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INNOVATION OF DRY NOODLES AS A SOURCE OF ENERGY, PROTEIN, AND IRON BASED ON CHICKEN LIVER, COWPEAS, AND SWEET POTATOES

Inovasi Mi Kering Sumber Energi, Protein, dan Zat Besi Berbasis Hati Ayam, Kacang Tunggak, dan Ubi Jalar

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ABSTRAK

Anemia merupakan masalah kesehatan masyarakat utama di Indonesia, dengan anemia defisiensi besi sebagai jenis yang paling umum. Meskipun Survei Kesehatan Indonesia tahun 2023 menunjukkan penurunan prevalensi anemia dari 23,7% pada tahun 2018 menjadi 16,2% pada tahun 2023, termasuk pada ibu hamil dari 48,9% menjadi 27,7%, angka tersebut masih tergolong tinggi. Oleh karena itu, diperlukan upaya berkelanjutan untuk meningkatkan konsumsi pangan sumber zat besi dan protein. Mi kering sebagai pangan pokok yang banyak dikonsumsi berpotensi ditingkatkan nilai gizinya melalui substitusi sebagian tepung terigu dengan bahan pangan lokal seperti hati ayam, tepung kacang tunggak, dan tepung ubi jalar yang kaya zat besi, protein, dan karbohidrat. Penelitian ini bertujuan untuk untuk mengetahui pengaruh formulasi ketiga bahan terhadap mutu mi kering meliputi sifat organoleptik, kandungan zat gizi makro, zat besi, umur simpan, dan harga jual. Penelitian eksperimental dilakukan dengan tiga formulasi hati ayam, tepung kacang tunggak, dan tepung ubi jalar, yaitu F1 (50%:30%:20%), F2 (40%:35%:25%), dan F3 (30%:40%:30%). Hasil uji organoleptik menggunakan metode hedonik yang dilakukan oleh 30 panelis non-standar menunjukkan bahwa formulasi F3 memiliki tingkat penerimaan tertinggi dengan skor 6,20. Analisis zat gizi menunjukkan bahwa mi kering F3 mengandung energi 414 kkal, protein 14,31g, lemak 9,16g, dan karbohidrat 68,58 g per 100g. Selain itu, F3 memiliki daya simpan selama 147 hari pada suhu ruang dan harga jual sebesar Rp6.000 per porsi. Substitusi tepung terigu dengan hati ayam, tepung kacang tunggak, dan tepung ubi jalar dapat meningkatkan nilai gizi mi kering dan berpotensi untuk membantu pencegahan anemia defisiensi besi di Indonesia.

Kata kunci: *anemia, hati ayam, kacang tunggak, mi kering, ubi jalar*

ABSTRACT

Anemia remains a major public health challenge in Indonesia, with iron deficiency anemia constituting the most prevalent form. Although the 2023 Indonesia Health Survey reported a decline in anemia prevalence from 23.7% in 2018 to 16.2% in 2023—including a reduction among pregnant women from 48.9% to 27.7%—these levels remain substantially high. Consequently, sustained interventions are necessary to increase the intake of iron and protein-rich foods. Dry noodles, as a widely consumed staple food, present considerable potential for nutritional enhancement through the partial substitution of wheat flour with locally available food ingredients such as chicken liver, cowpea flour, and sweet potato flour, which are rich sources of iron, protein, and carbohydrates. This study aimed to evaluate the effects of different formulations of these three ingredients on the quality of dry noodles, including organoleptic properties, macronutrient composition, iron content, shelf life, and market price. An experimental study was conducted using three formulations of chicken liver, cowpea flour, and sweet potato flour, respectively: F1 (50%:30%:20%), F2 (40%:35%:25%), and F3 (30%:40%:30%). Organoleptic evaluation using a hedonic method performed by 30 non-standard panelists demonstrated that formulation F3 achieved the highest level of

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acceptability, with a mean score of 6.20. Nutritional analysis revealed that F3 dry noodles contained 414 kcal of energy, 14.31 g of protein, 9.16 g of fat, and 68.58 g of carbohydrates per 100 g. Furthermore, formulation F3 exhibited a shelf life of 147 days at room temperature and a selling price of IDR 6,000 per serving. Overall, the substitution of wheat flour with chicken liver, cowpea flour, and sweet potato flour significantly enhanced the nutritional value of dry noodles and demonstrates potential as a dietary strategy for the prevention of iron deficiency anemia in Indonesia.

