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SENSORY ANALYSIS AND OPTIMUM COOKING TIME DRY NOODLES WITH UNRIPE BERLIN BANANA FLOUR SUBSTITUTION

Analisa Sensori dan Waktu Pemasakan Optimal Mi Kering Substitusi Tepung Pisang Berlin Mentah

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ABSTRACT

Dry noodles are widely consumed and generally made from wheat flour, which is low in fiber and micronutrients. Substitution with unripe Berlin banana flour (UBF), rich in resistant starch, is expected to improve nutritional value while maintaining sensory and cooking quality. This study aimed to analyze the sensory characteristics, nutritional value, and optimal cooking time of dry noodles substituted with UBF. Sensory analysis was carried out using hedonic and hedonic quality tests of color, taste, aroma, texture, and stickiness with 36 semi-trained panelists. Three formulas were tested with UBF and wheat flour ratios of F1 (10:90), F2 (15:85), and F3 (20:80). The best formulation was determined using the effectiveness index, followed by a proximate analysis of the selected formulation. Optimal cooking time was assessed in triplicate, and statistical analysis was performed using one-way ANOVA. The results showed that all formulas were rated as neutral in sensory attributes, and the best formulation was F2 (20 g UBF: 80 g wheat flour) with an effectiveness index of 0.937. The best formulation contained 13.56% protein and 11.60% moisture content. This indicates that the dried noodles substituted with UBF comply with SNI. The optimal cooking time increased with higher levels of UBF substitution.

Keywords: *dry noodle; functional food; Unripe Berlin Banana Flour (UBF)*

ABSTRAK

Mi kering merupakan makanan yang banyak dikonsumsi dan umumnya terbuat dari tepung terigu, yang rendah serat dan mikronutrien. Substitusi dengan tepung pisang Berlin mentah, kaya akan pati resisten, diharapkan dapat meningkatkan nilai gizi sekaligus mempertahankan kualitas sensori dan kualitas pemasakan. Penelitian ini bertujuan untuk menganalisis karakteristik sensori, nilai gizi, dan waktu pemasakan optimal mi kering yang disubstitusi tepung pisang Berlin mentah. Analisis sensori dilakukan menggunakan uji hedonik dan uji mutu hedonik terhadap warna, rasa, aroma, tekstur, dan kelengketan dengan melibatkan 36 panelis semi-terlatih. Tiga formula diuji dengan perbandingan tepung pisang Berlin mentah dan tepung terigu yaitu F1 (10:90), F2 (15:85), dan F3 (20:80). Formula terbaik ditentukan menggunakan indeks efektivitas, kemudian dilakukan analisis proksimat pada formulasi terpilih. Waktu pemasakan optimal diuji sebanyak tiga kali ulangan, dan analisis statistik menggunakan ANOVA. Hasil penelitian menunjukkan bahwa semua formula dinilai netral pada atribut sensori, dan formulasi terbaik adalah F2 (20 g tepung pisang Berlin mentah : 80 g tepung terigu) dengan indeks efektivitas sebesar 0.937. Formulasi terbaik memiliki kandungan protein 13.56% dan kadar air 11.60%. Hal ini menunjukkan bahwa mi kering yang disubstitusi dengan tepung pisang Berlin mentah memenuhi standar SNI. Waktu pemasakan optimal meningkat seiring dengan meningkatnya tingkat substitusi tepung pisang Berlin mentah.

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Kata Kunci : mi kering; pangan fungsional; tepung pisang berlin mentah

INTRODUCTION

Noodles are a major alternative staple food to rice and are widely favored by various segments of the Indonesian population. Noodles contain a relatively high amount of carbohydrates, which serve as an energy source for the body, making them a suitable substitute for rice. Among the various types of noodle products, dried noodles have the highest market competitiveness. Dried noodles are made primarily from wheat flour, with or without the addition of other permitted ingredients, through processes including mixing, sheeting, cutting, and drying until the moisture content reaches a maximum of 8%. This low moisture content contributes to their extended shelf life. Due to their practicality and high storage stability, dried noodles are among the most popular and widely consumed food products in many regions (Badan Standarisasi Nasional Indonesia, 2015).

