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THE EFFECT OF TEMPE FLOUR SUBSTITUTION AND THE ADDITION OF COFFEE GROUNDS ON PROTEIN, FIBER, CARBOHYDRATE CONTENT, AND ORGANOLEPTIC QUALITY OF DAHLIA COOKIES

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Abstract

Dahlia cookies are a food product generally made using wheat flour as the main ingredient and sugar as a flavor enhancer. Tempeh flour can be used as a substitute for wheat flour because it has a higher protein content, as well as containing essential amino acids and dietary fiber. Coffee grounds are coffee processing waste that still contains bioactive compounds and fiber so it has the potential to be used as an additional ingredient that can contribute to 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 dahlia cookies. This 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%, 12%, 12%). The parameters tested included protein content, fiber content, carbohydrate content, and organoleptic tests (color, aroma, taste, and texture). The data from the proximate content analysis were analyzed using ANOVA, while the organoleptic data were analyzed using the Kruskal-Wallis test.

Keywords: dahlia cookies; tempeh flour; coffee grounds; protein; fiber; carbohydrates; organoleptic.

INTRODUCTION

sweet taste , and relatively simple processing. This product is included in the *bakery group* with a fairly high fat and sugar content, and does not require a significant dough volume expansion process during processing (Mutmainna, 2013; Septiani, 2016). Based on the Indonesian National Standard SNI 01-2973-1992, cookies are classified as a type of biscuit with soft dough, high fat content , and a dense and crunchy texture (BSN, 1992). Tempeh is a fermented soybean product known as a source of vegetable protein with high nutritional value and contains various bioactive compounds with potential health benefits. Processing tempeh into flour opens up opportunities for wider use as a substitute ingredient in various food products, including bakery products, with the aim of increasing the protein content and functional value of the product (Astawan, 2010; Pratiwi, 2017).

Substituting wheat flour for tempeh flour in dahlia cookies is expected to increase the product's nutritional value, particularly its protein content. However, changes in the raw material formulation have the potential to affect organoleptic characteristics, including color, aroma, taste, and texture, which play a crucial role in determining consumer acceptance of the resulting product (La Ode, 2020). tempeh flour , coffee grounds have the potential to be used as a food additive because they retain the distinctive aroma and flavor of coffee, as well as bioactive compounds such as caffeine and dietary fiber. However, the use of coffee grounds in food products is still relatively limited and requires further study regarding its impact on product quality (Santoso and Minantyo, 2022). Therefore, research on the substitution of tempeh flour and the addition of coffee grounds in dahlia cookies is necessary to evaluate their effects on the nutritional content and organoleptic characteristics of the product.

The objectives to be achieved in this research are as follows:

a. Analyzing the effect of tempeh flour and the addition of coffee grounds with different concentrations on the levels of protein, fiber, carbohydrates and organoleptic quality of dahlia cookies.
b. Determining the concentration of tempeh flour and the addition of coffee grounds that provide the best results based on the levels of protein, fiber, carbohydrates and organoleptic quality of dahlia cookies.

LITERATURE REVIEW

Cookies

Cookies are a snack food product with a high consumption rate among various segments of society. They are popular for their distinctive sensory characteristics, particularly their crunchy texture and sweet flavor . Generally, cookies are made from wheat flour, sugar, butter, and other additives, resulting in a product with a relatively high fat and sugar content. In addition, the cookie processing process does not require a large amount of dough development stage, unlike several other *bakery products* (Mutmainna, 2013; Septiani, 2016). Based on the Indonesian National Standard SNI 01-2973-1992, cookies are classified as a type of biscuit made from soft dough with a high fat content and have a dense and crunchy texture when broken (BSN, 1992). The process of making cookies generally includes the stages of mixing ingredients, forming the dough, and baking, each of which plays an important role in determining the physical, chemical, and sensory characteristics of the final product (Rosida, 2008).

Tempeh Flour

Tempeh flour is a processed product made from fresh tempeh through a series of processes including slicing, steaming, drying, and grinding to form a flour (Admojo, 2007). This process aims to extend the shelf life and facilitate the use of tempeh as a raw material in various food products. Tempeh flour is known to have a higher protein and fiber content than wheat flour, so it has the potential to be used as a substitute in *bakery products* to increase nutritional value, especially the vegetable protein content (Faizah, 2012). In addition to its nutritional benefits, tempeh flour can also be used as a gluten-free alternative, offering potential for development in certain food products aimed at consumers with special needs. The flour form also offers advantages in terms of shelf life and ease of formulation compared to fresh tempeh (Sunardi, 2002; Oentoro, 2012).