Keywords: Anemia, chicken liver, cowpea, dry noodles, sweet potato

INTRODUCTION

Iron deficiency anemia is a public health problem that persists in Indonesia, particularly among pregnant women, adolescents, and children. Anemia occurs when the red blood cell count falls below normal limits, inhibiting oxygen transport to various body tissues [1]. Based on the cause, there are various types of anemia, such as iron deficiency anemia, megaloblastic anemia, hemolytic anemia, aplastic anemia, and anemia due to chronic disease, pregnancy, or bleeding. Iron deficiency is widely recognized as the most prevalent cause of anemia worldwide; however, anemia may also arise from a range of other etiological factors, including deficiencies of key micronutrients such as folate, vitamin B12, and vitamin A, as well as acute and chronic inflammatory conditions, parasitic infections, and inherited disorders that impair hemoglobin synthesis, red blood cell production, or red blood cell survival [2].

Anemia has an adverse effect that can cause growth and development disorders in children, a decrease in the immune system, and decreased productivity in adults [3]. The 2023 Indonesian Health Survey showed the national prevalence of anemia declined to 16.2%, compared with 23.7% in 2018. Similarly, the prevalence of anemia among pregnant women decreased from 48.9% to 27.7% [4]. Nevertheless, despite this improvement, the prevalence of anemia in pregnant women in Indonesia remains above 20% and is therefore classified as a moderate public health problem according to World Health Organization criteria [1]. Consequently, sustained interventions are necessary to increase the intake of iron and protein-rich foods [5].

Noodles are an alternative staple food that is widely consumed in Indonesia [6]. Wheat-based noodles have relatively low protein and iron content. Developing dry noodles using local food sources of iron and protein could be an innovative solution to address the problem of anemia in Indonesia. Noodles can be modified by replacing some of the flour with local ingredients such as chicken liver, cowpea flour, and sweet potato flour. Chicken liver is a local food source of animal protein and heme iron, which has a higher absorption rate than non-heme iron [3]. Chicken liver contains 27.4 g of protein and 15.8 mg of iron per 100 g [7]. Previous research reported that giving chicken liver along with iron tablets was faster in increasing hemoglobin levels in anemic adolescent girls [8].

Cowpeas, or tolo beans, are a type of local legume that is the second most important source of vegetable protein after soybeans. Every 100 g of cowpeas contains 24.4 g of protein. Furthermore, cowpeas have the highest iron content among other legumes, at 13.9 mg per 100 g [7]. One local food source that is affordable and abundant is the sweet potato. Fresh white sweet potatoes contain 20.6% carbohydrates[7], while white sweet potato flour contains 81.74-84.83% carbohydrates [9], so that it can be an alternative energy source in the development of dry noodles.

Previous studies have used these ingredients in product development to address nutritional issues. High-iron and zinc complementary food biscuits were developed from cowpea flour and chicken liver [10]. In addition, chicken liver sausage has also been developed to treat anemia in adolescent girls [11], as well as crispy noodles made from chicken liver, mocaf, and pumpkin seeds to prevent anemia [12]. Sweet potatoes have

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also been widely used in the development of dry noodles, combined with other ingredients such as soy flour [13], meniran [14], and modified cassava flour [15].

The use of these local food ingredients is expected to produce dry noodles rich in iron and protein, and has the potential to serve as an alternative staple food to help combat iron deficiency anemia. This study aimed to evaluate the effect of chicken liver, cowpea flour, and sweet potato flour formulations on the organoleptic properties, macronutrient content, iron content, and shelf life of dry noodles.

METHODS

This research is an experimental laboratory study using three formulations of chicken liver, cowpea flour, and sweet potato flour. The research was conducted from June to November 2024 and has received ethical approval from the Health Research Ethics Commission of the Bandung Ministry of Health Polytechnic on June 2, 2024, No. 66/KEPK/EC/V/2024. There are three dry noodles samples in this study with different formulations of chicken liver, cowpea flour, and sweet potato flour, namely F1: 50%: 30%: 20%, F2: 40%: 35%: 25%, and F3: 30%: 40%: 30%. The determination of this formulation is based on initial trials (trial-and-error) and nutritional value calculations to obtain optimal iron and protein content. The trial-and-error phase is a gradual development process to obtain the optimal formulation and process. Three dry noodles production trials were conducted using different formulations and equipment until the correct formulation and processing steps were achieved. The nutritional value of the dry noodles was calculated using nutritional reference tables (TKPI, related journals) and calculation software.