In general, dried noodles are produced using wheat flour, which contains a high level of gluten-forming proteins that contribute to the elastic and chewy texture characteristic of noodles. The high dependence on wheat flour has led to a continuous increase in wheat imports. The large volume of imported wheat correlates with the high consumption of wheat-based processed foods such as instant noodles, bread, and cakes, which together account for approximately 80% of total wheat imports. The consumption of wheat flour in Indonesia has shown an increasing trend compared to previous years. This phenomenon can be attributed to several factors, including population growth, increased demand for wheat flour, and the expanding variety of wheat-based processed food products, reflecting a strong societal dependence on wheat-based foods (Ayu et al., 2024).

Efforts to reduce dependence on wheat flour require alternative ingredients that can partially or completely replace wheat flour with non-wheat flour sources. Several studies have utilized non-wheat ingredients in noodle production, including composite flours made from potato and tapioca (Effendi et al., 2016), as well as banana corm flour (Asnani et al., 2019). The exploration and utilization of local food resources remain essential for developing alternative raw

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materials for noodle production. One potential local ingredient with considerable development potential is unripe Berlin banana flour.

Unripe berlin banana flour (*Musa acuminata*) contains high levels of resistant starch, minerals, and dietary fiber. The resistant starch content in unripe berlin banana flour is higher than in flour from ripe berlin bananas, with levels reaching 40,01% per 100 g of unripe berlin banana flour (Febriyatna et al., 2018). These nutritional components make unripe berlin banana flour a promising functional ingredient capable of enhancing the nutritional value of processed foods. In addition, the use of unripe bananas as raw material for flour can extend shelf life and increase the economic value of bananas, which are often underutilized during periods of surplus harvest. Previous research conducted by Agustin et al. (2024) showed that the substitution of raw berlin banana flour as a local prebiotic source in synbiotic yogurt development did not have a significant negative effect on panelist preference levels for taste and aroma attributes. The development of dry noodles using unripe berlin bananas has never been done before. The use of unripe berlin banana flour in dry noodle production is expected not only to improve the nutritional quality of the product but also to support food diversification and reduce dependence on imported raw materials.

Cooking time also influences the quality of noodles. Prolonged cooking can disrupt the gluten network structure, thereby reducing noodle quality (Liu et al., 2025). The optimal cooking time of noodles is influenced by the ingredients used. The substitution of unripe berlin banana flour in dry noodle formulations may affect the physical, chemical, and sensory characteristics of the product. Therefore, a comprehensive study is needed to determine the optimal substitution level of unripe berlin banana flour to produce dry noodles with desirable sensory properties, improved nutritional value, and efficient cooking time.

METHOD

Design, place, and time

This study employed an experimental design using a completely randomized design (CRD). The research was conducted at the Dietetics Laboratory and Food Technology Laboratory of Politeknik Negeri Jember.

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Ethical approval was obtained from the Research Ethics Committee of Politeknik Negeri Jember (No. 0284/DST/PL17.4/DT.06.01/2026).

Preparation for making unripe berlin banana flour

Unripe Berlin bananas at stage 1 ripeness, characterized by a dark green peel and newly harvested condition, were selected for flour production. The bananas were peeled, washed, and sliced into 5 mm thick pieces. The banana slices were then soaked in distilled water in plastic bags at a banana-to-water ratio of 3:4 and fermented for 24 hours. After fermentation, the slices were drained and dried using a dehydrator at 60°C for 8 hours. The dried banana slices were subsequently crushed and milled into flour, then sieved through a 100-mesh sieve to obtain ready-to-use flour (Agustin et al., 2019; Wulandari, 2012).

Formulation and process of making dry noodles substituted with unripe berlin banana flour

The process and formulation for producing modified dry noodles were adapted from the method developed by Yuliana & Novitasari (2014). The dry noodle production process consisted of ingredient mixing, dough preparation, sheeting, shaping, steaming, drying, and cooling. Wheat flour and unripe Berlin banana flour were mixed according to the formulation shown in Table 1, followed by the addition of cooking oil, eggs, salt, and warm water. The ingredients were mixed until a homogeneous dough was obtained and then allowed to rest for 30 minutes. The dough was subsequently rolled until smooth, sheeted, and cut into noodle strands. The noodles were steamed for 10 minutes and dried in an oven at 150°C for approximately 1 hour to produce ready-to-use dry noodles.

