

Development of Noodles with Pangasius Fish and Pumpkin Flour: Analysis of Iron and Protein Content

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ARTICLE INFO

Article History:

Received September 8, 2026

Accepted October 22, 2026

Published online November 10, 2026

Keywords:

anemia;

dry noodles;

female adolescent;

food product;

pangasius fish;

pumpkin

ABSTRACT

Iron and protein are essential nutrients for meeting dietary requirements. Local Indonesian foodstuffs rich in these nutrients include pangasius fish and pumpkin. This study aimed to formulate dried noodles using pangasius fish flour and pumpkin flour as substitutes and analyze their iron and protein content. This laboratory-based experimental study employed a completely randomized design with three dry noodle formulations containing different proportions of pangasius fish flour, pumpkin flour, and wheat flour: F1 (40%:50%:10%), F2 (40%:45%:15%), and F3 (40%:40%:20%). Each formulation was prepared in triplicate, and nutrient analyses were performed in duplicate. Protein content was determined using the Kjeldahl method, while iron content was analyzed using atomic absorption spectrophotometry. Results were expressed as mean $\pm$ standard deviation. Iron content ranged from 37.6145 ± 0.4305 to 46.505 ± 0.89 mg/kg, while protein content ranged from $19.03 \pm 0.06\%$ to $26.15 \pm 0.06\%$. Formula F1 exhibited the highest iron content (46.505 ± 1.259 mg/kg) and protein content ($26.15 \pm 0.06\%$). Significant differences among formulations were observed for both iron content ($p = 0.006$) and protein content ($p < 0.001$). Formula F1 exhibited the highest iron and protein contents among the tested formulations. Pangasius fish flour was maintained at a constant proportion of 40% across all formulations, while the proportions of pumpkin flour and wheat flour were varied. Therefore, the differences in iron and protein contents among formulations were primarily associated with variations in the pumpkin flour-to-wheat flour ratio. Further studies should assess sensory acceptability, iron bioavailability, and nutritional efficacy.

INTRODUCTION

Anemia remains an important public health problem among women of reproductive age, including adolescent girls. Anemia is characterized by a reduced hemoglobin concentration or a decreased number of red blood cells, resulting in impaired oxygen transport throughout the body.^{1,2} Globally, anemia affects nearly 25% of the population, with a particularly high burden among women, children, and populations in low- and middle-income countries.³ The World Health Organization (WHO) estimates that approximately 30% of women aged 15–49 years worldwide are affected by

anemia.³ Women and adolescent girls are physiologically vulnerable to anemia because of increased nutritional requirements during growth, menstruation, and preparation for increased need for iron in preparation for pregnancy or future childbearing. Among women of reproductive age, females aged 15–24 years have been reported to have one of the highest prevalences of anemia.⁴ To address this burden, WHO established a global target of reducing anemia among women of reproductive age by 50% by 2025.³ In Indonesia, anemia among adolescents and young women also remains a concern. The 2018 Basic Health Research reported that the prevalence of anemia among females aged 15–24 years was 26.8%,⁵ while the 2023 Indonesian Health Survey reported a prevalence of 15.5%,⁶ indicating that anemia and iron supplementation among adolescent girls remain important issues in national health programs.

Anemia has multifactorial causes, including inadequate intake of iron, protein, folate, vitamin B12, vitamin A, infection, inflammation, and other health-related factors. However, insufficient dietary intake of iron and protein remains one of the most important nutritional factors associated with anemia risk.⁷ Iron is essential for hemoglobin synthesis, while protein contributes to erythropoiesis and supports iron transport and utilization. Therefore, improving the nutrient quality of commonly consumed foods may serve as a complementary approach to support dietary diversification, particularly among population groups with increased nutritional requirements. Food fortification and the development of nutrient-enhanced foods have been recognized as long-term strategies to improve dietary iron intake and nutritional status among populations at risk of micronutrient deficiencies.⁸ In recent years, researchers have increasingly explored natural food sources of iron and protein because of their favorable acceptability, nutritional value, and potential application in functional food development.³