The independent variable was the formulation of chicken liver, cowpea flour, and sweet potato flour, while the dependent variables consisted of organoleptic properties, macronutrient content (protein, fat, carbohydrate), iron content, and shelf life of dry noodles. The research stages included ingredients preparation, making cowpea flour and sweet potato flour, determining the formulation, making dry noodles, organoleptic testing, analysis of macronutrient content, iron content, and shelf life testing.

Preparation of Ingredients

During the chicken liver preparation stage, fresh chicken livers were selected based on their bright coloration, mild odor, and firm, intact texture. The livers were thoroughly washed under running water to remove residual blood and impurities, and visible fat was carefully trimmed. Subsequently, the livers were marinated in lime juice for 10 minutes to mitigate undesirable odors. The marinated livers were then boiled for 20–25 minutes with aromatic spices, including bay leaves, lime leaves, and lemongrass, to further reduce the characteristic off-flavor [11]. After boiling, the chicken livers were allowed to cool and were subsequently ground into a smooth, homogeneous paste, which was then ready for incorporation with the other ingredients.

Cowpea flour was produced from dried cowpeas and utilized as a partial substitute for wheat flour owing to its high protein and iron content. The processing of cowpea flour began with washing the dried cowpeas to remove adhering dust and impurities, followed by boiling for 60 minutes to reduce the undesirable beany aroma associated with lipoxygenase enzyme activity [16], [17]. Thermal treatment during boiling effectively inactivates the lipoxygenase enzyme [17]. After boiling, the cowpeas were dried using a food dehydrator at 90 °C for 5–6 hours. The dried cowpeas were subsequently milled using a grinder and sieved through a 100-mesh sieve to obtain a fine, uniform flour. The resulting cowpea flour was stored in thick polypropylene ziplock bags to protect it from deterioration during storage.

Sweet potato flour was produced from white-fleshed sweet potatoes and used as a partial substitute for wheat flour in combination with chicken liver and cowpea flour. The processing of sweet potato flour began with peeling and washing to remove adhering

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soil and impurities. The tubers were then sliced to a thickness of 1–2 mm and soaked for 15 minutes to remove exuded sap. Subsequently, the sweet potato slices were dried using a food dehydrator at 90 °C for 4–5 hours. The dried slices were then milled using a grinder and sieved through a 100-mesh sieve to obtain a fine, uniform flour [18]. The resulting flour was stored in thick polypropylene ziplock bags to protect against deterioration during storage.

Making Dry Noodles

Dry noodles was produced by substituting 37.5% of the wheat flour with chicken liver, cowpea flour, and sweet potato flour, along with the addition of tapioca, eggs, cooking oil, salt, and water. The steps for making dry noodles are shown in Figure 1.