Coffee grounds

Coffee grounds are solid waste produced from the coffee bean brewing process and still contain various bioactive compounds, such as polyphenols, caffeine, and dietary fiber. Their high crude fiber and *antioxidant* content makes them potentially useful as a *functional food ingredient* (Wijayanti, 2017; Roussos *et al.* , 2021). The use of coffee grounds in food products, especially cookies, can contribute to improving the distinctive aroma of coffee, the color of the product, and its nutritional value. In addition, the use of coffee grounds as a food additive also supports the concept of sustainable food processing by reducing waste and increasing the added value of by-products of the coffee beverage industry. However, the use of coffee grounds in food products is still limited, so further studies are needed regarding its effect on the *sensory quality* and chemical characteristics of the product (Santoso & Minantyo, 2022; Haryati, 2021).

Ingredients for Making Dahlia Cookies

The main ingredients in making dahlia cookies include wheat flour which acts as a source of starch and gluten in forming the dough structure (Sukoco & Bahar, 2013). Butter is used as a source of fat which functions to provide a distinctive aroma, enhance the taste, and contribute to the formation of a crispy texture in the final product (Faridah et al., 2008). Fine sugar functions as a sweetener as well as a flavor and color former through a browning reaction during baking (Mudjajanto & Yulianti, 2004). Eggs act as emulsifiers and form the dough structure, while powdered milk contributes to the product's aroma and color through the Maillard reaction. In addition to the main ingredients, additional ingredients such as cornstarch, *vanilla essence* , and *chocolate chips* are used to improve the texture, aroma, and appearance of the final product, thereby increasing consumer appeal (Rukmana, 1997; Towaha & Heryana, 2012; Ransom, 2021).

Test Analysis

The chemical analysis conducted in this study included testing for fiber, protein, and carbohydrate levels . Crude fiber analysis aimed to determine the residual insoluble fiber content in the product using acid and base hydrolysis methods (Abdul et al., 2018). Protein analysis was conducted to evaluate the quality and nutritional value of the resulting food product (Andri & Pambudi, 2020). Meanwhile, carbohydrate levels are determined indirectly using the *by difference method* , namely by calculating the difference between the total components of food and other components that have been analyzed, considering that carbohydrates cannot be measured specifically (Sudarmadji et al., 2007; Pratiwi & Hidayat, 2020).

Organoleptic Test

Organoleptic testing is a method of evaluating the sensory quality of a product based on the response of the five human senses, including the attributes of color, aroma, taste, and texture. The assessment was carried out by trained and untrained panelists using a hedonic scale to determine the level of consumer preference and acceptance of the dahlia cookie products produced (Gusnadi et al., 2021).

Effectiveness Test

Effectiveness testing is used to determine the best treatment based on a combination of nutritional value and panelist preference levels. The treatment with the highest value is considered the most optimal formulation and can then be used as a basis for developing dahlia cookie products on a wider production scale (Pratiwi & Rahmadhan, 2020; Aprilia & Hidayat, 2021).

RESEARCH METHODS

This research was conducted in October–November 2025 at the Food Technology Chemistry Laboratory, Faculty of Agriculture, Dr. Soetomo University, Surabaya. The research used a laboratory experimental method aimed at examining the effect of tempeh flour substitution and coffee grounds addition on the nutritional content and organoleptic quality of dahlia cookies. The experiment was arranged using a Completely Randomized Design (CRD) with four treatment combinations and three replications, resulting in 12 experimental units, with homogeneously controlled research conditions (Kerlinger, 1973; Hanafiah, 2009). The dahlia cookies were made through several stages, namely weighing the ingredients, mixing the dough, molding, baking at 130 °C for 20 minutes, and cooling before analysis. The variables observed included protein content analyzed using the Kjeldahl method, fiber content using the acid and base reflux method, and carbohydrate content calculated using the *by difference method* . In addition, organoleptic tests were conducted on the attributes of color, aroma, taste, and texture using a hedonic scale by untrained panelists (Sudarmadji et al., 2007). Chemical analysis data were analyzed statistically using the ANOVA test and further tests if there were significant differences, while organoleptic test data were analyzed using the Kruskal–Wallis test (Akbar et al., 2022).

