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ENHANCEMENT OF PROTEIN AND FIBER CONTENT IN WHEAT-CASSAVA COMPOSITE NOODLES WITH OYSTER MUSHROOM (*PLEUROTUS OSTREATUS*): NUTRITIONAL AND SENSORY EVALUATION

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Abstract
Background: Noodles are widely consumed in Indonesia but are commonly made from wheat flour, which is low in protein and fiber. Cassava flour, a local carbohydrate source, and oyster mushroom (*Pleurotus ostreatus*), a source of protein and fiber, have potential for developing nutritionally improved noodles. **Objective:** This study aimed to analyze the nutritional content and sensory acceptability of wheat-cassava composite noodles fortified with oyster mushroom as a local food alternative. **Methods:** A laboratory experimental design with a quantitative approach compared three noodle formulations (F0, F1, and F2) differing in the proportion of wheat flour, cassava flour, and oyster mushroom. Nutritional analysis covered energy, protein, fat, carbohydrate, and fiber content, while sensory acceptability was evaluated by 30 untrained panelists using a five-point hedonic scale for color, aroma, taste, and texture. **Results:** F1 contained 277.74 kcal/100 g energy, 9.23% protein, 0.62% fat, 58.61% carbohydrate, and 0.20% fiber, exceeding the minimum protein requirement of 8% for dried noodles under SNI 8217:2015. F1 also achieved the highest acceptance for most sensory attributes, particularly color and taste. No significant differences were found among formulations for color, aroma, and taste ($p > 0.05$), whereas texture differed significantly ($p < 0.05$). The overall mean acceptance score of F1 was 3.97, categorized as like. **Conclusion:** F1 was the most acceptable formulation, with protein content above the SNI requirement, although the fiber increase remained relatively small. These findings support further development of wheat-cassava composite noodles with oyster mushroom as a local food product with improved nutritional and sensory quality.

Introduction

Noodles are widely consumed in Indonesia because of their convenience, ease of preparation, and affordability. The high consumption of wheat-based noodles contributes to the continued demand for wheat flour, while Indonesia remains dependent on imported wheat as a raw material (1). This condition highlights the importance of developing noodle products that utilize locally available carbohydrate sources as part of food diversification and efforts to strengthen national food independence. Cassava is one potential local raw material because it is abundant, accessible, and can be processed into cassava flour. However, replacing wheat flour with cassava flour presents a nutritional and technological challenge (2). Cassava flour has a substantially lower protein content than wheat flour and does not contain gluten; therefore, increasing the proportion of cassava flour can reduce protein content and affect the elasticity and structural integrity of noodles (3). This issue is particularly important because protein is one of the quality parameters required for dried noodles under Indonesian National Standard (SNI) 8217:2015.

The development of food products based on local flours must also address public nutritional issues, particularly the low intake of dietary fiber. Data from the Indonesian Health Survey (SKI) indicate that more than 95% of the Indonesian population aged 5 years and older fail to meet the recommended daily intake of fruits and vegetables—the primary sources of fiber (*Indonesian Ministry of Health, 2023*). Sustained consumption of high-carbohydrate, low-fiber foods is closely linked to an increased prevalence of non-communicable diseases (NCDs), such as constipation, type 2 diabetes mellitus, and cardiovascular disorders (4). Oyster mushroom (*Pleurotus ostreatus*) has potential as a complementary ingredient to address the nutritional limitations of cassava-based noodles. Oyster mushrooms contain protein, dietary fiber, vitamins, and minerals and can therefore contribute to improving the nutritional profile of noodle products. The protein fraction of oyster mushrooms contains essential amino acids, while their dietary fiber includes structural polysaccharides such as β-glucan and chitin, which may contribute to the fiber content of the product (5).

In addition to its nutritional contribution, oyster mushroom may affect the physical characteristics of noodle dough. The protein and fiber components can interact with water and the starch matrix during dough formation and processing. Such interactions may modify water binding, dough structure, and the final texture of noodles (6). Therefore, the amount of oyster mushroom must be carefully controlled because an appropriate proportion may improve nutritional value while excessive addition may interfere with dough cohesiveness and elasticity, particularly in a system with reduced gluten (3). The use of cassava flour and oyster mushroom also presents a formulation challenge because nutritional improvement and sensory acceptability do not necessarily increase simultaneously. Increasing cassava flour may reduce gluten-mediated elasticity, while increasing oyster mushroom may alter water absorption, color, aroma, and texture. Thus, formulation is required to identify a suitable balance between the nutritional contribution of oyster mushroom and the structural role of wheat flour. Previous studies have reported that cassava flour can be used as a substitute for wheat flour in noodle production, but the resulting protein content may remain below the required quality standard. Other studies have shown that oyster mushroom addition can improve protein and fiber content while maintaining acceptable sensory characteristics.

