results of *brownie cookie* color content

Treatment	Color Content (%)
F1 (tempeh flour 30%, coffee grounds 6%)	5.6 ^a
F2 (tempeh flour 70, coffee grounds 6%)	5.5 ^a
F3 (30% tempeh flour, 9% coffee grounds)	5.1 ^b
F4 (70% tempeh flour, 9% coffee grounds)	4.2 ^b

The results showed that variations in the proportion of tempeh flour and coffee grounds did not significantly affect the color attributes of brownie cookies ($p > 0.05$) based on the BNJ test at the 5% level. However, the data pattern showed a tendency for changes in color intensity between treatments. The highest color value was obtained in the formulation using 30% tempeh flour and 6% coffee grounds, while the lowest color value was found in the formulation using 70% tempeh flour and 12% coffee grounds. Using a lower proportion of tempeh flour (30%) tends to produce a brighter product color than using 70% tempeh flour. Conversely, increasing the addition of coffee grounds to 12% results in a darker brownie color. This suggests that the combination of tempeh flour and coffee grounds plays a role in influencing the product's color intensity, although the effect is not strong enough to produce a statistically significant difference. These results align with research by Hermawan et al. (2020), which reported that tempeh flour has a color value of around 3.85, and research by Putri and Hidayat (2019), which stated that coffee grounds have a dark color with a value of around 4.25. Furthermore, Wulandari et al. (2018) reported that increasing the proportion of coffee grounds in biscuit products tends to produce a darker brown color and is generally still acceptable to panelists.

Flavor

The results of the taste test of *brownie cookies* made from tempeh flour and coffee grounds with each different treatment have an effect on the taste of *brownie cookies*.

Table 5. Average results of *brownie cookie* flavor levels

Treatment	Flavor Level (%)
F1 (tempeh flour 30%, coffee grounds 6%)	5.1 ^a
F2 (tempeh flour 70, coffee grounds 6%)	5.2 ^a
F3 (30% tempeh flour, 9% coffee grounds)	5.1 ^b
F4 (70% tempeh flour, 9% coffee grounds)	4.1 ^b

The results showed that the combination of tempeh flour and coffee grounds had a significant effect on the level of taste acceptance of brownie cookies. Based on the results of the analysis of variance, there was a significant difference between treatments ($p < 0.05$). The highest taste preference value was obtained in the formulation with 70% tempeh flour substitution and 6% coffee grounds addition, with an average value of 5.2. Conversely, the lowest taste preference value of 4.1 was found in the formulation with 70% tempeh flour substitution and 9% coffee grounds addition. These results indicate that the use of tempeh flour at up to 70% concentration was acceptable to panelists, especially at relatively low levels of coffee grounds. However, increasing the coffee grounds concentration to higher concentrations tended to decrease panelists' preference for the brownie cookie flavor. This is thought to be related to the emergence of a bitter taste or aftertaste typical of coffee which becomes stronger as the proportion of coffee grounds increases. These findings align with research by Hermawan et al. (2020), which reported that tempeh flour had an average taste acceptance score of 3.90, categorized as favorable, and research by Putri and Hidayat (2019), which found that coffee grounds had a taste score of around 4.30, still considered favorable. Furthermore, Wulandari et al. (2018) reported that adding coffee grounds to biscuit products can strengthen the taste and aroma of coffee, thereby increasing panelists' preference, but if used in excessive amounts, it can actually reduce the level of sensory acceptance.

Texture

The results of the aroma test of *brownie cookies* made from tempeh flour and coffee grounds with each different treatment have an effect on the aroma level of *brownie cookies*.

Table 6. Average results of brownie cookie texture levels

Treatment	Texture Content (%)
F1 (tempeh flour 30%, coffee grounds 6%)	3.5 ^a
F2 (tempeh flour 70, coffee grounds 6%)	4.9 ^a
F3 (30% tempeh flour, 9% coffee grounds)	3.9 ^b
F4 (70% tempeh flour, 9% coffee grounds)	3.3 ^b

The results of the analysis of variance showed that there were significant differences between treatments on the texture attributes of brownie cookies ($p < 0.05$). The highest texture preference value was obtained in the formulation with 70% tempeh flour substitution and 6% coffee grounds addition, with an average value of 4.9. Conversely, the lowest texture preference value of 3.3 was found in the formulation with 70% tempeh flour substitution and 9% coffee grounds addition. These results indicate that using up to 70% tempeh flour can still produce a brownie cookie texture that panelists prefer when combined with low concentrations of coffee grounds. However, increasing the proportion of coffee grounds to 9% tends to significantly decrease texture acceptance. This decrease is thought to be caused by the high content of coarse fiber in coffee grounds which can increase density and give the impression of a rougher texture to the product. These findings align with research by Hermawan et al. (2020) which reported that tempeh flour had an average texture acceptance score of 3.95, and research by Putri and Hidayat (2019) which stated that coffee grounds had a texture score of around 4.10 and were categorized as preferred. Furthermore, Wulandari et al. (2018) reported that increasing the use of tempeh flour in biscuit products resulted in a crispier texture, while the addition of large amounts of coffee grounds tended to increase density and produce a slightly rougher texture.