Dietary iron exists in two forms, namely heme iron and non-heme iron. Heme iron is predominantly found in animal-source foods, whereas non-heme iron is derived from plant-based foods. Heme iron is generally absorbed more efficiently than non-heme iron and is less affected by dietary inhibitors. Previous studies have shown that consumption of heme iron-rich foods, such as fish, may contribute to maintaining body iron status.^{9–11} In addition, protein, particularly from animal-source foods and their digestion products, may support iron absorption by maintaining iron solubility during digestion.¹² Therefore, combining animal and plant-based ingredients may contribute to improving the nutritional profile of food products intended to increase dietary iron intake.

Food-based product development has been widely explored as a strategy to improve the nutritional quality of daily diets. However, it should be emphasized that a formulated food product cannot be directly claimed as an anemia prevention intervention without further evidence from bioavailability studies, acceptability testing, and human intervention trials assessing hemoglobin, ferritin, or other anemia-related biomarkers. Therefore, the present study is positioned as an initial

stage of product development, focusing on the formulation of dry noodles and the analysis of selected nutrient contents, particularly iron and protein.

Dry noodles were selected as the food matrix because noodle-based products are practical, affordable, easy to prepare, and widely consumed in Indonesia. Indonesia is one of the largest instant noodle consumers globally, ranking second in the world with approximately 14.68 billion servings consumed in 2024.¹³ National consumption data also show that the average Indonesian population consumed approximately 296.64 g of instant noodles per capita per month in 2024.¹⁴ Although consumption data specifically among adolescent girls remain limited, available data indicate that instant noodle consumption is common among Indonesian adolescents. Therefore, noodle-based products may represent an acceptable food matrix for developing nutrient-improved food prototypes. From a technological perspective, dry noodles offer several advantages as a product development vehicle. Their relatively low moisture content contributes to better storage stability, longer shelf life, easier packaging, and wider distribution. Dry noodles also allow the incorporation of alternative flour ingredients, such as pumpkin flour and pangasius fish flour, which may improve the nutritional profile of the product. However, the use of dry noodles in this study is limited to the formulation and nutritional evaluation stage. Further studies are needed to evaluate sensory acceptability, nutrient retention after cooking and storage, bioavailability, and potential effects on anemia-related biomarkers.

Pumpkin and pangasius fish are local food ingredients that are relatively accessible in Indonesia and have considerable potential for food product development. Pumpkin contains carbohydrates, dietary fiber, protein, minerals such as calcium, phosphorus, and iron, as well as vitamins A, B, and C.¹⁵ Pumpkin is also recognized as a source of carotenoids and other phytochemicals that contribute to its nutritional value.¹⁵ Pangasius fish (*Pangasius hypophthalmus*) is a freshwater fish widely available in Indonesia and contains approximately 17% protein, 6.6% fat, 0.23–1.3% carbohydrates, 0.9% ash, and 74.4% water¹⁴. In addition, pangasius fish contains approximately 1.6 mg iron per 100 g and may contribute heme iron to the diet.¹⁶ Despite their availability, the utilization of pumpkin and pangasius fish in processed food products, particularly dry noodles, remains limited. The incorporation of pumpkin flour and pangasius fish flour into dry noodles may improve the nutritional profile of the product, especially with respect to protein and iron contents.

The research gap addressed in this study is the limited evidence regarding the formulation of dry noodles using a combination of pumpkin flour and pangasius fish flour as locally available ingredients to improve selected nutrient contents. Previous studies have discussed anemia prevention, iron supplementation, or the nutritional value of individual food ingredients; however, studies focusing on the formulation of dry noodles using these two ingredients and evaluating their iron and protein contents remain limited. Therefore, the novelty of this study lies in the development

of a dry noodle prototype substituted with pumpkin flour and pangasius fish flour and the evaluation of its iron and protein contents as preliminary data for further product development.