Research on cassava-based noodles has also demonstrated that appropriate combinations of cassava flour with other ingredients can improve physical properties such as elasticity and water absorption (7). However, these studies have generally examined cassava substitution, oyster mushroom addition, or physical and sensory characteristics separately (6). More specifically, although oyster mushroom has been studied as an ingredient in wheat-based noodles, the interaction between oyster mushroom and cassava flour in a composite noodle system has not been comprehensively evaluated, particularly in relation to achieving the minimum protein requirement of 8% specified for dried noodles by SNI 8217:2015 while maintaining acceptable sensory characteristics (8). The main challenge is therefore to identify a formulation that provides a suitable balance or "sweet spot" between nutritional improvement and consumer acceptance. This is important because increasing the proportion of local ingredients may improve food diversification but may simultaneously compromise noodle elasticity and sensory quality. Evaluating several formulations is therefore necessary to determine whether an appropriate combination of cassava flour, wheat flour, oyster mushroom, and other ingredients can achieve the desired nutritional and sensory characteristics (6).

In this study, tapioca flour and cassava flour were utilized as distinct ingredients tailored to the specific objectives of each formulation. Tapioca flour was used in the control formulation (F0) to establish a baseline for noodle characteristics in the absence of cassava flour, whereas formulations F1 and F2 incorporated cassava flour as the experimental ingredient to assess the impact of using a local food source on the noodles' characteristics and nutritional content. The inclusion of cassava flour in the experimental formulations is based on its potential as a local raw material for noodle production and its role in supporting food diversification in Indonesia (9). Developing cassava-based noodles offers broader societal benefits by enhancing the utilization of local food, adding value to cassava commodities, and bolstering food security through reduced reliance on imported wheat-based products (10). Consequently, the innovation of cassava flour-based noodles aims not only to produce a product with favorable organoleptic qualities and good nutritional value but also to support food diversification and the sustainable use of local food resources.

The hypothesis of this study was that a specific proportion of cassava flour substitution and oyster mushroom addition would improve the protein and fiber profile of the noodles while maintaining sensory acceptance within the acceptable category (6). Therefore, this study aimed to analyze the nutritional profile of the noodles, including energy, protein, fat, carbohydrate, and fiber, and to evaluate sensory acceptability based on color, aroma, flavor, and texture across three formulations (F0, F1, and F2). The findings are expected to contribute to the development of wheat-cassava composite noodles fortified with oyster mushroom as a local food product that can support food diversification and reduce dependence on imported wheat-based raw materials (8).

Materials and Methods

This study employed a laboratory experimental design with a quantitative approach, utilizing a Completely Randomized Design (CRD) that encompassed three treatment formulations: F0 (control), F1, and F2. Nutritional content analysis—covering energy, protein, fat, carbohydrates, and fiber was conducted once for each formulation; consequently, the nutritional data are presented descriptively, without inferential statistical analysis regarding differences in nutritional content between formulations. Fresh oyster mushrooms were used as an additive in formulations F1 and F2. These fresh mushrooms were selected, thoroughly cleaned, and then ground or blended directly into a paste. The resulting oyster mushroom paste was then mixed directly into the noodle dough according to the specific formulation. Subsequently, an organoleptic test involving 30 untrained panellists was conducted. All panellists evaluated the three formulations (F0, F1, and F2) based on attributes of color, aroma, flavor, and texture using a five-point hedonic scale. Samples were presented to the panellists in a randomized order to minimize assessment bias. Panellists were provided with plain water between tests to cleanse their palates and reduce the carry-over effect before evaluating the next sample.

Venue and Time

The research was conducted from June 12 to 22, 2026. The noodle production process took place at the Culinary Laboratory of the Faculty of Health Sciences, Universitas Muhammadiyah Parepare. Nutritional content analysis was performed at the Feed Chemistry Laboratory, Department of Animal Nutrition and Feed Science, Faculty of Animal Science, Universitas Hasanuddin. Organoleptic testing was carried out in Lapadde Urban Village, Parepare City.