RESULTS AND DISCUSSION

1. Chemical Test

Protein Content

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

Table 1. Average protein content of dahlia cookies

Treatment	Protein Content (%)
F1 (30% Tempeh Flour, 6% Coffee Grounds)	9.46 [a]
F2 (70% Tempeh Flour, 6% Coffee Grounds)	12.42 [a]
F3 (Tempeh Flour 30%, Coffee Grounds 12%)	10.65 [b]
F4 (70% Tempeh Flour, 12% Coffee Grounds)	12.97 [b]

The results of the analysis of variance showed a significance value of < 0.05 , indicating that the substitution of tempeh flour and the addition of coffee grounds had a significant effect on the protein content of dahlia cookies. An increase in the proportion of tempeh flour tended to be followed by an increase in the protein content of the product, while a decrease in the proportion of coffee grounds correlated with a decrease in the resulting protein content. The highest protein content was obtained in the F4 treatment at 12.97 % , while the lowest protein content was found in the F1 treatment at 9.46%. The formulation using 70% tempeh flour and the addition of 12% coffee grounds was proven to be able to optimally increase protein levels. This increase is supported by the high protein content in tempeh flour, which is 18.3 % (Omosebi, 2013), and the protein content of coffee grounds at 13.5% (Putri & Hidayat, 2019). The results of this study align with the findings of Wulandari et al. (2018), who stated that increasing the proportion of tempeh flour in biscuits significantly increased the protein content. Furthermore, the protein content of the dahlia cookies produced in all treatments met the protein quality requirements for biscuits based on SNI 2973:1992.

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 dahlia cookies

Treatment	Fiber Content (%)
F1 (30% Tempeh Flour, 6% Coffee Grounds)	0.4 [a]
F2 (70% Tempeh Flour, 6% Coffee Grounds)	1.14 [a]
F3 (Tempe Flour 30%, Coffee Grounds 12%)	0.5 [b]
F4 (70% Tempeh Flour, 12% Coffee Grounds)	1.42 [b]

The results of the analysis of variance showed a significance value of < 0.05 , indicating that the substitution of tempeh flour and the addition of coffee grounds had a significant effect on the fiber content of dahlia cookies. Increasing the proportion of tempeh flour and coffee grounds tended to be followed by an increase in the fiber content of the resulting product. The highest fiber content was obtained in treatment F4 at 1.42 % , while the lowest fiber content was found in treatment F1 at 0.40%. This indicates that the use of 70% tempeh flour and the addition of 12% coffee grounds can provide an optimal increase in fiber content. This increase in fiber content is supported by the relatively high fiber content in tempeh flour, which is 7.2 % (Maulina, 2015), and the fiber content of coffee grounds which reaches 45.3% (Putri & Hidayat, 2020). The results of this study align with those of Wulandari et al. (2019), who stated that increasing the use of tempeh flour in biscuits significantly increased fiber content. Furthermore, the fiber content of dahlia cookies produced in all treatments met the quality requirements based on SNI 2973:1992.

Carbohydrate Content

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

Table 3. Average carbohydrate content of dahlia cookies

Treatment	Carbohydrate Content (%)
F1 (tempeh flour 30%, coffee grounds 6%)	65.14 [a]
F2 (70% tempeh flour, 6% coffee grounds)	61.45 [a]
F3 (30% tempeh flour, 12% coffee grounds)	63.84 [b]
F4 (70% tempeh flour, 12% coffee grounds)	60.39 [b]

The results of the analysis of variance showed a significance value of < 0.05 , indicating that the substitution of tempeh flour and the addition of coffee grounds had a significant effect on the carbohydrate content of dahlia cookies. Increasing the proportion of tempeh flour and coffee grounds tended to be followed by a decrease in the carbohydrate content of the resulting product. The highest carbohydrate content was found in treatment F1 at 65.14 % , while the lowest content was found in treatment F4 at 60.39%. This indicates that the use of 70% tempeh flour and the addition of 12% coffee grounds resulted in the most significant reduction in carbohydrate content. This decrease was supported by the relatively lower carbohydrate content of tempeh flour, which was 26.2 % (Hermawan et al., 2020), and the carbohydrate content of coffee grounds, which was 58.1% (Putri & Hidayat, 2019). The results of this study align with those of Wulandari et al. (2018), who stated that increasing the use of tempeh flour in biscuits significantly reduced the carbohydrate content. Furthermore, the carbohydrate content of dahlia cookies produced in all treatments still met the quality requirements based on SNI 2973:1992.

