Characteristics of Breadfruit-Wheat Composite Flour Cookies with Mung Bean Flour: A Study of Flour Proportions

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ABSTRACT

The study's goal was to determine the characteristics of cookies produced using flour made from mung beans added to breadfruit-wheat composite flour. It is anticipated that processing breadfruit flour as a local raw material and turning it into cookie dough will lessen reliance on imported wheat for wheat flour. Wheat flour is currently the primary ingredient used to make cookies, and its use has increased in tandem with the rise in the use of processed goods. The research employed mung bean flour for composite flour to boost the protein level of the cookies and improve the quality of the cookies produced. Results from studies employing a 4 (four) treatment level Randomized Block Design revealed statistically significant differences across all parameters. Taste, color, aroma, texture, The water content, ash content, fat content, protein content, and carbohydrate content were the factors used in this investigation. As a consequence of the choice analysis, treatment P4 (70% breadfruit-wheat composite flour: 30% mung bean flour) has the highest expected value, measuring 6.37, whereas treatment P2 (90% breadfruit-wheat composite flour: 10% mung bean flour) has the lowest expected value, measuring 3.77.

Keywords*: breadfruit-wheat composite flour; mung bean flour; quality cookies*

INTRODUCTION

For many people, cookies are a popular food product. There is still a lot of wheat flour used in cookie manufacturing nowadays. According to Yulistiati et al. (2019), wheat flour is typically produced by importing wheat grains and the milling business from outside of Indonesia. The amount of wheat flour consumed nationally is steadily rising. The Ministry of Agriculture's Food use Statistics report indicates that the country's use of wheat flour has been rising recently. Up until 2023, the average Indonesian used 2.94 kg of wheat flour annually per person. According to Ahdiat (2024), consumption rose by 6.75% from 2022 to 2024, setting a record high that hasn't been surpassed in at least eight years. In light of these circumstances, steps must be taken to lessen reliance on imported wheat. One (Ahdiat, 2024). Based on these conditions, efforts need to be made to reduce the dependence on imported wheats. One of the efforts is done by using local raw materials which can be processed into flour. As an alternative ingredient, breadfruit can be used to make breadfruit flour.Another advantage of breadfruit flour as a local raw material is that it is gluten free. This flour can be used to make cakes, cookies, brownies and snacks. One of food products that can be made from breadfruit flour is cookies. The low protein content in breadfruit flour (4.56%) makes breadfruit flour suitable for use as raw materials for products that do not need a high expansion volume during baking, such as cookies (Budijanto, 2016).

The quality of breadfruit flour, which predominantly contains carbohydrates, needs to be improved in the development of processed products by adding other ingredients that are high in protein content. One ingredient that can be used is flour from legumes. Vegetable protein that is suitable for ingestion is found in legumes. Mung beans are among them. The mung beans possess a comparatively high level of protein of 22.75% and are a rich source of calcium and phosphorus. Mung beans are very abundant in nutrients when compared to other varieties of legumes (Yanti et al., 2019).

METHODS

The research method contains the main ingredients used in the study and the methods used in solving problems including the analysis method.

Material

The ingredients included powdered sugar, egg yolk, milk powder, margarine, baking powder, mung bean flour (Kusuka Ubiku, Bantul, Yogyakarta), breadfruit flour (Kusuka Ubiku, Bantul, Yogyakarta), and chemicals for proximate analysis. The wheat flour was from ISM Bogasari Flour Mills. Among Petroleum ether was one of the substances utilized in the analysis, H2SO4, NaOH, boric acid, methylene blue, and HCl (Merck, Guaranteed Reagents).

Tools

Equipment used in cookie manufacture includes containers, scales, basins, mixers, spatulas, cookie molds, spoons, napkins, aprons, trays, chopsticks, brushes, knives, stoves, pans, plastic packing, and plastic jars. The glassware (pyrex), water bath (Memerth), drying oven (Binder), and analytical balance (Ohaus) are some of the instruments used in analysis.