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Noodle-making process

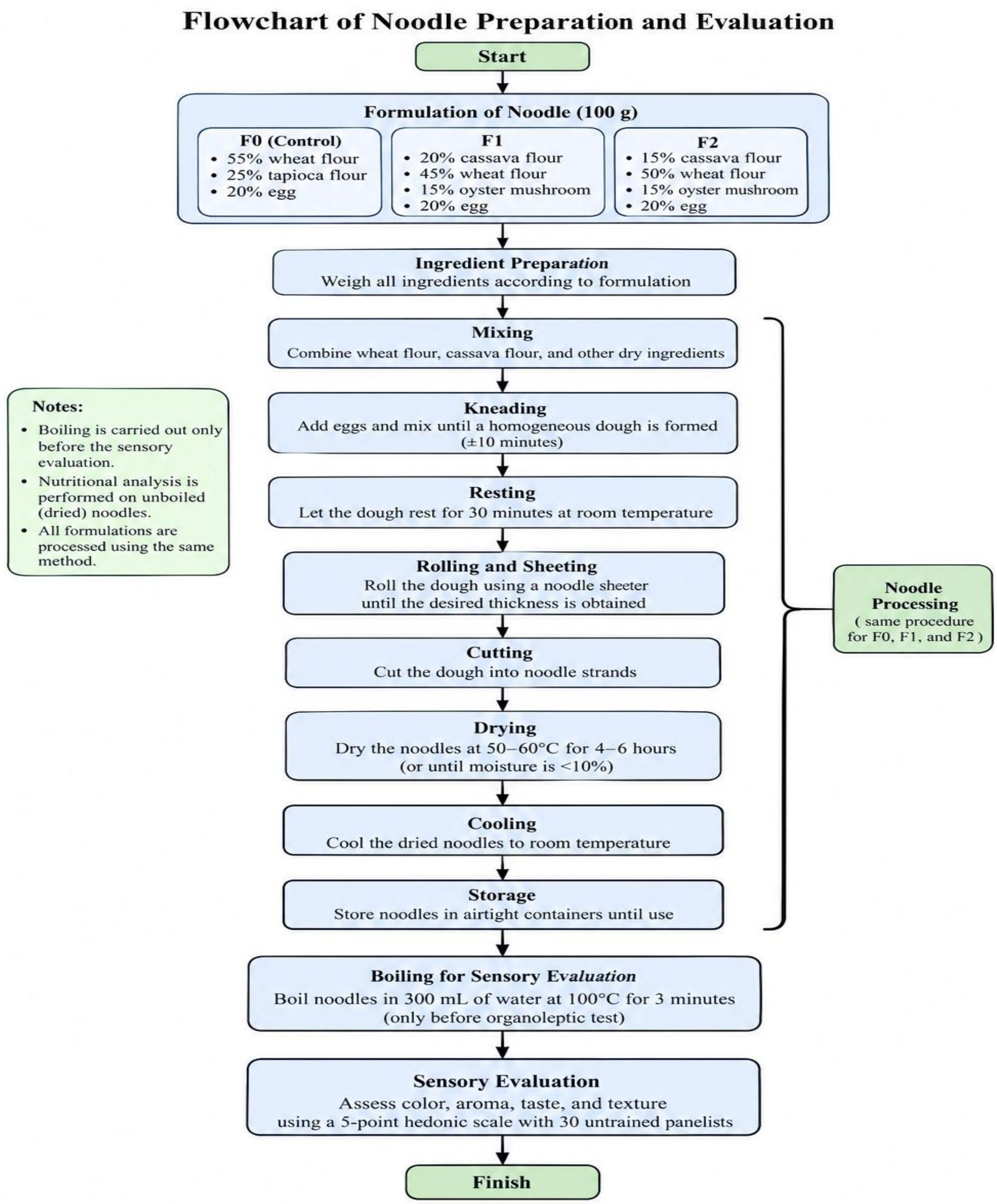

Figure 1. Flowchart of noodle production using cassava flour and oyster mushrooms

Research sample

The samples in this study consisted of product samples and a panel of participants. The product samples comprised noodles made from cassava flour and oyster mushrooms, prepared in three formulations: F0, F1, and F2. The panel consisted of 30 untrained individuals selected using purposive sampling a method where participants are chosen based on criteria established by the researchers. A panel size of 30 was selected as it meets the recommended minimum for organoleptic testing with untrained panellists, making it sufficient to gauge the level of consumer acceptance of the product. Inclusion criteria required participants to be aged 20–30, willing to serve as respondents, free from flavor or olfactory disorders, free from allergies to cassava flour, oyster mushrooms, or eggs, and in good health at the time of testing. Exclusion criteria applied to panellists suffering from the flu, fever, a cough, or flavor/olfactory impairments; those taking medication that could affect flavor perception; active smokers; or those who failed to complete the entire testing sequence.