Based on this background, this study aimed to formulate dry noodles substituted with pumpkin flour and pangasius fish flour and to analyze their iron and protein contents. The findings of this study are expected to provide preliminary evidence for the development of nutrient-improved dry noodle products. Further studies are needed to evaluate sensory acceptability, nutrient bioavailability, shelf-life stability, and the potential effects of the product on anemia-related biomarkers before it can be recommended as part of an anemia prevention strategy.

MATERIALS AND METHODS

Study Design

The research was conducted at the Food Technology Laboratory and the Chemistry Laboratory of the Nutrition Department, Poltekkes Kemenkes Palangka Raya, Indonesia. The research was conducted from March to June 2025. This study was a laboratory-based experimental study using a completely randomized design (CRD). Three dry noodle formulations (Formula F1, F2, and F3) were developed. The treatment factor was the proportion of pumpkin flour and wheat flour, while the proportion of pangasius fish flour was maintained at 40% in all formulations.

Each formulation was prepared in two independent product preparation replicates. Protein and iron analyses were performed in duplicate for each formulation. Protein content was determined using the Kjeldahl method according to AOAC Official Method 920.87, while iron content was analyzed using atomic absorption spectrophotometry (AAS) following AOAC Official Method 999.11 after wet digestion of the samples. The results were expressed as mean $\pm$ standard deviation.

Sample Preparation

The sample preparation stage consisted of preparing pangasius fish flour, pumpkin flour, and dry noodle formulations (Figure 1). In this study, dry noodles were made with three formulas using seven kinds of ingredients as shown in Table 1.

Table 1. Dry noodles formulation

Ingredient	Formula F1	Formula F2	Formula F3
Pangasius fish flour	40 %	40 %	40 %
Pumpkin flour	50 %	45 %	40 %
Wheat flour	10 %	15 %	20 %
Fried onions	2 grams	2 grams	2 grams
Egg	1 egg (50 grams)	1 egg (50 grams)	1 egg (50 grams)
Salt	2 grams	2 grams	2 grams

Water

40 ml

40 ml

40 ml



Figure 1. Dry noodles formula F1, F2, and F3

Preparation of pangasius fish flour

The procedure for processing fish flour was based on the method used by Mahalia *et al.*,¹⁶ with slight modifications. Two kilograms of cleaned pangasius fish were weighed. The weighed pangasius fish was seasoned with lemon juice and steamed for approximately 10 minutes. After that, to remove excess fat, the pangasius fish was crushed and squeezed using a cloth. The crushed fish was dried in a dehydrator at 50°C for 12 hours. The dried pangasius fish was ground using a blender and sifted with an 80-mesh sieve.

Preparation of pumpkin flour

Pumpkin flour was prepared based on the method of Canti *et al.* with modifications.¹⁷ The pumpkin was cleaned and peeled then thinly sliced to a thickness of 2 mm. Then the pumpkin was soaked in 0.25% sodium metabisulfite to prevent the occurrence of both enzymatic and non-enzymatic browning processes for 30 minutes, thus optimally maintaining the color of the pumpkin. Next, the pumpkin was dried using a dehydrator at 60°C for 8 hours. Then the pumpkin was ground using a blender and sifted with an 80-mesh sieve.

Formulation of dry noodles

The stage of making dry noodles began with weighing the ingredients according to the formulation. All ingredients used (pangasius fish flour, pumpkin flour, wheat flour, salt, fried onions) were mixed. Then, water was added until the dough became smooth. After that, it was made into sheets and molded into strands of noodles using a noodle maker. The molded noodle dough was allowed to rest for 30 minutes, then steamed at 100°C for 15 minutes. Drying was carried out with a

dehydrator for 3 hours at 60°C. After that, the dry noodles were cooled at room temperature for 15 minutes.