Procedure of Making Breadfruit-Wheat Composite Flour Cookies with Mung Bean Flour

Breadfruit flour, wheat flour, and mung bean flour are weighed in accordance with the treatment after the components have been prepared and weighed in accordance with the formulation. The next step is to mix the components, which are divided into two stages. In stage 1, margarine and powdered sugar are combined and beaten at a high speed for three minutes. Next, using a mixer set at a low speed to thoroughly mix the dough, combine the egg yolks, baking powder, breadfruit flour, wheat flour, and mung bean flour in stage 2. Third, the well-mixed dough is flattened before it is shaped into the appropriate cookie shape. Fourth, bake for 30 minutes at 160°C in the oven. Lastly, the baked cookies are taken out of the oven and allowed to cool for twenty-five minutes at room temperature. In order to prevent the cookies from easily going rotten and molding when they are packaged, heat is released throughout the cooling process.

Design of Research

The investigation was carried out with a Single-factor Randomized Block Design, specifically P1 (100% breadfruit-wheat composite The composition of P2's flour is 90% breadfruit-wheat composite flour, P3's flour is 80% breadfruit-wheat composite flour, P4's flour is 70% breadfruit-wheat composite flour, and so on which was repeated 3 times at a laboratory scale of unit experiments.

Analysis Parameters

The variables that were investigated included color, scent, taste, and texture in the sensory test and by difference in the chemical test, the contents of water, ash, fat, protein, and carbohydrates (Nielsen, 2010). A preference test was employed to conduct the sensory test, and 30 panelists with the following hedonic scale value categories were used in this study: (Anonymous, 2006) 1 denotes strong two negative votes, three neutral votes, four positive votes, and five extreme positive votes.

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Data Analysis

The study's findings, which were parametric data, were examined using variance analysis. Duncan's test was performed to further assess the data if there was a There was a statistically significant difference between the treatments, with $P < 0.05$ being deemed significant. We examined the sensory data using the Friedman and descriptive tests because they were non-parametric.

Alternate Choice

A weight test is used to evaluate the relative value of several characteristics. Taste, color, aroma, texture, fat, protein, and carbohydrate contents were the characteristics employed in this study, and the yield was given as a percentage. It is evident from this weight test which parameters are given the greatest weight. The idea of anticipated value decisions, according to Haudi and Wijoyo (2021), is to select options with the greatest potential for gain (profit or utility) or the least amount of risk (losses or sacrifices).

RESULT AND DISCUSSIONS

Based on statistical data analysis, the chemical test's outcomes and sensory test show the following.

Chemical Analysis

Table 1 displays the results of the chemical test on the cookies.

Table 1. Average Chemical Test Results (%)

Handling	Water Ratio (%)	Carbohydrate Content (%)	Ash Content (%)	Fat Content (%)	Protein Content (%)
P1	11.00±0.05^{a}	72.02±0.10^{a}	1.34±0.04^{a}	4.09±0.11^{a}	7.09±0.08^{a}
P2	10.90±0.02^{b}	67.92±0.18^{b}	2.20±0.02^{b}	5.21±0.12^{b}	9.05±0.07^{b}
P3	10.76±0.06^{c}	65.91±0.14^{c}	2.82±0.08^{c}	5.97±0.05^{c}	11.00±0.05^{c}
P4	10.76±0.07^{c}	65.09±0.16^{d}	3.00±0.02^{d}	6.04±0.06^{c}	11.42±0.07^{d}

Notes: distinct symbols within the same column signify a noteworthy variation at α = 5%.

Water Content

The main ingredient in many dishes is water. Water is a direct reactant in hydrolytic reactions and acts as a medium to facilitate chemical reactions. (Belitz et al., 2009). Water is a dispersant and solvent that works for everything. According to Estesih et al. (2016), water is also the most reactive chemical component. Table 1 shows that the average water content varied from 10.76±0.06% to 11.00±0.05%.At α level = 5%, The course of treatment has a notable impact regarding water content, according to statistical data analysis of the water content using the ANOVA test and Duncan's test. The F table value (4.46) is less than the estimated F value (15.91). Table 1 presents the results of the Duncan test, This suggests that there is a substantial difference between treatment P1 and P2 and P3, but not between P3 and P4.