Prior to the organoleptic test, panellists were instructed to refrain from eating, drinking coffee or strongly flavored beverages, smoking, and wearing perfume for at least 30 minutes to minimize sensory evaluation bias. Before the test began, all panellists received an explanation regarding the study's objectives, benefits, and procedures; they were then asked to sign an informed consent form providing written agreement to participate before completing the questionnaire and evaluating the samples. Acceptability testing was conducted using an organoleptic questionnaire based on a 5-point hedonic scale. Panellists were asked to evaluate four sensory attributes color, aroma, flavor, and texture using the following criteria: dislike extremely (score 1), dislike (score 2), neutral (score 3), like (score 4), and like extremely (score 5).

Table 1 Formulation of cassava flour and oyster mushroom noodles

Material	F0	F1	F2
Cassava flour	-	20%	15%
Flour	55%	45%	50%
Tapioca flour	25%	-	-
Oyster mushroom	-	15%	15%
Egg	20%	20%	20%
Total	**100%**	**100%**	**100%**

Nutritional Analysis

Nutritional content analysis covered protein, fat, total carbohydrate, and fiber levels. Protein content was analyzed using the Kjeldahl method, fat content using the Soxhlet method, fiber content using the crude fiber method, and total carbohydrate content using the Luff–Schoorl method. The total carbohydrate content was determined based on the amount of reducing sugars obtained through the Luff–Schoorl procedure. All analyses were conducted in accordance with standard AOAC (*Association of Official Analytical Chemists*) procedures.

Data Analysis

Nutritional content analysis data are presented descriptively in tabular form. Before the organoleptic test, all panellists received a brief orientation regarding the sensory attributes to be evaluated to ensure a common understanding of the assessment criteria. The panellists were provided with explanations of the definitions and characteristics of color, aroma, flavor, and texture, as well as instructions on how to use the five-point hedonic scale. The orientation was limited to explaining the assessment procedure and sensory attributes and did not involve training or influencing the panellists' preferences. Organoleptic test data were processed using IBM SPSS Statistics version 25 software. Descriptive analysis was conducted by calculating the mean and standard deviation to describe the panellists' level of acceptance for each formulation based on the attributes of color, aroma, flavor, and texture. Differences in panellists' preference levels for formulations F0, F1, and F2 were analyzed using the Friedman test, as all panellists evaluated all three formulations and the obtained data were ordinal in scale. If the Friedman test results indicated a significant difference ($p < 0.05$), a Wilcoxon Signed-Rank test was performed as a post-hoc analysis to identify which pairs of formulations differed significantly. The analysis results are presented in tables and interpreted to determine the formulation with the highest level of acceptability. Meanwhile, nutritional content results were compared descriptively across formulations based on energy, protein, fat, total carbohydrate, and fiber values.

Noodle Preparation

The noodle preparation process was carried out using the same procedure for formulations F0, F1, and F2. First, all ingredients were weighed according to their respective formulations. The dry ingredients were mixed until evenly distributed, followed by the addition of eggs. The dough was kneaded for approximately 10 minutes at room temperature until a homogeneous dough was obtained. The dough was then rested for 30 minutes at room temperature to allow the dough to stabilize before further processing. After resting, the dough was rolled and sheeted using a noodle sheeter until the desired thickness was obtained and then cut into noodle strands. For the organoleptic evaluation, the freshly prepared noodles were boiled in 300 mL of water at 100 °C for 3 minutes immediately before serving to the panellists. The cooked noodles were then evaluated based on color, aroma, flavor, and texture using a five-point hedonic scale. The processing conditions were kept consistent across all formulations to ensure that differences in the physical, nutritional, and sensory characteristics of the noodles were primarily attributable to differences in formulation.

Ethical Considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. All panellists were informed about the purpose and procedures of the organoleptic evaluation before participation. Participation was voluntary, and informed consent was obtained from each panelist. Panellists were informed that they could withdraw from the study at any time. Personal information and individual responses were kept confidential and used solely for research purposes.