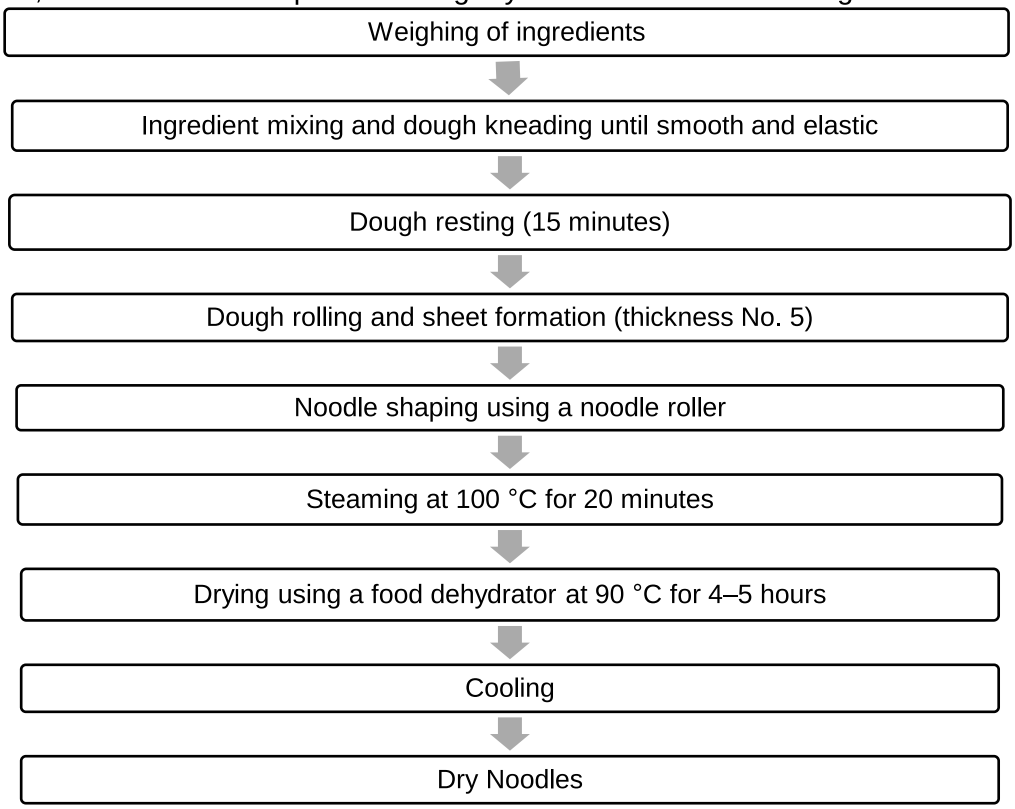

Figure 1. Dry Noodle Making Process[15], [19] with Modifications

Organoleptic Test of Dry Noodles

The organoleptic evaluation was conducted using a hedonic (preference) test employing a seven-point hedonic scale, ranging from 1 (dislike very much) to 7 (like very much). This evaluation was designed to determine panelists' preferences for organoleptic attributes, including taste, aroma, color, texture, and overall acceptability. Three dry noodle samples were evaluated by 30 non-standard panelists who met the inclusion criteria of being in good health and having an adequate understanding of hedonic scaling and the basic principles of organoleptic evaluation [20]. Panelists with known allergies to chicken liver or cowpeas were excluded from the study. Before the evaluation, all participants received a standardized explanation of the study procedures and provided written informed consent. The hedonic test was conducted in the Organoleptic Laboratory, Department of Nutrition, Poltekkes Kemenkes Bandung.

The results of the hedonic evaluation of dry noodles for each sensory attribute are presented as bar graphs illustrating the mean preference scores assigned by the panelists. To assess the effect of different formulations of chicken liver, cowpea flour, and sweet potato flour on each organoleptic attribute of the dry noodles, a Kruskal–Wallis test was applied at a 95% confidence level ($\alpha = 0.05$), as the data did not follow a normal

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distribution. When the Kruskal–Wallis test indicated a statistically significant difference ($p \leq \alpha$), pairwise comparisons were subsequently conducted using the Mann–Whitney U test to identify specific differences among treatments [21].

Analysis of Macronutrient Content, Iron, and Shelf Life of Dry Noodles

Macronutrient composition analysis was conducted at the Saraswanti Indo Genetech Laboratory, Bogor. The parameters analyzed included energy, protein, fat, and carbohydrate contents. Energy values were calculated based on the energy contributions of fat, carbohydrates, and protein. Protein content was determined using the Kjeldahl method, while fat content was measured using the gravimetric method. In addition, moisture and ash contents were analyzed using the thermogravimetric method [22]. Shelf-life assessment was performed using an accelerated gravimetric method under room temperature conditions.

RESULT

In this study, a total of 37.5% of the wheat flour was substituted with chicken liver, cowpea flour, and sweet potato flour in three different formulations (F1, F2, and F3). Other ingredients added were tapioca, eggs, cooking oil, salt, and water. The main ingredient formulations for making dry noodles can be seen in Table 1.

Table 1. Dry Noodle Formulation with Chicken Liver, Cowpea Flour, and Sweet Potato Flour Substitutions

Material (Unit)	Formulation of Chicken Liver, Cowpea Flour, and Sweet Potato Flour		
	F1: 50%:30%:20%	F2: 40%:35%:25%	F3: 30%:40%:30%
Chicken liver (g)	30	24	18
Cowpea flour (g)	18	21	24
Sweet potato flour (g)	12	15	18
Wheat flour (g)	100	100	100

Dry noodles formulated with substitutions of chicken liver, cowpea flour, and sweet potato flour exhibited a brownish coloration, which can be attributed to the inherent pigments of chicken liver and cowpea flour. An increase in the proportion of chicken liver resulted in a progressively darker noodle color. The texture of the dry noodles was firm and elastic, with no observable differences among formulations F1, F2, and F3. A slightly fishy aroma was detected, with its intensity increasing in accordance with higher levels of chicken liver formulation. The visual appearance of the dry noodles produced from the three formulations is presented in Figure 2.

