



Acceptability and iron content of catfish-based wonton as a potential iron-rich snack

Daya terima dan kadar zat besi wonton ikan lele untuk alternatif kudapan sumber zat besi

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Abstract

Anemia remains a health problem among adolescent girls, partly due to low iron intakes. The development of snacks based on local ingredients that are rich in iron and acceptable in terms of their sensory properties is a potential approach. However, studies integrating acceptability evaluation and analysis of actual iron content in a single snack product are limited. This study aimed to analyze the acceptability and iron content of catfish wontons with variations in catfish and wood ear mushroom formulations. An experimental study with three formulations (F1B, F2B, and F3B) was conducted and tested on 25 trained panelists. Organoleptic data were analyzed using the Kruskal–Wallis test, followed by the Mann–Whitney U test at a 5% significance level. The iron content was analyzed using the ICP-OES method with replication. The results showed that formulation F3B had the highest level of acceptance. No differences were observed in color, aroma, and texture ($p > 0.05$); however, significant differences were observed in taste attributes ($p < 0.05$). The iron content in F3B was 2.22 mg/100 g, which is equivalent to approximately 14–15% of the daily iron requirement for adolescent girls. In conclusion, the F3B formulation has the potential to be an alternative source of iron based on local ingredients with good sensory acceptance. Further research is needed to evaluate the bioavailability and contribution of actual consumption to iron adequacy.

Keywords: Anemia, Adolescent; Food Preferences, Iron, Catfish, Functional Food, Sensory Evaluation.

Abstrak

Anemia masih menjadi masalah kesehatan pada remaja putri, salah satunya disebabkan oleh rendahnya asupan zat besi. Pengembangan kudapan berbasis bahan lokal yang memiliki kandungan zat besi serta dapat diterima secara sensori menjadi salah satu pendekatan yang potensial. Namun, kajian yang mengintegrasikan evaluasi daya terima dan analisis kadar zat besi aktual dalam satu produk kudapan masih terbatas. Penelitian bertujuan untuk menganalisis daya terima dan kadar zat besi wonton ikan lele dengan variasi formulasi ikan lele dan jamur kuping. Penelitian eksperimen dengan tiga formulasi (F1B, F2B, F3B) dan diuji pada 25 panelis terlatih. Data organoleptik dianalisis menggunakan uji Kruskal–Wallis dan dilanjutkan uji Mann–Whitney dengan tingkat signifikansi 5%. Kadar zat besi dianalisis menggunakan metode ICP-OES dengan replikasi. Hasil, formulasi F3B memperoleh tingkat penerimaan tertinggi. Tidak terdapat perbedaan pada warna, aroma, dan tekstur ($p > 0.05$), namun terdapat perbedaan signifikan pada atribut rasa ($p < 0.05$). Kadar zat besi pada F3B sebesar 2.22 mg/100 g, yang setara dengan sekitar 14–15% kebutuhan harian zat besi remaja putri. Kesimpulan, formulasi F3B berpotensi sebagai sumber zat besi alternatif berbasis bahan lokal dengan tingkat penerimaan sensori yang baik. Penelitian

lanjutan diperlukan untuk mengevaluasi bioavailabilitas dan kontribusi konsumsi nyata terhadap kecukupan zat besi.

Kata Kunci: Anemia; Remaja, Preferensi Makanan, Zat Besi, Ikan Lele, Functional Food, Sensory Evaluation.

Introduction

Anemia is a global health problem and a major concern, especially in developing countries. This condition is characterized by hemoglobin (Hb) levels in the blood that are lower than normal for age and gender, thereby disrupting the transport of oxygen and carbon dioxide in the body (Permata et al., 2023). Anemia can be caused by various factors, including iron (Fe) deficiency, inadequate nutritional intake, and specific physiological conditions. According to the WHO in 2023, the prevalence of anemia in women aged 15-49 years reached 30.7%, indicating that nearly one-third of women in this age group suffer from anemia (WHO, 2025).

Adolescent girls are vulnerable to anemia because their iron requirements increase due to rapid growth and blood loss during menstruation (Kurniati, 2020). Adolescence is characterized by physical, mental, and reproductive development, which increases nutritional needs (Noviyanti, 2023). This vulnerability is exacerbated by the high prevalence of anemia, 32–34% among school-aged children in Indonesia (Mirani et al., 2021). Inadequate iron intake is the main cause of iron-deficiency anemia in adolescent girls. This condition is generally associated with a diet that lacks variety, is low in easily absorbed iron sources, and has unbalanced eating behaviors (Cohen & Powers, 2024). Animal protein consumption plays a crucial role in improving iron status because it contains heme iron, which is more absorbable than nonheme iron from plant sources. This is because heme iron from animal sources has a higher bioavailability (approximately 15–35%) than nonheme iron from plant sources (approximately 2–10%).

Iron bioavailability involves intestinal absorption and is influenced by heme and non-heme forms. Heme iron is more easily absorbed than non-heme iron. Vitamin C and protein enhance absorption, whereas phytate, polyphenols, tannins, and calcium inhibit absorption by forming insoluble complexes (Piskin et al., 2022).

The 2023 Indonesian Health Survey (SKI) data show that the prevalence of anemia among

adolescents aged 15–24 years in Indonesia is 15.5%, with a higher proportion among adolescent girls than boys (SKI, 2023). Globally, anemia among adolescents remains a public health issue, particularly in low- and middle-income countries, with a high prevalence in Southeast Asia. The incidence of anemia is influenced by iron intake and socioeconomic factors (Arisnawati & Zakiudin, 2018) and has an impact on concentration and academic performance (Rahman, 2021).