Results

Nutritional Content of Noodles Based on Cassava Flour and Oyster Mushrooms

Table 2 Results of Nutritional Content Analysis of Noodles Based on Cassava Flour and Oyster Mushrooms

Sample code	Energy (kcal)	Crude fat (%)	Crude protein (%)	Carbohydrate (%)	Crude fiber (%)
F0	273.88	1.12	8.65	56.85	0.13
F1	277.74	0.62	9.23	58.61	0.20
F2	275.91	0.15	9.11	59.33	0.20

Table 2 shows that F1 had the highest protein content (9.23%) and a lower fat content (0.62%) compared to F0. The crude fiber content in F1 and F2 was identical, at 0.20%, indicating that there was no difference in the crude fiber values between the two treatment formulations. Overall, the crude fiber content across the three formulations was relatively low, ranging from 0.13% to 0.20%. This result should be interpreted cautiously because the nutritional analysis was conducted only once for each formulation, and therefore no statistical inference can be made regarding differences in nutritional content. The highest carbohydrate content was found in F2 (59.33%), whereas the highest energy content was found in F1 (277.74 kcal). Thus, based on the descriptive analysis, F1 exhibited a notable nutritional profile in terms of protein and fat content. The identical crude fiber values in F1 and F2 indicate that, descriptively, the addition of the ingredients used in these formulations did not result in a difference in the measured crude fiber content.

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Table 3 Characteristics of Organoleptic Test Panellists

Panelist Characteristics	Number (n)	Percentage (%)
Age (years)		
20–25	21	70.0
26–30	9	30.0
Education		
Senior High School	21	70.0
D3	3	10.0
S1	6	20.0
Work		
Student	11	36.7
IRT	10	33.3
Nurse	2	6.7
Teacher	1	3.3
Technician	1	3.3
Private sector employee	5	16.7
Gender		
Male	5	16.7
Female	25	83.3
Total	**30**	**100**

Table 3 shows that the majority of panellists fell into the 20–25 age group (21 individuals or 70.0%), while 9 individuals (30.0%) were in the 26–30 age group. All panellists were within the 20–30 age range, in accordance with the study's inclusion criteria. Regarding gender, the majority of panellists were female (83.3%), while 16.7% were male. Most panellists held a high school education (70.0%), with the remainder holding Diploma (10.0%) or Bachelor's (20.0%) degrees. In terms of occupation, the panel consisted predominantly of university students (36.7%) and housewives (33.3%), while others worked as private-sector employees, nurses, teachers, and technicians. These characteristics demonstrate a diversity of backgrounds regarding age, education, occupation, and gender, thereby providing a sensory assessment profile from panellists who met the study's criteria. The physical appearance of the noodle samples from the three formulations (F0, F1, and F2) is presented in Figure 2. The figure illustrates the visual differences among the formulations following the noodle preparation process

F0 F1 F2

Figure 2 Physical appearance of noodle samples based on cassava flour and oyster mushroom across formulations (F0, F1, and F2)

The noodle preparation process consisted of several stages, including ingredient preparation, mixing, kneading, resting, rolling and sheeting, cutting, and cooking. All ingredients were weighed according to the respective formulation (F0, F1, and F2). The dry ingredients were mixed, followed by the addition of eggs, and the dough was kneaded for approximately 10 minutes until a homogeneous dough was formed. The dough was then rested for 30 minutes at room temperature before being rolled and sheeted using a noodle sheeter until the desired thickness was obtained. The sheeted dough was subsequently cut into noodle strands. All three formulations were processed using the same procedure. For sensory evaluation, the freshly prepared noodles were boiled in 300 mL of water at 100 °C for 3 minutes immediately before the organoleptic test. The cooked noodles were then evaluated for color, aroma, flavor, and texture by 30 untrained panellists using a five-point hedonic scale.

Table 4 Organoleptic Test Results for Noodles Based on Cassava Flour and Oyster Mushrooms

Parameter	Mean value of sample hedonic test		
	F0	**F1**	**F2**
Color	3.90 ± 0.548^{a}	4.13 ± 0.571^{a}	3.93 ± 0.583^{a}
Aroma	3.72 ± 0.591^{a}	3.53 ± 0.629^{a}	3.40 ± 0.724^{a}
Flavor	4.14 ± 0.743^{a}	4.30 ± 0.651^{a}	3.90 ± 0.662^{a}
Texture	3.90 ± 0.724^{ab}	3.90 ± 0.662^{ab}	3.10 ± 0.662^{b}

Note: Hedonic scale 1–5 (1 = dislike extremely, 5 = like extremely); different letter superscripts (a, b) indicate significant differences, while similar letters indicate no significant difference at the tested mean level.