Dry Noodles (F1) Dry Noodles (F2) Dry Noodles (F3)

Figure 2. Dry Noodle Product Based on Chicken Liver, Pea Flour, and Sweet Potato Flour

Organoleptic Properties of Dry Noodles

Dry noodles F1, F2, and F3 were boiled without any additional seasoning before being served to the panelists. The organoleptic properties of the three dry noodle variations were tested using a hedonic test method by 30 non-standard panelists. The results of the panelists' preference evaluation for the three dry noodle samples for each organoleptic attribute were then averaged to obtain a mean panelist preference score.

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The results can be seen in Figure 3. The data show that based on overall preference, the most preferred dry noodle product is F3 with a score of 6.20, which is in the range of "like moderately" to "like very much". Dry noodles F3 excelled in all attributes, namely taste, aroma, color, texture, and overall. Meanwhile, the product with the lowest preference was dry noodles F1 with a score of 5.40, which is in the range of "like slightly" to "like moderately", while dry noodles F2 took second place with a score of 5.60. In general, panelists preferred dry noodles containing chicken liver, cowpea flour, and sweet potato flour substitutes, but the level of preference tended to decrease as the chicken liver formulation increased.

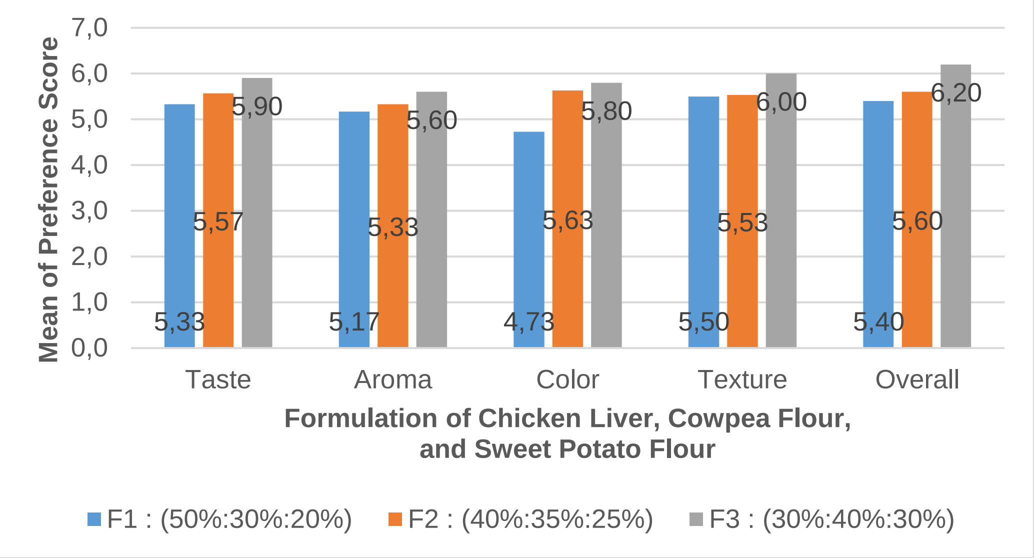

Figure 3. Average Panelist Preference Score for the Organoleptic Properties of Dry Noodles

The influence of the chicken liver, cowpea flour, and sweet potato flour formulations on the organoleptic properties of dry noodles was analyzed using statistical tests. The normality test using the Shapiro–Wilk method showed that the data were not normally distributed ($p < 0.001 < \alpha = 0.05$). Therefore, the Kruskal-Wallis test was applied to analyze the differences among formulations. The results of the analysis are presented in Table 2.

Table 2. Effect of Chicken Liver, Cowpea Flour, and Sweet Potato Flour Formulation on the Organoleptic Properties of Dry Noodles

Treatment	Flavor		Aroma		Color		Texture		*Overall*	
	Median (Min-Max)	p-value	Median (Min-Max)	p-value	Median (Min-Max)	p-value	Median (Min-Max)	p-value	Median (Min-Max)	p-value
F1	5.5 (3-7)		5.0 (3-6)		5.0 (2-7)		6.0 (3-7)		6.0 (4-7)	
F2	6.0 (4-7)	0.127	6.0 (3-7)	0.128	6.0 (3-7)	0.001*	6.0 (4-7)	0.095	5.5 (4-7)	<0.001*
F3	6.0 (4-7)		6.0 (3-7)		6.0 (3-7)		6.0 (4-7)		6.0 (5-7)	

*) p ≤ α (0.05)

Based on the data in Table 2, it can be concluded that there is an effect of the formulation on the color and overall attributes of dry noodles. Further test results using the Mann-Whitney test showed that dry noodles F1 and F2 differed in color attributes (p=0.004 ≤ α=0.05), dry noodles F1 and F3 differed in color and overall attributes (p<0.001 ≤ α=0.05), and dry noodles F2 and F3 differed in overall attributes (p=0.004 ≤ α=0.05). On the other hand, there was no effect of the formulation on taste (p=0.127> α=0.05), aroma (p=0.128 > α=0.05), and texture (p=0.127 > α=0.095) of dry noodles.