Nutritional Analysis

The dry noodles were analyzed for iron and protein content. Protein content was analyzed using the Kjeldahl method. Iron content was assessed using Atomic Absorption Spectroscopy (AAS). The analytical procedures were performed according to the methods described by Mahalia *et al.*¹⁶

Protein analysis

Protein content was determined using the Kjeldahl method according to AOAC Official Method 920.87. A total of 2 grams of the sample was placed into a 100 mL Kjeldahl flask, together with 2 catalyst tablets and several boiling stones. Subsequently, 15 mL of H₂SO₄ (95%–97%) and 3 mL of H₂O₂ were slowly added, and the mixture was left to stand for 10 minutes in an acid chamber. Digestion was carried out at 410°C for approximately 2 hours until the solution turned clear. The digested samples were then cooled to room temperature and diluted with 50–75 mL of distilled water. Next, 25 mL of 4% boric acid solution was added into an Erlenmeyer flask. The digested solution was transferred into a steam distillation apparatus, followed by the addition of 50–75 mL of sodium hydroxide (NaOH) 10 N. The distillate was collected in the Erlenmeyer flask containing 4% boric acid solution until the volume reached at least 150 mL. Finally, the distillate was titrated using standardized 0.2 N HCl until the color shifted from green to purplish grey.

Iron (Fe) analysis

Iron content was determined using atomic absorption spectrophotometry (AAS) following wet digestion of the samples, according to AOAC Official Method 999.11. Results were expressed as mg/kg on a wet weight basis. Iron concentrations were measured using an atomic absorption spectrophotometer at the appropriate wavelength for iron determination.

Data Analysis

Data were analyzed using one-way analysis of variance (ANOVA), followed by Duncan's multiple range test when significant differences were observed. A p-value of < 0.05 was considered statistically significant.

RESULTS

The results of iron and protein analyses of dry noodles formulated with pangasius fish flour and pumpkin flour are presented in Tables 2 and 3. Iron content ranged from 37.615 to 46.505 mg/kg, while protein content ranged from 19.03% to 26.15%. Formula F1 exhibited the highest iron content (46.505 ± 0.89 mg/kg), followed by F2 (37.9195 ± 0.8505 mg/kg) and F3 (37.6145 ± 0.4305 mg/kg).

Table 2. Results of iron content testing of formula F1, F2, and F3

Chemical Analysis	Formula	Result		Mean $\pm$ SD	P Value
		Replication 1	Replication 2		
Iron (mg/kg)	F1	45.615	47.395	46.505 $\pm$ 0.89	0.006
	F2	38.770	37.069	37.9195 $\pm$ 0.8505	
	F3	37.184	38.045	37.6145 $\pm$ 0.4305	

Source: Primary data, 2025

Similarly, Formula F1 showed the highest protein content ($26.15 \pm 0.04\%$), followed by F2 ($21.04 \pm 0.05\%$) and F3 ($19.03 \pm 0.04\%$). Statistical analysis demonstrated significant differences among formulations for both iron content ($F = 44.934$, $p = 0.006$) and protein content ($F = 7091.807$, $p < 0.001$). These findings indicate that variations in the proportions of pumpkin flour and wheat flour significantly influenced the nutritional composition of the dry noodles.

Table 3. Results of protein content testing of formula F1, F2, and F3

Chemical Analysis	Formula	Result		Mean $\pm$ SD	P Value
		Replication 1	Replication 2		
Protein (%)	F1	26.11	26.19	26.15 $\pm$ 0.04	$p < 0.001$
	F2	20.99	21.09	21.04 $\pm$ 0.05	
	F3	19.07	18.99	19.03 $\pm$ 0.04	

Source: Primary data, 2025

DISCUSSION

The higher iron content observed in Formula F1 should be interpreted carefully. In the present study, the proportion of pangasius fish flour was maintained at 40% across all formulations, whereas pumpkin flour was gradually reduced from 50% in Formula F1 to 45% in Formula F2 and 40% in Formula F3. At the same time, the proportion of wheat flour increased from 10% in Formula F1 to 20% in Formula F3. Formula F1 had the highest measured iron content; however, because the iron contents of the individual raw ingredients were not determined, the differences among formulations cannot be attributed specifically to pumpkin flour. Previous studies have reported that pumpkin is a nutritionally valuable food ingredient containing minerals, including iron, and is recognized for its nutritional and phytochemical properties.^{18,19} Pumpkin is also considered a functional food ingredient due to its content of phenolic compounds, carotenoids, vitamins, amino acids, and minerals, including

iron and selenium.^{20,21} Although these findings support the potential contribution of pumpkin flour to the iron content of the noodles, they do not establish that pumpkin was the primary source of the observed differences.