Table 4 shows that formulation F1 achieved the best panelist acceptance levels for most organoleptic attributes particularly color and flavor whereas F0 received the highest scores for aroma. These results indicate that formulation F1 possesses the sensory characteristics most preferred by panellists compared to the other formulations. Statistical test results indicate that the attributes of color, aroma, and flavor did not show significant differences among formulations ($p > 0.05$), whereas the texture attribute showed a significant difference ($p < 0.05$). Follow-up Wilcoxon test results show that the texture of F2 differed significantly ($p < 0.05$) from that of F0 and F1, while there was no significant difference between F0 and F1 ($p > 0.05$).

Regarding the texture attribute, F2 received the lowest mean score of 3.10 ± 0.662, whereas F0 and F1 each received a score of 3.90. These results indicate that panelist acceptance of the F2 texture was lower compared to that of F0 and F1.

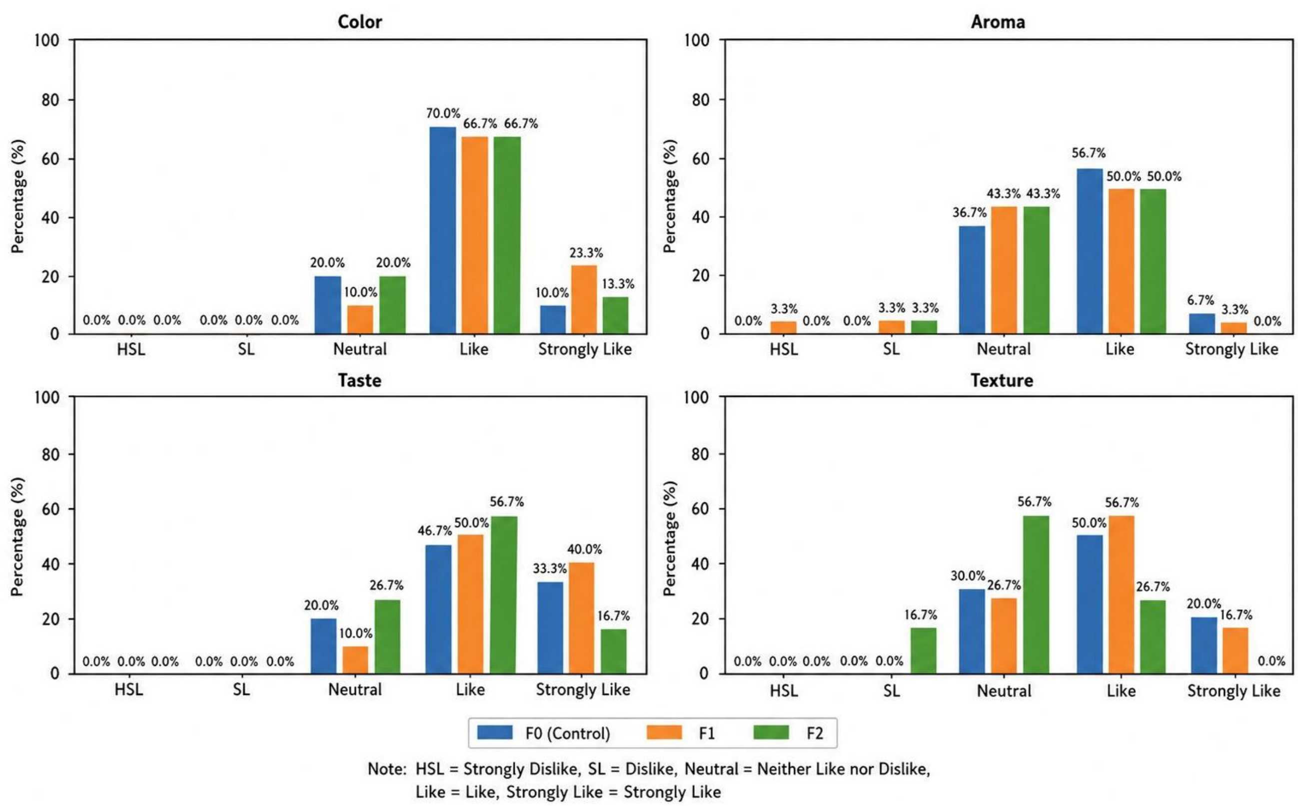

Figure 3. Percentage distribution of panellists' preference levels regarding the organoleptic attributes of noodles based on cassava flour and oyster mushroom.