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Nutritional Content of Dry Noodles

The nutritional content of dry noodles from three formulations of chicken liver, cowpea flour, and sweet potato flour was analyzed in an accredited laboratory at the Saraswanti Indogenetech Bogor Laboratory. The nutritional content analyzed included energy, carbohydrates, protein, fat, and iron, as well as moisture and ash content. The results of the dry noodle analysis are shown in Table 3.

Table 3. Nutritional Content of Dry Noodles (per 100 g)

Nutrient content	Formulation of Chicken Liver, Cowpea Flour, and Sweet Potato Flour		
	F1(50%:30%:20%)	F2(40%:35%:25%)	F3 (30%:40%:30%)
Energy (kcal)	414.75	414.99	414.00
Protein (g)	16.56	15.30	14.31
Fat (g)	9.41	9.35	9.16
Carbohydrates (g)	65.96	67.42	68.58
Iron (mg)	5.47	6.41	8.34
Water content (g)	3.77	4.03	4.26
Ash content (g)	4.31	3.92	3.70

The results of the nutritional composition analysis presented in Table 3 indicate that dry noodle formulations F1, F2, and F3 exhibited comparable energy values, ranging from approximately 414 to 415 kcal per 100 g. The protein content of the dry noodles ranged from 14.31 to 16.56 g per 100 g, while the fat content ranged from 9.16 to 9.41 g per 100 g. Carbohydrate content varied between 65.96 and 68.58 g per 100 g. In addition, the iron content ranged from 5.47 to 8.34 mg per 100 g, the moisture content from 3.77 to 4.26%, and the ash content from 3.70 to 4.31% per 100 g of dry noodles.

Shelf Life of Dry Noodles

Shelf-life evaluation was performed on the dry noodle formulation with the highest organoleptic acceptability, namely formulation F3. The analysis was conducted at PT. Sibaweh Laboratories uses the accelerated gravimetric method. The results indicated that dry noodles packaged in metallized plastic window standing pouches and stored at room temperature exhibited a shelf life of 147 days.

DISCUSSION

Dry noodles are conventionally produced using wheat flour as the primary ingredient. In this study, 37.5% of the wheat flour was substituted with chicken liver, cowpea flour, and sweet potato flour to enhance the protein and iron content of the product. Complete replacement of wheat flour was not feasible, as gluten proteins are essential for developing the elastic and firm noodle structure [19]; total substitution would result in noodles with a brittle and inelastic texture. Nevertheless, partial substitution with these alternative ingredients yielded dry noodles with substantially higher protein and iron contents compared with conventional products, representing a key advantage of the formulation developed in this study.

In addition to these ingredients, other ingredients are needed, namely tapioca, eggs, cooking oil, salt, and water. The addition of tapioca is necessary to increase the carbohydrate content and help form the optimal texture of the dry noodles. Eggs can increase the protein content of the noodles and also help produce strong, fluffy noodles. Cooking oil is added to prevent the noodle dough from becoming too sticky and to increase the total energy content of the dry noodles. Water acts as a solvent and helps form the chewy gluten properties. Salt can help bind water, strengthen the noodle texture, and add flavor to the dry noodles[19].

Dry noodle production commenced with weighing the ingredients according to the formulation, followed by uniform mixing of flour and water to ensure adequate hydration and homogeneous gluten development. The dough was kneaded to promote gluten

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formation, with the dough temperature maintained between 25 and 45 °C to preserve optimal dough rheology; temperatures below this range result in brittle dough, whereas higher temperatures promote stickiness due to increased enzymatic gluten degradation [19]. The dough was then rested at room temperature for 10–15 min to allow further gluten development and uniform water distribution [15], [19]. Subsequently, the dough was sheeted using a noodle roller to align and smooth the gluten network [19], and cut into strands approximately 2 mm in width. The noodles were steamed for 20 min, during which starch gelatinization and gluten coagulation occurred, yielding a firm and elastic texture [19], [23]. The steamed noodles were then dried in a food dehydrator at 90 °C for 4–5 h to reduce moisture content and inhibit microbial growth [24]. Before packaging, the dried noodles were cooled to room temperature to prevent condensation and subsequent mold development [19].