Table 1. Dry Noodle Formula Substituted with Unripe Berlin Banana Flour

Composition	Dry Noodle Formula		
	F1	F2	F3
Unripe Berlin banana flour (g)	10	15	20
Wheat flour (g)	90	85	80
Egg (g)	30	30	30
Palm oil (mL)	15	15	15
Salt (g)	2.5	2.5	2.5

*modified formulation from Yuliana & Novitasari (2014)

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Organoleptic test

Organoleptic testing of dry noodles substituted with unripe Berlin banana flour (F1, F2, and F3) was conducted using hedonic testing and hedonic quality methods. The noodles were cooked in boiling water before organoleptic testing (Koh et al., 2022). The cooking time was 6.25 minutes. Sensory evaluation included the attributes of color, aroma, flavor, texture, and stickiness, and was conducted by 36 semi-trained panelists. The hedonic evaluation was conducted using a 5-point hedonic scale, where 1 = dislike, 2 = somewhat like, 3 = neutral, 4 = like, and 5 = very like. The hedonic quality evaluation included color, aroma, flavor, texture, and stickiness attributes. The color attribute was assessed using the following scale: 1 = very bright brownish-green, 2 = bright brownish-green, 3 = slightly dark brownish-green, 4 = dark brownish-green, and 5 = very dark brownish-green. Aroma (characteristic banana aroma) was evaluated as follows: 1 = very weak, 2 = weak, 3 = moderately strong, 4 = strong, and 5 = very strong. Flavor (banana flour aftertaste) was assessed using the following scale: 1 = very weak, 2 = weak, 3 = moderately strong, 4 = strong, and 5 = very strong. Noodle texture was evaluated as follows: 1 = very soft, 2 = soft, 3 = slightly chewy, 4 = chewy, and 5 = very chewy. Noodle stickiness was assessed using the following scale: 1 = very non-sticky, 2 = non-sticky, 3 = slightly sticky, 4 = sticky, and 5 = very sticky.

The best formula was determined based on the hedonic parameters of taste, color, texture, aroma, and stickiness of dry noodles using the effectiveness index method proposed by De Garmo EP, Sullivan WG (1994). Priority weighting was assigned to each hedonic parameter, including taste, color, texture, aroma, and stickiness. Each panelist provided a weighting score for each parameter, where a higher score indicated a greater level of importance.

Optimal cooking time

The optimum cooking time was determined using the cooking time parameter, which was defined as the time required for the noodles to reach a fully cooked condition. A 20-gram sample of dry noodles was boiled in 1 liter of boiling water, and after 2 minutes, the doneness level was checked every 15 seconds. The test was stopped when the noodles no longer showed a white color when pressed (Koh et al., 2022).

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The number of samples for optimum cooking time testing was determined using the calculation formula proposed by Gomez & Gomez, (1984) with three repetitions for each treatment.

Proximate analysis

Each treatment was analyzed using a proximate test that includes total energy content, energy from fat, ash content, moisture content, carbohydrates, total fat, and protein (Badan Standarisasi Nasional Indonesia, 2015; AOAC, 2005).

Data analysis

The analysis for the organoleptic test was performed using one-way analysis of variance (ANOVA) at the 5% significance level to determine significant differences (p< 0.05) between means. If it is significant, further testing is carried out using the Tukey test.

RESULT AND DISCUSSION

The panelists' acceptance in the hedonic test for the color and aroma of dry noodles was highest for treatment F2, with a mean score of 3.4 (neutral) and 3.4 (neutral), respectively. The highest acceptance of dry noodle flavor was in F2 and F3, with an average of 3.3 (neutral). The acceptance of dry noodle texture had an average of 3.3 neutral) in all groups. The highest acceptance of dry noodle stickiness was in F1 with an average of 3.6 (neutral). Statistical test results showed no differences between treatments in color, aroma, flavor, texture, and stickiness of dry noodles (p>0,05) (Table 2).

Table 2. Results of Hedonic Test, Hedonic Quality Test, and Optimum Cooking Time of Dry Noodles Substituted with Unripe Berlin Banana Flour

Sensory Attributes	Groups			p-value
	F1	**F2**	**F3**	
Hedonic Test				
Color	3.1±0.90 (neutral)	3.4±0.73 (neutral)	3.0±1.08 (neutral)	0.156
Aroma	3.1±0.92 (neutral)	3.4±0.69 (neutral)	3.3±1.03 (neutral)	0.350
Flavor	2.9±0.92 (somewhat like)	3.3±0.86 (neutral)	3.3±1.02 (neutral)	0.100
Texture	3.3±0.78 (neutral)	3.3±0.84 (neutral)	3.3±0.84 (neutral)	0.223
Stickiness	3.6±0.91 (neutral)	3.0±0.85 (neutral)	3.2±0.96 (neutral)	0.242
Hedonic Quality				
Color	2.2±0.56 [a] (Bright brownish-green)	2.9±0.49[b] (Bright brownish-green)	3.8±0.68[c] (slightly dark brownish-green)	<0.001*