Figure 3 illustrates the percentage distribution of panelist preference levels regarding the color, aroma, flavor, and texture attributes of noodles made from cassava flour and oyster mushrooms. Overall, the "like" category recorded the highest percentages across all attributes and formulations; notably, formulation F1 achieved the highest percentages for color, flavor, and texture. In contrast, formulation F2 showed higher percentages of "neutral" and "dislike" ratings, particularly regarding texture. These results indicate that formulation F1 enjoyed a higher level of panelist acceptance compared to formulations F0 and F2.

Discussion

Nutritional Content Analysis of Noodles Based on Cassava Flour and Oyster Mushrooms

Formulation F1 exhibits the most optimal nutritional profile compared to the other formulations, particularly regarding protein, fiber, and fat content. The increased protein and fiber levels in F1 indicate that the combination of cassava flour and oyster mushrooms yields a superior nutritional composition compared to the control formulation. Meanwhile, the fat content in F1 is lower than in F0, demonstrating a better balance between macronutrients and fiber. Variations in ingredient composition across the formulations indicate that the proportions of cassava flour, wheat flour, oyster mushrooms, and eggs play a key role in determining the product's nutritional profile. Therefore, F1 can be considered the most optimal formulation in terms of its overall nutritional profile.

The increased protein and fiber content in F1 is thought to be associated with the use of oyster mushrooms as one of the formulation ingredients. Oyster mushrooms are a source of plant-based protein and dietary fiber that can contribute to enhancing the product's nutritional value (11). Conversely, cassava flour has a relatively low protein content; therefore, substituting wheat flour with cassava flour without adding a protein source can result in a reduction of the product's protein level. Consequently, the inclusion of oyster mushrooms is important in the formulation of cassava-based noodles to help maintain protein content. However, the control formulation (F0) also met the minimum protein requirement for dried noodles stipulated by SNI 8217:2015, with a protein content of 8.65%, which exceeds the minimum requirement of 8%. F1 showed an even higher protein content of 9.23%, indicating that both F0 and F1 fulfilled the SNI protein requirement. Thus, the combination of cassava flour and oyster mushrooms in the appropriate proportions can produce noodles that meet the protein quality standard while potentially providing an alternative source of protein in the product.

The results of this study indicate that formulation F1 has a protein content of 9.23%, meeting the minimum protein requirement for dried noodles set by SNI 8217:2015. This value is higher than that reported by Mariyani (12), who found a protein content of 6.69% in dried noodles with an optimal formulation of 40% mocaf and 60% wheat flour. This difference in protein content may be attributed to the composition of the ingredients used.

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In Mariyani's study, the substitution ingredients consisted primarily of cassava flour and mocaf both of which have relatively low protein content whereas formulation F1 in the current study incorporated oyster mushrooms alongside cassava flour, wheat flour, and eggs. The addition of oyster mushrooms and eggs likely contributed to the increased protein content of the final product. Beyond ingredient composition, variations in the type and characteristics of raw materials, moisture content, and processing methods may also account for the differences in protein content observed between the studies (7).

Oyster mushrooms contain protein and dietary fiber that can contribute to enhancing the nutritional value of the product. Protein serves to build and maintain body tissues, whereas dietary fiber is a food component that is not fully digested within the digestive tract. In this study, the inclusion of oyster mushrooms primarily contributes to the protein and fiber profiles of the noodles. Therefore, utilizing oyster mushrooms in combination with cassava flour offers a viable alternative for developing noodle products that incorporate local food ingredients. Research findings indicate that cassava flour and oyster mushrooms have the potential to serve as alternative raw materials for developing noodles based on local food sources. Utilizing these ingredients can support food diversification and enhance the use of local commodities in food product manufacturing. Further development is required to achieve a formulation that offers not only a favorable nutritional profile but also physical and sensory characteristics suitable for large-scale production.