Organoleptic Properties of Dry Noodles

Formulation F3 was identified as the most preferred dry noodle product by the panelists. The mean hedonic score for taste in F3 was 5.90, reflecting its lower proportion of chicken liver and higher levels of cowpea and sweet potato flours. This formulation produced a mild chicken liver flavor that was balanced by the characteristic notes of sweet potato and cowpea. Increasing the proportion of chicken liver was associated with reduced taste acceptability, likely due to its bitter taste. This finding was consistent with previous studies on chicken liver–based MPASI biscuits [10]and chicken liver–based biscuits formulated for pregnant women [25] . Conversely, higher levels of sweet potato flour were associated with improved taste preference, in agreement with earlier research on sweet potato–substituted dry noodles [14]. The flavor contribution of cowpea flour was not dominant in the final product.

A similar trend was observed for aroma, with dry noodle F3 receiving the highest mean score (5.60) and F1 the lowest. Aroma acceptability was primarily influenced by the level of chicken liver, as higher formulation resulted in a more fishy aroma and reduced panelist preference, consistent with previous findings in chicken liver–enriched sausage products [11].

Color evaluation also favored formulation F3, which achieved a mean score of 5.80. The color of the dry noodles was largely determined by the amount of chicken liver formulation; higher levels of chicken liver produced a darker brown color due to myoglobin denaturation during heating [11], [26]. Darker noodle coloration was less preferred by panelists, aligns with earlier reports on chicken liver–substituted MPASI biscuits [10].

Texture assessment further supported the preference for F3, which attained the highest mean score (6.00). Higher chicken liver content resulted in a softer dough that was easier to process but produced boiled noodles with a stickier and more brittle texture, likely attributable to the high moisture content of chicken liver (53.4 g/100 g) [7]. In contrast, increased formulation of cowpea flour improved textural quality, as higher protein content contributed to a firmer, chewier, and less fragile noodle structure [27].

Consistent with the individual sensory attributes, overall acceptability was highest for formulation F3. Statistical analysis revealed that the formulations significantly affected color and overall acceptability, whereas no significant differences were observed for taste, aroma, or texture. The darker color associated with higher chicken liver proportions was readily perceived by panelists and exerted a significant influence on preference, indicating that color was a key determinant of overall sensory acceptance of the dry noodles.

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Nutritional Content of Dry Noodles

The energy content of dry noodle formulations F1, F2, and F3 was comparable, ranging from approximately 414 to 415 kcal per 100 g. According to the Indonesian Food Composition Table, conventional dry noodles contain 339 kcal per 100 g[7], while market survey reports an average energy content of approximately 360 kcal per 100 g. The higher energy values observed in the substituted dry noodles are attributable to the addition of oil during formulation and the use of energy-dense substitute ingredients, namely chicken liver, cowpea flour, and sweet potato flour[7]. These findings are consistent with previous reports on dry noodles formulated with chicken liver and red beans, which exhibited an energy content of 417.1 kcal per 100 g [28].

The protein content of dry noodles ranged from 14.31 to 16.56%, increasing with higher formulation of chicken liver and decreasing with greater amounts of cowpea and sweet potato flour. This trend reflects the high protein content of chicken liver (27.4%) [7], compared with the relatively low protein content of white sweet potato flour (2.11–4.46%). The protein content of the formulated dry noodles exceeded that of conventional dry noodles (10%) [7] and met the Indonesian National Standard (SNI 8217:2015), which specifies a minimum protein content of 10% for dry noodles [29]. Based on regulations about processed food claims, formulation F3 may be classified as a source of protein, as its protein content (14.31 g per 100 g) corresponds to 23.8% of the Nutrient Label Reference. Solid food products may be claimed as a protein source if they provide at least 20% of the Nutrition Label Reference per 100 g [30], [31].

The fat content of dry noodles ranged from 9.16-9.23% and increased with a higher level of chicken liver formulation, which contains approximately 16.1% fat [7]. The fat content of formulated dry noodles was substantially higher than that of conventional dry noodles (1.7%) [7], largely due to oil addition during processing. These values are comparable to those reported for dry noodles formulated with chicken liver and red beans (9.19–10.25%)[28].

Carbohydrate content ranged from 65.96% to 68.58% and increased with greater substitution of sweet potato flour, which is rich in carbohydrates (81.74–84.83%) [9]. In contrast, higher inclusion of chicken liver and cowpea flour resulted in lower carbohydrate levels due to their higher protein and fat contents [7]. The carbohydrate content observed in this study is consistent with that reported for dry noodles formulated with chicken liver and red beans (59.04–68.61%) [28].