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Sensory Attributes	Groups			p-value
	F1	**F2**	**F3**	
Aroma	2.3±0.76[a] (week banana aroma)	2.8±0.79[b] (week banana aroma)	3.4±0.91[c] (Moderately strong banana aroma)	<0.001*
Flavor	2.2±0.93[a] (weak flavor of banana flour)	2.9±0.89[b] (weak flavor of banana flour)	3.1±0.99[b] (moderately strong flavor banana flour)	<0.001*
Texture	2.8±0.68[a] (soft)	3.3±0.75[b] (slightly chewy)	3.4±0.68[b] (slightly chewy)	<0.001*
Stickiness	2.9±0.95[a] (non-sticky)	2.7±0.76[b] (non-sticky)	2.9±0.99[b] (non-sticky)	0.001*
Optimum Cooking Time (seconds)				
Mean±SD	370±8,6[a]	375±0.0[a]	435±0.00[b]	<0.001*

(*) p<0,05 One Way Anova test; Different superscript letters indicate a significant difference based on the test results of Tukey test

The hedonic quality assessment of dried noodles with the addition of unripe Berlin banana flour revealed significant differences in color and aroma. The more unripe Berlin banana flour was substituted, the browner-green the resulting color became and the stronger the banana aroma became. This result is almost identical to the findings regarding the color of dried noodles reported in the study by Iriyanti et al. (2021), which showed that the color of noodles substituted with Baranang banana flour turned brownish. Raw Berlin banana flour contains phenolic flavonoids and tannins that can be oxidized by the enzyme polyphenol oxidase (PPO). This results in the conversion of chlorophyll pigments into pheophytin during processing (mixing, drying, or cooking), thereby producing a brownish-green color (Anyasi et al., 2018; Anyasi et al., 2017). The banana aroma in dried noodles is due to the banana flour, which has a distinctive aroma as a raw material. The components of this banana aroma are isoamyl acetate, amyl acetate, amyl propionate, amyl butyrate, hexyl acetate, methyl acetate, pentanol, butyl alcohol, amyl alcohol, and hexyl alcohol (Anggraeni & Saputra, 2018). Meanwhile, the flavor, texture and stickiness of the dried noodles made using a formula with a ratio of raw Berlin banana flour to wheat flour were significantly different for F1 (10:90) compared to F2 (15:85) and F3 (20:80). However, the addition of raw Berlin banana flour did not affect the taste, texture, and stickiness in F2 and F3. The stickiness of the noodles is greatly influenced by the gluten content; the higher the gluten content, the

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stickier the dough tends to be (Anggraeni & Saputra, 2018). The source of gluten in this noodle formula is wheat flour (Kurniawan et al., 2015). The higher the percentage of wheat flour, the stickier the dough becomes. Research by Anggraeni & Saputra (2018) found that the addition of 10% raw Nangka banana flour to the noodles did not result in a significant difference in the acceptance of stickiness and flavor in the dried noodles compared to those without the addition of unripe Nangka banana flour. The panelists' preferences regarding aroma and taste parameters may also be influenced by the preparation method and raw materials. These two factors significantly influence color, mouthfeel, and overall preference (Zhou et al., 2013).

Dried noodles made with unripe Berlin banana flour have a faint aftertaste of banana flour. Banana flour is obtained from green or unripe bananas, which at this stage have an astringent taste caused by their content of condensed tannins or proanthocyanidins (Ovando-Martinez et al., 2009). In terms of stickiness, the dried noodles in this study fall into the non-sticky category. This fact may be because unripe Berlin banana flour is a gluten-free ingredient (Marcela et al., 2019). The gluten content in noodles affects their stickiness; the higher the gluten content, the stickier the dough (Kurniawan et al., 2015).