Organoleptic Evaluation of Noodles Based on Cassava Flour and Oyster Mushrooms

Organoleptic test results indicate that F1 achieved a good overall acceptance level, falling into the "liked" category. F1 demonstrated relatively high acceptance scores for color and flavor attributes, whereas F0 scored higher on the aroma attribute. However, statistical analysis revealed no significant differences among the formulations regarding color, aroma, and flavor ($p > 0.05$). Thus, in terms of sensory properties, F1 cannot be considered significantly superior to F0 and F2 for these attributes, though it matched the control noodles' acceptance levels across several sensory characteristics. The difference in aroma acceptance between F1 and F2 is thought to be related to the addition of oyster mushrooms and the change in the proportion of cassava flour in the formulation. Oyster mushrooms possess a distinctive aroma that becomes more perceptible after processing; thus, increasing their content in the formulation can influence panellists' perception of the noodles' aroma. Furthermore, the inherent aroma characteristics of the ingredients and the heating process can alter the volatile compounds that contribute to the product's final aroma. However, the differences in aroma scores between the formulations were not statistically significant, meaning the observed variation cannot be considered a substantial effect of the formulation.

These findings align with research by Hardoko, which demonstrated that using cassava as a base ingredient for analog noodles yields acceptable sensory characteristics, although the proportions of ingredients and the use of additives influence the product's physical properties and level of acceptance. In that study, carrageenan was added to improve the physical characteristics particularly the texture of cassava-based noodles. Similarly, the current study found that varying the proportions of cassava flour, wheat flour, and oyster mushrooms resulted in differences in acceptance regarding texture; specifically, formulation F2 received lower scores than F0 and F1. These results indicate that cassava flour should be combined with other ingredients that help form the dough structure, thereby achieving a noodle texture that is more elastic and acceptable to panellists (7).

From a physicochemical perspective, the gluten in wheat flour forms a protein network that imparts elasticity and chewiness to noodles. Conversely, cassava flour lacks gluten; thus, increasing its proportion can diminish the dough's ability to form an elastic network. The fiber and structural components of oyster mushrooms can also influence dough matrix formation, necessitating careful control of their usage proportion. Beyond ingredient composition, the mixing and heating processes during production can affect the final noodle characteristics. Heating induces starch gelatinization in the cassava flour, while proteins undergo structural changes due to the heat. The interplay between starch gelatinization, proteins, and fiber components can influence the noodles' texture and sensory attributes. Therefore, a balanced ratio of wheat flour, cassava flour, and oyster mushrooms is required to achieve a texture acceptable to panellists (13).

Overall, F1 demonstrates potential as the formulation with the most optimal nutritional profile and a favorable level of sensory acceptance. Its advantages are particularly evident in the balance of protein, fiber, and fat content, while in terms of sensory attributes, the formulation achieved acceptance levels comparable to the control. These results indicate that the use of cassava flour and oyster mushrooms offers a viable alternative for developing noodles based on local ingredients, although further formulation optimization is required to maintain the quality of texture and aroma. This study offers the advantage of evaluating the nutritional profile and sensory acceptance of noodles based on cassava flour and oyster mushrooms. However, it has certain limitations: the nutritional analysis was conducted without replication, meaning the results cannot be used to statistically test the significance of differences in nutritional content between formulations. Furthermore, the study utilized only three formulations and a limited number of panellists, and it did not evaluate physical characteristics such as springiness and color instrumentally, nor did it assess the product's shelf life. Future research should involve replicating nutritional analyses, developing a wider range of ingredient proportions, and conducting tests on physical properties, shelf life, and consumer acceptance with a larger panel.

Conclusion

This study demonstrates that partial substitution of wheat flour with cassava flour and the addition of fresh oyster mushrooms in composite noodles have the potential to produce a locally sourced food product with an acceptable nutritional and sensory profile. Formulation F1 was identified as the optimal formulation, based on its overall nutritional profile and sensory acceptance. F1 had a protein content of 9.23%, which met the minimum protein requirement for dried noodles stipulated by SNI 8217:2015, while the control formulation F0 also met the standard with a protein content of 8.65%. Organoleptically, F1 was accepted by the panellists, with preferences for color, aroma, and flavor comparable to the control, although a significant difference was observed in texture. The crude fiber content of F1 and F2 was identical at 0.20%, indicating that the formulations did not show a descriptive difference in measured crude fiber content. Therefore, further research is recommended to optimize the fiber content of cassava-based noodles through the use of appropriate high-fiber local ingredients or formulation modifications, while maintaining protein content and sensory acceptability. Further nutritional analysis with repeated measurements, dietary fiber analysis, instrumental evaluation of physical characteristics, and shelf-life testing are also recommended to provide more robust evidence for future product development.

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