The iron content of the final product may reflect the combined contributions of pumpkin flour, pangasius fish flour, and wheat flour, as well as variations associated with processing and analytical measurements. Because the proportions of pumpkin and wheat flour changed simultaneously, their individual effects on iron content cannot be separated using the present experimental design. Future studies should determine the iron content of each raw ingredient and evaluate the effects of individual ingredient proportions on the nutritional composition of the final product.

Pangasius fish may also contribute to the iron content of the formulated dry noodles. Pangasius fish is one of the fastest-growing freshwater aquaculture species worldwide and is widely available in Indonesia.¹⁶ In addition to being an affordable local food resource, pangasius fish contains various nutrients, including protein and iron. Previous reports indicate that pangasius fish contains approximately 1.6 mg of iron per 100 g.¹⁶ Nevertheless, because pangasius fish flour was included at the same proportion in all three formulations, its contribution alone does not explain the differences in iron content among the formulations. Furthermore, the total iron content measured in this study does not indicate the proportions of heme and non-heme iron or establish the bioavailability of iron from the finished product. These distinctions are important when considering the potential nutritional benefits of incorporating fish flour into plant-based food formulations.

The results of protein analysis showed a similar trend, with Formula F1 exhibiting the highest protein content among all formulations. Although pangasius fish flour was maintained at the same proportion in all formulas, differences in protein content were still observed. This finding may be related to interactions among ingredients, differences in dry matter composition, and analytical variability. Pumpkin itself contains protein, and previous studies have reported that pumpkin flour contains approximately 10.69% protein.²² In addition, every 100 g of fresh pumpkin contains approximately 1.1 g of protein.¹⁵ The observed trend may reflect differences in the overall composition of the flour mixtures, but the individual protein contributions of the ingredients cannot be quantified because the raw materials were not analyzed separately. Further investigation should determine the protein contents of the individual ingredients and evaluate whether differences in ingredient composition, moisture content, processing, or analytical variability contributed to the observed results.

The role of pangasius fish flour as a protein source should also be considered. Pangasius fish is recognized as a protein-rich food ingredient. The protein content of pangasius meat and pangasius fillet has been reported to be approximately 17.6 g/100 g and 12.51 g/100 g, respectively.²³ Animal-source proteins are generally characterized by a favorable amino acid profile and high digestibility, making them valuable ingredients for food fortification and product development. Nevertheless, the

present study measured total protein content rather than amino acid composition, protein quality, or digestibility. Therefore, the contribution of pangasius fish flour to the nutritional quality of the final product cannot be fully characterized from the available results. In addition, because the fish flour proportion was held constant, further studies are needed to distinguish its contribution from that of the other ingredients.

The present findings demonstrate that local food ingredients such as pumpkin and pangasius fish can be utilized to improve the nutritional composition of dry noodles. This is particularly relevant because noodles are widely consumed in Indonesia and many other countries. Noodles are also frequently selected during periods of economic hardship or emergency because they are relatively affordable, easy to prepare, and generally well accepted by consumers.¹⁸ However, the potential usefulness of these noodles as a nutrient-improved food depends not only on their measured nutrient concentrations but also on their sensory acceptability, serving size, nutrient retention during preparation, and contribution to overall dietary intake. These aspects were not evaluated in the present study and should be investigated before broader nutritional applications are proposed.

The iron concentration of Formula F1 was 46.505 mg/kg, equivalent to approximately 4.65 mg per 100 g of dry noodles. This result provides a quantitative basis for comparison with previous studies of fortified or formulated noodles. To establish how the present formulation compares with existing products, its iron concentration should be discussed alongside the numerical findings reported by Canti, Rustanti, and other relevant studies, taking into account differences in ingredients, formulation, analytical methods, and whether the results were reported on a dry-weight or cooked-product basis. Because these methodological differences can affect measured concentrations, direct comparisons should be made only when the reported values are sufficiently comparable. The iron concentration alone also does not establish the amount of iron that would be consumed or absorbed in a typical serving.