Cookies have a lower water content when the less amounts of breadfruit-wheat composite flour used. This causes a reduction in the amount of wheat flour which, as is known, contains gluten. Gluten network can be formed due to the presence of mixing wheat flour in water during the mixing process of ingredients. The low gluten content can be resulting in weaker water holding capacity so that the release of water molecules during drying becomes easier

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(Nurcahyo et al., 2014). Other factors influencing water content is protein content. The more mung bean flour added, the water content increases, so reduced the protein content (Kurniawan et al., 2020). This is supported by (Khairunnisa et al., 2018) research results which state that differences in water content can also occur influenced by the protein content. The amount of water lost are getting higher as the protein content increasing. This can occur due to protein denaturation during roasting, so that the ability to store water and the emulsification properties of the protein decrease causes proteins to coagulate. According to (Triyono, 2010) proteins will be hydrophilic if the peptide chains contain some polar collectives. There are various groups inside protein molecules that do not contain a pair of N or O atoms. The negatively charged N atom in the peptide chain attracts the positively charged H atoms in water. The bond between the N atom and the H atom of water produce hydrate compounds. The hydrates have ionic bonding properties so it is difficult to evaporate.

Ash Content

The components that remain as ash after plant and animal tissues burn are known as minerals. (Belitz et al., 2009).The ash ranged from 1.34±0.04 % to 3.00±0.02% as shown in Table 1. The outcomes of statistical examination of the ash content data using ANOVA test showing that the treatments have a significant effect on ash content at α at the 5% level. The calculated F value (15.91) is greater than the F table value (4.46). Duncan's test results show differences between treatments which as shown in Table 1. Table 1 displays the Duncan test findings. show that treatment P1 is distinct from P2, P3, and P4, but P2's treatment differs significantly from P3 and P4 and P3's treatment differs greatly from P4.

The greater the amount of The more mung bean flour used, the more ash is present. This is as a result of the mung bean flour's appropriately high 3.5% ash level. (Skylas et al., 2018), while wheat flour has an ash content of 0.46 (Kusnandar et al., 2022), breadfruit flour has an ash content of 2.85 (Mehta et al., 2023). According to (Belitz et al., 2009) The mineral content of the materials utilized will affect a product's ash content.

Protein Content

Protein is the largest fraction of cells (besides water) and is a polymer of amino acids (Setiadi, 2013). According to (Ischak et al., 2017), Proteins typically consist of the following chemical elements: 50% carbon, 7% hydrogen, 23% oxygen, 16% nitrogen, 0-3% sulfur, and 0-3% phosphorus. A food's protein composition can be ascertained by using a nitrogen content of 16%. The protein content ranged from 7.09±0.08% to 11.42±0.07% can be seen in Table 1. An increase in the amount of mung bean flour in, causes an increase in protein levels (Shabnum Shaheen, 2012; Suneja et al., 2011). The outcomes of statistical data protein content analysis using the ANOVA showing that the medical interventions have a noteworthy impact on protein content at the 5% α level. The calculated F value (2.567E3) is greater than the F table value (4.46). Duncan's test results show differences between treatments which as shown in Table 1as shown in Table 1. Table 1 displays the Duncan test findings. The Duncan test results in Table 4 show that treatment P1 is distinct from P2, P3, and P4, but P2's treatment differs significantly from P3 and P4 and P3's treatment differs greatly from P4.

Based on the Duncan test findings, which are displayed in Table 1, the protein content increases in proportion to the amount of added mung bean flour. Its protein concentration is higher in mung bean flour than breadfruit-wheat composite flour. Mung bean flour has 22.75% protein (Lestari et al., 2017), while breadfruit flour has 4.46% protein (Budijanto, 2016). This is in accordance with (Khairunnisa et al., 2018) research results which state that The higher the protein level, the more mung bean flour is used.

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Fat Content

Structural components with a strong hydrophobicity combine to produce lipids. This solubility attribute is specific to this class of chemicals rather than being a shared structural trait. Water does not dissolve lipids; only organic solvents do. Their easy separation from proteins and carbohydrates is based on their analytical property of water insolubility. Despite being minor food ingredients, they need special attention because of their high reactivity, which can have a significant impact on the dish's organoleptic quality. (Belitz et al., 2009). According to Ladamay & Yuwono (2014), products with low fat content have a longer shelf life and are less likely to spoil.

Table 1 displays the fat content, which varied from 4.09±0.11% to 6.04±0.06%. At the 5% fat content, the therapy significantly affected the fat content significance level, according to the results of the statistical data analysis of fat content using the ANOVA test. The F table value (4.46) is less than the estimated F value (312.76). Table 5 displays the major changes between treatments found in the Duncan's test findings. Table 1 displays the findings of the Duncan test, which indicate that treatment P1 differs significantly from P2, P3, and P4, whereas treatment P2 differs considerably from P3 and P4 but not significantly from P4.