2. Organoleptic Test

Color

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

Table 4. Average results of dahlia cookie color content

Treatment	Color Content (%)
F1 (tempeh flour 30%, coffee grounds 6%)	4.8 [a]
F2 (70% tempeh flour, 6% coffee grounds)	4.4 [a]
F3 (30% tempeh flour, 12% coffee grounds)	4.6 [a]
F4 (70% tempeh flour, 12% coffee grounds)	4.5 [a]

The results of the analysis of variance showed a significance value of > 0.05 , which indicated that there was no significant difference between treatments on the color attributes of dahlia cookies. However, the results of the panelists' assessments showed a tendency for differences in color values, where the highest value was obtained in the F1 treatment at 4.8 , while the lowest value was found in the F2 treatment at 4.4. Using 30% tempeh flour tends to produce a lighter cookie color than using 70% tempeh flour. Conversely, adding 12% coffee grounds produces a darker product color than adding 6%. This indicates that the combination of tempeh flour and coffee grounds influences the color intensity of dahlia cookies, although this effect is not statistically significant. This finding aligns with the research of Hermawan et al. (2020), who reported that tempeh flour had a color score of 3.85, which was in the preferred category. Furthermore, Putri and Hidayat (2019) stated that the color of coffee grounds was in the preferred category among panelists. Research by Wulandari et al. (2018) also showed that increasing the use of coffee grounds in biscuit products can produce a darker brown color and tends to be preferred by panelists.

Flavor

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

Table 5. Average results of the taste levels of dahlia cookies

Treatment	Flavor Level (%)
F1 (tempeh flour 30%, coffee grounds 6%)	3.8 [a]
F2 (70% tempeh flour, 6% coffee grounds)	3.4 [a]
F3 (30% tempeh flour, 12% coffee grounds)	4.6 [b]
F4 (70% tempeh flour, 12% coffee grounds)	3.2 [b]

The results of the analysis of variance showed a significance value of < 0.05 , which indicated that the substitution of tempeh flour and the addition of coffee grounds had a significant effect on the taste attributes of dahlia cookies. The results of the panelists' assessment showed that the highest taste score was obtained in treatment F3 at 4.6 , while the lowest score was in treatment F4 at 3.2. Increasing the use of tempeh flour by 70% tended to decrease panelists' preference for the product's flavor, possibly due to the dominant tempeh flavor. Conversely, adding 12% coffee grounds actually increased panelists' preference for the dahlia cookie flavor, imparting a distinctive and stronger coffee flavor. These results align with research by Hermawan et al. (2020) which reported that tempeh flour's taste preference score was in the preferred category with a score of 3.90 . Furthermore, Putri and Hidayat (2019) reported that coffee grounds had a taste preference score of 4.30 in the preferred category. Research by Wulandari et al. (2018) also showed that increasing the use of coffee grounds in biscuit products resulted in a more distinctive taste with a coffee aroma, thus tending to be more preferred by panelists.

Texture

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

Table 6. Average results of the texture content of dahlia cookies

Treatment	Texture Content (%)
F1 (tempeh flour 30%, coffee grounds 6%)	4.4 [a]
F2 (70% tempeh flour, 6% coffee grounds)	4.1 [a]
F3 (30% tempeh flour, 12% coffee grounds)	4.9 [b]
F4 (70% tempeh flour, 12% coffee grounds)	4 [b]

The results of the analysis of variance showed a significance value of < 0.05 , which indicated that the substitution of tempeh flour and the addition of coffee grounds had a significant effect on the texture attributes of dahlia cookies. The results of the panelists' assessment showed that the highest texture score was obtained in treatment F3 at 4.9 , while the lowest score was in treatment F4 at 4.0. Increasing the use of tempeh flour to 70% tended to decrease panelists' preference for the product's texture, which is thought to be related to reduced gluten formation, resulting in a less crispy texture. Conversely, adding 12% coffee grounds actually increased the product's cohesiveness and density, although to some extent, it resulted in a denser and slightly rougher texture. This finding aligns with the research of Hermawan et al. (2020) who reported that the preferred texture of tempeh flour was 3.95, and the preferred texture of coffee grounds was 4.10 (Putri & Hidayat, 2019). Furthermore, Wulandari et al. (2018) stated that increasing the use of tempeh flour in biscuits resulted in a crispier texture, while the addition of coffee grounds tended to result in a denser and slightly rougher texture.