In contrast, the absorption of non-heme iron is influenced by numerous dietary factors. Compounds such as phytates, polyphenols, calcium, and dietary fiber may inhibit iron absorption, whereas vitamin C and animal protein may enhance it.¹² Because pumpkin flour contains plant-derived iron, the actual amount of absorbable iron may differ from the total iron concentration measured analytically. Therefore, although the addition of pumpkin flour and pangasius fish flour increased total iron content, the proportion of iron that would ultimately be absorbed by the body remains unknown. Bioavailability studies are required before any conclusions can be drawn regarding the effectiveness of the product as a dietary source of absorbable iron.

The findings of the present study should not be interpreted as evidence that the formulated dry noodles can prevent or treat anemia. Anemia remains a major public health problem, particularly among adolescent girls and women of reproductive age.²⁴ Although iron and protein are important

nutrients for maintaining hematological health, the effectiveness of a food product in preventing or treating anemia depends on multiple factors, including nutrient bioavailability, serving size, consumption frequency, dietary patterns, and physiological status of the target population. The present study did not evaluate these factors and did not include any human intervention component. Therefore, the product should be regarded as a nutrient-improved food prototype rather than an evidence-based intervention for anemia prevention.

The development of value-added food products from local ingredients remains important for improving food diversity and nutritional quality. Pumpkin has attracted increasing attention because of its rich phytochemical profile and associated health benefits.^{19,21} Likewise, numerous studies have demonstrated the potential of pangasius fish as a raw material for the development of value-added products with commercial and nutritional value.^{23,25} The utilization of locally available food resources may also contribute to improving access to nutritious foods and supporting healthier dietary environments.²⁶ In this context, fortified and value-added foods have been recognized as useful complementary approaches for nutritional interventions and dietary improvement.^{27,28}

Limitations

Several limitations should be acknowledged. First, the study was limited to product formulation and laboratory analysis of total protein and iron contents. The individual nutrient compositions of the raw ingredients were not determined, limiting the interpretation of their respective contributions to the final product. Furthermore, because pumpkin flour and wheat flour proportions varied simultaneously, their independent effects on nutrient content could not be established. Second, sensory acceptability, cooking quality, and consumer preferences were not evaluated. Third, nutrient retention after cooking and storage stability were not assessed. Fourth, the contribution of the product to recommended dietary requirements per serving was not calculated. Fifth, iron bioavailability was not investigated. Finally, no human intervention study was conducted; therefore, the effects of the product on hemoglobin concentration, ferritin status, or anemia outcomes remain unknown.

CONCLUSION

Local food ingredients, such as pumpkin and pangasius fish, can be processed into flour and further utilized in the development of functional foods, such as dry noodles. Based on the nutritional analysis, the F1 formula had the highest iron and protein contents among the three formulations tested. These findings suggest that F1 has potential for further development as a nutrient-rich food product. However, further research is required to evaluate its sensory acceptability, nutrient retention during processing and storage, iron bioavailability, contribution to dietary requirements per serving, and efficacy among the target populations. Future studies should also assess product acceptability

and consider the development of ready-to-eat or ready-to-cook products to determine the feasibility of incorporating this formulation into dietary interventions.

Acknowledgements

We would like to express our gratitude to Poltekkes Kemenkes Palangka Raya for facilitating this research, providing financial support, and offering infrastructure and resources.

Conflict of interest

All the authors declare that there are no conflicts of interest.

Funding Source

No specific funding was received for this study.

Ethical Statement

The research received ethical approval from the Research Ethics Committee (KEPK) of Poltekkes Kemenkes Palangka Raya with Reference No. 104/I/KE.PE/2025.

Author Contributions

All authors participated in the manuscript preparation and approved the final manuscript.

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