The Duncan test results in Table 1 show that the fat content increases in proportion to the quantity of additional mung bean flour. This is due to the fact that mung bean flour possesses more fat than wheat flour (Suprianto et al., 2015). What percentage of fat is in mung bean flour 1.67% (Khairunnisa et al., 2018), while wheat flour is 1.00% and breadfruit flour is 0.5% (The Ministry of Health, 2017).

Carbohydrates Content

Quantitatively speaking, carbohydrates are the most significant source of energy and constitute one of the fundamental nutrients. Their kJ/g or kcal/g dietary energy content is 17. Even nondigestible carbs play a significant role in a daily diet that is balanced, serving as bulk material. Carbohydrates serve other vital purposes in meals (Belitz et al., 2009).Table 1 displays the outcomes of the carbohydrate content, which varied from 65.09±0.16% to 72.02±0.10%. The carbohydrate content was analyzed statistically using the ANOVA test, and the results indicate that at a 5% significance level, the interaction between the treatments had an impact on the carbohydrate content. The F table value (4.46) is less than the computed F value (1.320E3). The findings of Duncan's test reveal variations in the treatments in Table 1. The Duncan test results in Table 6 show that treatment P1 is distinct from P2, P3, and P4, but P2's treatment differs significantly from P3 and P4 and P3's treatment differs greatly from P4.

The Duncan test results in Table 1 show that the greater the proportion of mung bean flour added, the carbohydrate content decreases. Fatkurahman et al. (2012) stated that carbohydrate levels are calculated Difference: The lower the carbohydrate level, the more the other nutritional components—namely, protein, fat, water, and ash—influence it, the higher the proportion of mung beans, The amount of carbohydrates decreases as the protein concentration increases.

The higher the usage breadfruit-wheat composite flour and lower usage mung bean flour then the carbohydrate The output of content is increasing. This is because breadfruit flour and wheat flour contains carbohydrates which are higher than mung beans flour. The carbohydrate content of wheat flour is 77.2%, breadfruit flour is 84.4% (The Ministry of Health, 2017), and mung bean flour is 72.86% (Yanti et al., 2019).

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Sensory Test

A sensory test is a hedonic preference test that includes preferences for taste, texture, color, and fragrance. Consumer preference for breadfruit-wheat composite flour cookies made with mung bean flour was determined through sensory testing. Figure 1 displays the outcomes of the sensory test.

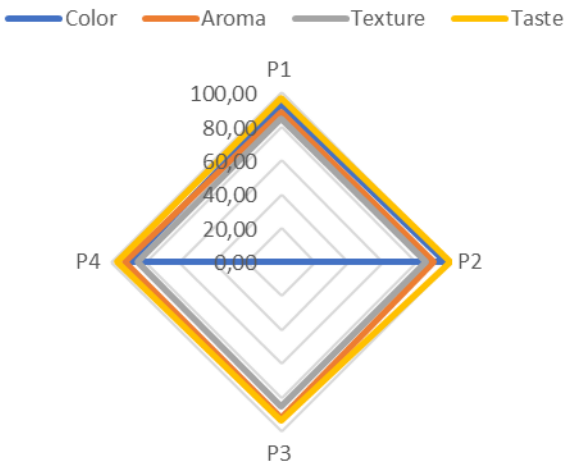

Figure 1. The results of the sensory test

Considering the outcomes of the Friedman test, As is well known the treatments give significant effects on the taste parameters of the cookies. The highest total score was obtained by treatment P2, while the lowest total score was obtained by treatment P3.

Furthermore, the treatment of breadfruit-wheat composite flour cookies with mung bean flour resulted in a significant effect on the cookies color parameters. The highest total score was obtained by treatment P2, while the lowest total score was obtained by treatment P4. The greater the proportion of mung bean flour, the lower the level of preference. This is because the pigment from mung beans affects the color of the cookies (Yanti et al., 2019).

In light of the Friedman test findings for aroma parameters, it is known that the treatment of breadfruit-wheat composite flour cookies with mung bean flour resulted in an insignificant effect on the cookie aroma parameters. The highest total scores were obtained by treatment P3 and P4, while the lowest total scores were obtained by treatment P1. The decrease in the proportion of breadfruit flour further increases the preference for cookies. This is due to the unpleasant aroma of breadfruit flour (Ugwu & Oranye, 2006; Sukandar et al., 2014).