Aroma

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

Table 7. Average results of the aroma content of dahlia cookies

Treatment	Aroma Content (%)
F1 (tempeh flour 30%, coffee grounds 6%)	4.7 [a]
F2 (70% tempeh flour, 6% coffee grounds)	3.8 [a]
F3 (30% tempeh flour, 12% coffee grounds)	4.8 [a]
F4 (70% tempeh flour, 12% coffee grounds)	4.3 [a]

The results of the analysis of variance showed a significance value > 0.05 , which indicated that the use of tempeh flour and the addition of coffee grounds did not provide a significant difference between treatments on the aroma attributes of dahlia cookies. However, the results of the panelists' assessments showed a tendency for differences in the level of aroma preference between treatments. The highest aroma score was obtained in treatment F3 at 4.8 , while the lowest score was in treatment F2 at 3.8. tempeh flour tended to lower the aroma score, presumably due to the increasingly dominant aroma of fermented soybeans. Conversely, the addition of 12% coffee grounds tended to increase the product's aroma intensity by imparting a stronger coffee aroma, although this increase did not demonstrate statistical significance. These results align with research by Hermawan et al. (2020) which reported that the aroma preference value for tempeh flour was in the preferred category with a score of 3.85 . Furthermore, Putri and Hidayat (2019) stated that coffee grounds had an aroma preference value of 4.20 in the preferred category. Research by Wulandari et al. (2018) also showed that the use of tempeh flour in biscuit products produced a distinctive fermented soybean aroma, while the addition of coffee grounds could strengthen the coffee aroma, which tended to be preferred by panelists.

3. Determination of Best Treatment (effectiveness test)

Effectiveness testing is used to determine the best and most preferred treatment. Based on the effectiveness test on all research parameters including chemical tests and organoleptic tests which can be seen in table 4.8, it shows that the best treatment obtained the highest yield value (NH). The average NH of all research parameters for the effectiveness test 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	0.00	0.08	0.08	0.08
Aroma	0.00	0.00	0.13	0.13
TOTAL	0.41	0.30	0.59	0.67

Based on the results of the effectiveness test using the weighted index method, it was found that the F4 treatment had the highest total effectiveness value, which was 0.64, followed by the F3 treatment at 0.59, F1 at 0.41, and F2 at 0.30. This effectiveness test was carried out by considering several parameters, including protein, fiber, and carbohydrate levels , as well as organoleptic attributes consisting of color, taste, texture, and aroma, with weighting adjusted based on the level of importance of each parameter. The high effectiveness score for the F4 treatment was influenced by its relatively higher protein and fiber content compared to the other treatments, as well as its aroma, which was highly favored by the panelists. Furthermore, the lower carbohydrate content in the F4 treatment contributed positively to the effectiveness score, considering that the carbohydrate parameter used the "lower is better" assessment criterion. In contrast, treatment F2 demonstrated the lowest effectiveness value, due to the low contribution of several sensory parameters, particularly taste and aroma, as well as relatively lower protein and fiber levels . Therefore, treatment F4 was considered the best treatment because it produced an optimal combination of chemical and sensory qualities of dahlia cookies.

CONCLUSION

This study shows that the substitution of tempeh flour and the addition of coffee grounds significantly impacted the nutritional content and organoleptic quality of dahlia cookies. Increasing the concentration of tempeh flour to 70% increased the protein content, while the addition of coffee grounds to 12% enhanced the aroma and color of the cookies. Formulation F4 obtained the highest score in the organoleptic test, indicating that panelists liked the aroma, taste, and crunchy texture of the cookies. An effectiveness analysis that considered the balance between nutritional content and sensory quality showed that the combination of tempeh flour and coffee grounds can produce functional cookies that are high in nutritional value, sensorially appealing, and have the potential to be developed as an alternative environmentally friendly raw material.

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