Modifying dry noodles by adding chicken liver and cowpea flour was intended to enhance the iron content of these products. The results demonstrated iron levels ranging from 5.47 to 8.34 mg per 100 g, which are higher than those reported for dry noodles formulated with chicken liver and red beans (1.2–2.1 mg per 100 g) [28] and conventional wheat-based dry noodles (3.9 mg per 100 g) [7]. Based on processed food labeling regulations, formulation F3 may be classified as high in iron, as its iron content (8.34 mg per 100 g) corresponds to 37.9% of the Nutrition Label Reference. A solid food product may be claimed as high or rich in iron if it provides at least 30% of the Nutrition Label Reference per 100 g[30], [31].

In addition to nutrient content, moisture and ash content were analyzed. Moisture content ranged from 3.77% to 4.26%, meeting the quality standard for dried noodles, which specifies a maximum moisture content of 13% for dry noodles [29]. Moisture content increased with higher proportions of cowpea and sweet potato flours but decreased with greater formulation of chicken liver, likely due to evaporation of its high moisture content (53.4%) during drying [7] These values are comparable to those reported for dry noodles formulated with gembili and rice bran (2.67–8.8%) [32], and chicken liver–red bean dry noodles (4.00–7.76%) [28], and are lower than those reported for sweet potato dry noodles (5.86–6.15%) [33], [34], and wheat-based dry noodles (10.6%) [7].

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The ash content of dried noodles ranged from 3.70 to 4.31%, which is higher than values reported for chicken liver–red bean dry noodles (2.02-3.03%) [28]. The ash content of the dry noodles in this study was comparable to that reported for dry noodles produced from yellow sweet potato varieties, which contain approximately 4.27% ash [33].

Based on the nutritional profile, a serving size of approximately 80 g was established to ensure comparability with similar products available on the market. One serving of dry noodles provides 331.2 kcal of energy, 11.4 g of protein, 54.9 g of carbohydrates, and 6.7 mg of iron. The energy content per serving is comparable to that of 200 g of cooked rice (320 kcal) [7], while offering substantially higher protein and iron contents.

Shelf Life of Dry Noodles

Dry noodles are classified as low-moisture food products and therefore generally exhibit a relatively long shelf life. They are typically packaged in plastic materials and stored at room temperature. In this study, dry noodles packaged in metallized plastic window standing pouches (22 × 15 cm) exhibited a shelf life of 147 days at room temperature. Previous studies have reported shelf life for sweet potato–based dry noodles ranging from 55 to 150 days, depending on the type of packaging material used [34]

The shelf life observed in this study was shorter than that of commercial dry noodles, which commonly range from 6 months to 1 year. This difference may be attributed to differences in packaging materials and raw ingredients. The formulation of chicken liver, cowpea, and oil increased the lipid content of the dry noodles, rendering the product more susceptible to deterioration through lipid oxidation. Although dry noodles possess low moisture content, which limits microbial spoilage [29]. Lipid oxidation remains a primary factor affecting product stability. Commercial dry noodle products typically contain added antioxidants to inhibit lipid oxidation, thereby extending shelf life. Alternatively, the selection of packaging materials with superior barrier properties may further enhance shelf-life stability [34].

CONCLUSION

The dry noodle formulation with the most favorable organoleptic properties was F3, which achieved the highest overall mean hedonic score (6.20) with a formulation of chicken liver, cowpea flour, and sweet potato flour of 30%:40%:30%. Statistical analysis demonstrated that the formulation significantly affected the color ($p = 0.001 \leq \alpha = 0.05$) and overall acceptability ($p < 0.001 \leq \alpha = 0.05$) of the dry noodles, whereas no significant effects were observed for taste ($p = 0.127 > \alpha = 0.05$), aroma ($p = 0.128 > \alpha = 0.05$), or texture ($p = 0.127 > \alpha = 0.05$). Nutritional analysis revealed that F3 dry noodles contained 414 kcal of energy, 14.31 g of protein, 9.16 g of fat, and 68.58 g of carbohydrates per 100 g. The formulated dry noodles met established quality standards and qualify for labeling as a source of protein and as a high-iron food product. The shelf life of dry noodles stored at room temperature was 147 days. Future studies are warranted to evaluate the effectiveness of this product as a dietary intervention for adolescent girls and pregnant women in efforts to prevent iron deficiency anemia.

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