Furthermore, the Friedman test findings for texture parameters showed that the treatment of breadfruit-wheat composite flour cookies with mung bean flour was insignificantly different in terms of aroma parameters. The highest total score was obtained by treatment P2, while the lowest total score was obtained by treatment P4. It can be seen that the greater the proportion of composite flour added, the more favorable the texture of the cookies. This is thought to be because the greater the proportion of breadfruit flour, the crunchier the texture of the wheat breadfruit composite flour (Sukandar et al., 2014).

Alternative Selection

The goal of alternative selection is to select the most effective treatment from a range of available options (Haudi and Wijoyo, 2021). Making decisions involves methodically choosing the optimal course of action. AHP is used to determine each parameter's importance weight (Analytical Hierarchy Process). Meanwhile, the Expected Value technique is used to determine which treatment option is better.

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The process of The Hierarchy of Analyses (AHP)

Decision-making is done using the Analytical Hierarchy Process (AHP) process (tool). Due to the fact that multiple alternatives determine the priorities — some of which may be criteria created based on the significant qualities of the product — AHP is dependable. Experts who are aware of the product's interests choose AHP and assess its relationship of interests. After deciding which therapies to choose, this decision is utilized to create a priority scale or weight of interests. After analyzing all of the data from the chemical and organoleptic tests, it is determined that the AHP importance weight values are derived from the following factors: protein, water, fat, texture, aroma, taste, and color. Figure 2 displays a pie graphic illustrating the relative importance of cookies.

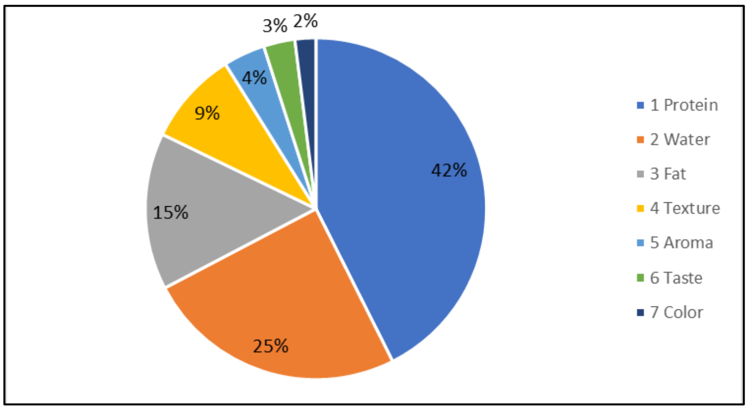

Figure 2. Pie Diagram of The Weight of Importance Breadfruit Cookies

Based on AHP, the highest value is found in the protein parameter with a probability value or importance weight of 43%. Meanwhile, the lowest probability or importance weight value is found in the color parameter at 2%.

Decision Analysis

The total of the values that are anticipated to happen in relation to a probability is the expected value. The product caliber findings for every criterion and the importance the relative weight of each of these criteria serve as the foundation for determining the optimal treatment. When making decisions, the optimum course of action with the highest possible expected value should always be considered. The treatment with The optimal choice is the one with the highest expected value score. The treatment that scored the best for predicted value among the many options will always be chosen as the optimal substitute. Table 2 displays the predicted value scores for each therapy as a consequence of the computation.

Table 2. Expected Value Score for Each Treatment

Treatment	Protein	Texture	Taste	Carbohydrate	Color	Total Expected Value
P1	7.09	90.00	81.01	72.02	72.02	5.21
P2	9.05	83.03	78.09	67.92	82.02	3.77
P3	11.00	87.08	71.01	65.91	90.00	6.02
P4	11.42	87.08	80.00	65.09	86.70	6.37

Table 2 shows that treatment P4 (70% breadfruit-wheat composite flour: 30% mung bean flour) has the greatest anticipated value score, 6.37. The treatment with the highest anticipated value is the best one.

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CONCLUSION

It may be inferred from the research findings that the mung bean flour added to the cookie treatments differed significantly from each other. Based on the decision analysis results, treatment P4 (70% breadfruit-wheat composite flour: 30% mung bean flour) was selected as the preferred treatment since it had the highest expected value. Treatment P4 features include water content 10.76±0.07%, protein content 11.42±0.07%, fat content 6.04±0.06%, carbohydrate content 65.09±0.16%, and ash content 3.00±0.02%.

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