Aroma

The results of the aroma test of *brownie cookies* made from tempeh flour and coffee grounds with each different treatment have an effect on the aroma level of *brownie cookies*.

Table 7. Average results of aroma levels of brownie cookies

Treatment	Aroma Content(%)
F1 (tempeh flour 30%, coffee grounds 6%)	4.8 ^a
F2 (tempeh flour 70, coffee grounds 6%)	5.0 ^a
F3 (30% tempeh flour, 9% coffee grounds)	5.0 ^a
F4 (70% tempeh flour, 9% coffee grounds)	4.2 ^a

The results of the analysis of variance showed that there was no statistically significant difference between treatments in the aroma attributes of brownie cookies ($p > 0.05$). However, observations of the mean values indicated a tendency for changes in aroma scores due to variations in the proportion of tempeh flour and coffee grounds. Increasing the use of tempeh flour tended to decrease the aroma score, while the addition of coffee grounds up to 9% showed a tendency to increase the intensity of the distinctive coffee aroma. The highest aroma score was obtained from the combination of 70% tempeh flour substitution with the addition of 6% coffee grounds, with an average value of 5.0. Conversely, the lowest aroma score of 4.2 was found in the combination of 70% tempeh flour and 9% coffee grounds. This indicates that the use of tempeh flour in high proportions is still acceptable to panelists in terms of aroma, especially when combined with the addition of coffee grounds at a moderate level. The distinctive aroma produced comes from volatile compounds in tempeh flour, including fermented soybean aroma, and coffee aroma from coffee grounds, which still contain aromatic compounds. This finding aligns with research by Hermawan et al. (2020), which found that tempeh flour has a distinctive fermented aroma that is acceptable to panelists, and research by Putri and Hidayat (2019), which reported that coffee grounds can impart a desirable coffee aroma. Furthermore, Wulandari et al. (2018) also stated that adding coffee grounds to biscuit products can increase the aroma of coffee, but at high concentrations it tends to reduce the level of panelists' preference.

3. Determination of Best Treatment (effectiveness test)

Effectiveness testing was used to determine the best and most preferred treatment. Based on the effectiveness test for all research parameters, including chemical and organoleptic tests, as shown in Table 4.8, the best treatment achieved the highest yield (NH) value. The average NH for all effectiveness test research parameters can be seen in Table 8 below.

Table 8. Effectiveness Test

Parameter	Yield Value (NH) of Treatment			
	F1	F2	F3	F4
Protein	0.00	0.05	0.13	0.15
Fiber	0.00	0.01	0.11	0.15
Carbohydrate	0.15	0.11	0.02	0.00
Color	0.11	0.06	0.06	0.06
Flavor	0.08	0.00	0.08	0.08
Texture	0.08	0.08	0.08	0.08
Aroma	0.00	0.00	0.13	0.13
TOTAL	0.42	0.33	0.59	0.65

Based on the results of the effectiveness test using the weighted index method, the yield value (NH) was obtained for each treatment (F1, F2, F3, and F4). Treatment F4 showed the highest effectiveness value of 0.65 , followed by F3 at 0.59, F1 at 0.42, and F2 at 0.33. The high effectiveness value in treatment F4 indicates that the formulation provides the most optimal combination of chemical and sensory parameters. The high effectiveness score in the F4 treatment was influenced by the relatively higher protein and fiber content , as well as the aroma attributes preferred by the panelists. Furthermore, the carbohydrate parameter in this study used the "lower is better" criterion, so the lower carbohydrate content in the F4 treatment also contributed positively to the total effectiveness score. In contrast, treatment F2 demonstrated the lowest effectiveness value. This was due to the lower contribution of several sensory parameters, particularly taste and aroma, as well as lower protein and fiber levels compared to the other treatments. Based on the results of the effectiveness test, it can be concluded that the F4 treatment is the best formulation, because it is able to produce an optimal balance between the chemical quality and sensory quality of brownie cookies.

CONCLUSION

Based on the results of research on the effect of tempeh flour substitution and the addition of coffee grounds on the nutritional content and organoleptic quality of brownie cookies, it was found that the treatment formulation had a significant effect on the levels of protein, fiber, carbohydrates, as well as sensory attributes such as color, aroma, taste, and texture of the product. Substitution of wheat flour with tempeh flour increased the protein and dietary fiber content while reducing the carbohydrate content, thus potentially increasing the nutritional value of brownie cookies (Omosebi, 2013; Putri & Hidayat, 2019; Wulandari et al., 2018). The addition of coffee grounds contributed to the distinctive aroma of coffee, but high concentrations tended to reduce panelists' preference for taste and texture (Hermawan et al., 2020; Putri & Hidayat, 2019; Wulandari et al., 2018). The formulation combining tempeh flour and coffee grounds produced brownie cookies that were acceptable to panelists, with an effectiveness value that showed a balance between nutritional quality and organoleptic quality. Analysis of the effectiveness index and NH value showed that formulation F4 (70% tempeh flour substitution and 9% coffee grounds) was the best formulation with the highest NH value of 0.65 , so it was recommended as a superior formulation for the development of functional brownie cookies products based on local ingredients and food waste.

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