The optimal cooking time is the time required for the noodles to cook through. Cooking time can be influenced by the ingredients used, the thickness of the noodles, and the starch gelatinization temperature (Yuliana & Novitasari, 2014; Zhou et al., 2013; Zulman Effendi et al., 2016). In this study, the optimal cooking time for dried noodles made with unripe Berlin banana flour showed significant differences between groups ($p<0.05$). Formula F3 required a longer cooking time than formula F2 (Table 2). Excessively long cooking times resulted in a reduction in firmness, elasticity, hardness, and extensibility, as well as a softer noodle texture. Heating causes denaturation of gluten proteins, altering the gluten network structure and exposing starch granules, which gradually absorb water and swell, thereby enlarging the internal pores of the gluten network (Liu et al., 2025). Raw banana flour is rich in type II RS, which has a denser crystalline structure and is more resistant to gelatinization than ordinary starch. Consequently, heat and water take longer to

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penetrate the starch granules, meaning the noodles require a longer cooking time (Ovando-Martinez et al., 2009). In the study by Balmurugan et al. (2022) it was found that the optimum cooking time for dry noodles substituted with 45% unripe banana flour was 9 minutes. Meanwhile, the optimal cooking time for dried noodles containing 10% and 20% raw Nangka banana flour is 4 minutes (Anggraeni & Saputra, 2018). The addition of protein to the formulation can lead to competition between carbohydrates and protein. Unripe Berlin banana flour contains 86.02% carbohydrates and 4.23% protein per 100 g of flour (Agustin et al., 2019). This phenomenon occurs because carbohydrates and proteins compete with one another to utilize the limited amount of water in the system. Proteins tend to inhibit the entry of water into the starch granules. Water plays a vital role in the starch gelatinization process and is bound by proteins; consequently, the process takes longer due to this competition (Trisnawati & Nisa, 2015).

Based on the results of the effectiveness index assessment, the best formula was found to be F2, with a ratio of raw Berlin banana flour to wheat flour of 15:85 and an effectiveness index value of 0.937. Meanwhile, the effectiveness index for F1 was 0.081 and for F3 0.642. The highest weighting for the importance of variables, as determined by the panelists, was for the taste indicator with a weight of 1, followed by color at 0.68, texture at 0.61, aroma at 0.6, and stickiness at 0.45. This is consistent with related research on noodle selection preferences, which indicates that taste is a priority in consumer choice, depending on whether it aligns with the consumer's preferences or not (Mulyadi & Fauziyah, 2014).

Table 3. **Proximate Analysis of F2 Formula Dry Milk per 100 g**

Parameter	N	ALG	SNI
Total calories (kkal)	389.47	2150	-
Calories from fat (kkal)	83.07	603	-
Ash (%)	2.57	-	Max 0.1
Water (%)	11.60	-	Max 13
Carbohydrate (%)	63.02	325	-
Fat (%)	9.23	67	-
Protein (%)	13.58	60	Min 10

ALG: Angka Label Gizi (Indonesian RDA); SNI 8217:2015

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The proximate analysis in Table 3 shows that formula F2 indicates that dried noodles substituted with raw berlin banana flour contain 13.58% protein and comply with SNI standards. According to SNI 8217:2015, dried noodles in their dry form must have a minimum protein content of 10%. The moisture content of the dried noodles is 11.60% and complies with SNI. According to SNI, dried noodles must have a maximum moisture content of 13%. Based on nutritional claims from the BPOM, the best dried noodle formulation is classified as a source of protein, as it contains more than 20% ALG (Badan Pengawas Obat dan Makanan, 2022). The protein sources in this formulation are eggs and wheat flour. According to research by Anggraeni & Saputra (2018) and Choo & Aziz (2010), the protein content of noodles increases with an increase in the content of raw banana flour. The presence of gluten in the mixture can lead to a significant increase in protein content (Anggraeni & Saputra, 2018; Choo & Aziz, 2010). A limitation of this study is that proximate analysis was only conducted on the best formula, F2; however, the testing was carried out in duplicate, thereby enhancing the precision of the results.

CONCLUSION

The best formula is F2, with a ratio of 20 g of unripe banana flour to 80 g of wheat flour and an effectiveness index of 0.937. These dried noodles have a protein content of 13.58% and comply with SNI 8217:2015 regarding standards for dried noodles. According to the BPOM nutritional claims, dry noodles made with the F2 raw unripe banana flour formula are a source of protein. The optimal cooking time for dry noodles in this study was found to increase with the increase in the content of unripe banana flour and was optimal at 375 seconds or 6.25 minutes for the F2 formula.

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