Low iron intake is often exacerbated by the presence of absorption inhibitors, such as phytic acid, tannins, coffee, and tea, which are commonly consumed by adolescents. In addition, adolescents tend to choose foods based on taste rather than nutritional value, making it difficult to achieve optimal iron intake (Sholicha & Muniroh 2019). Studies have shown that iron, vitamin C, and protein intake are significantly associated with the incidence of anemia, making food interventions based on locally available iron-rich foods and nutrition education effective strategies for preventing anemia (Baha et al., 2021). Therefore, the WHO recommends iron and folic acid supplementation, and in Indonesia, efforts to combat anemia in adolescent girls are carried out through supplementation, food fortification, and nutritional education (Kusuma, 2022).

Compliance with iron supplementation among adolescent girls remains a significant challenge (Merlisia et al., 2025). Low compliance with iron tablet consumption can reduce the effectiveness of anemia prevention programs. However, adolescents' limited knowledge about anemia and the importance of iron intake also influences their consumption of nutritious foods (Sembiring et al., 2023). This highlights the need for more contextual, engaging, and easily implementable intervention strategies in the daily diets of adolescents.

The development of functional foods based on local ingredients is a promising approach because it not only increases iron intake but also promotes healthier and more sustainable dietary habits (Setyaningrum et al., 2023). The use of catfish as a relatively

affordable source of heme iron has been reported to contribute to increased hemoglobin levels and a reduced prevalence of anemia in adolescent girls (Nurita et al., 2024). Additionally, wood ear mushrooms, as a local food source, contain vitamins and minerals, including iron, which have the potential to prevent anemia (Sari et al., 2021). Considering that the bioavailability of iron from plant-based foods tends to be lower without animal-based sources, the integration of these two ingredients is relevant for product formulation (Rahfiludin et al., 2021).

Previous studies have developed food products based on local ingredients with iron content analysis or acceptability testing; however, they generally focus on one main ingredient or specific processed forms, such as nuggets and biscuits. Studies on the development of wonton-shaped snacks combining catfish and wood ear mushrooms, which are evaluated simultaneously from sensory and actual iron content aspects, are limited. However, wontons, as a popular and easily modifiable snack, have the potential to become a practical and appealing nutritional intervention medium for adolescents (Fithriyah, 2021; Putri et al., 2024; Setyaningrum et al., 2023).

Based on these gaps, the novelty of this study lies in the development and evaluation of catfish and wood ear mushroom-based wontons as a local functional snack that is comprehensively assessed in terms of sensory acceptance and iron content. This study aimed to assess the acceptability and iron content of catfish wonton as an alternative snack to prevent anemia in adolescent girls to support the development of non-supplemental food interventions that are more practical, attractive, and sustainable.

Methods

This study used an experimental research design with a completely randomized design (CRD) of one factor with three treatment levels to evaluate the acceptability and iron content of three catfish wonton formulations (F1B, F2B, and F3B). Non-parametric tests were chosen because the organoleptic data obtained from the panelists were ordinal (scale of 1–5 for taste, aroma, texture, and color), and the iron content data may not meet the assumptions of normality

and homogeneity of variance required for parametric tests such as ANOVA. This study used a completely randomized design (CRD) with three treatment levels and two replicates (duplicates).

This research was conducted at the Nutrition Department Laboratory of the Surabaya Ministry of Health Polytechnic and the Research Center for Standardization and Industry, Indonesia. Chromium and fiber content testing was performed at the ULP Faculty of Pharmacy, Airlangga University. The study was conducted from April to October 2024.

The study population comprised female adolescents aged 15–21 years. A sample of 25 trained panelists was selected using purposive sampling preceded by selection and training, namely panelists who were healthy, not allergic to the ingredients used, and willing to participate in the sensory testing. All panelists were female students majoring in nutrition at the Surabaya Polytechnic of Health. The panelist randomization technique was applied to randomize the order of presentation of the three wonton formulations (F1B, F2B, and F3B) to each purposively selected trained panelist. A 5-point hedonic scale (1 = strongly dislike, 5 = strongly like) was used to assess four sensory attributes: color, aroma, taste, and texture of the cookies. The number of panelists and their selection criteria were stated in accordance with institutional guidelines. This randomization aimed to reduce sequence bias and ensure a more objective organoleptic assessment. Each panelist assessed the samples in a different order so that the scores reflected real preferences and not the influence of the sample position. Thus, the sensory test data became more valid and could be fairly compared between formulations.

The data collection stage included the formulation of F1B, F2B, and F3B according to processing standards, followed by organoleptic testing to assess color, aroma, texture, and taste. In addition, samples were analyzed for iron content using the ICP-OES method. The organoleptic test instrument was declared valid because the rating scale (1–5) with criteria of 1: strongly dislike, 2: dislike, 3: neutral, 4: like, and 5: strongly like was in accordance with the food attributes being assessed to ensure that the panelists understood the criteria. Reliability was maintained by using trained panelists and prior training, which ensured consistent and

repeatable assessments. Thus, the organoleptic test results can be trusted for comparing the formulations. Internal reliability was analyzed using Cronbach's alpha to ensure assessment consistency.

The study was conducted in the Nutrition Department laboratory at the Surabaya Ministry of Health Polytechnic for 6 months, covering

material preparation, formulation, sensory testing, iron analysis and data processing. During the study, research ethics were maintained by obtaining approval from the ethics committee, providing informed consent to the panelists, maintaining the safety and confidentiality of the panelists, and ensuring the panelists' right to refuse participation.

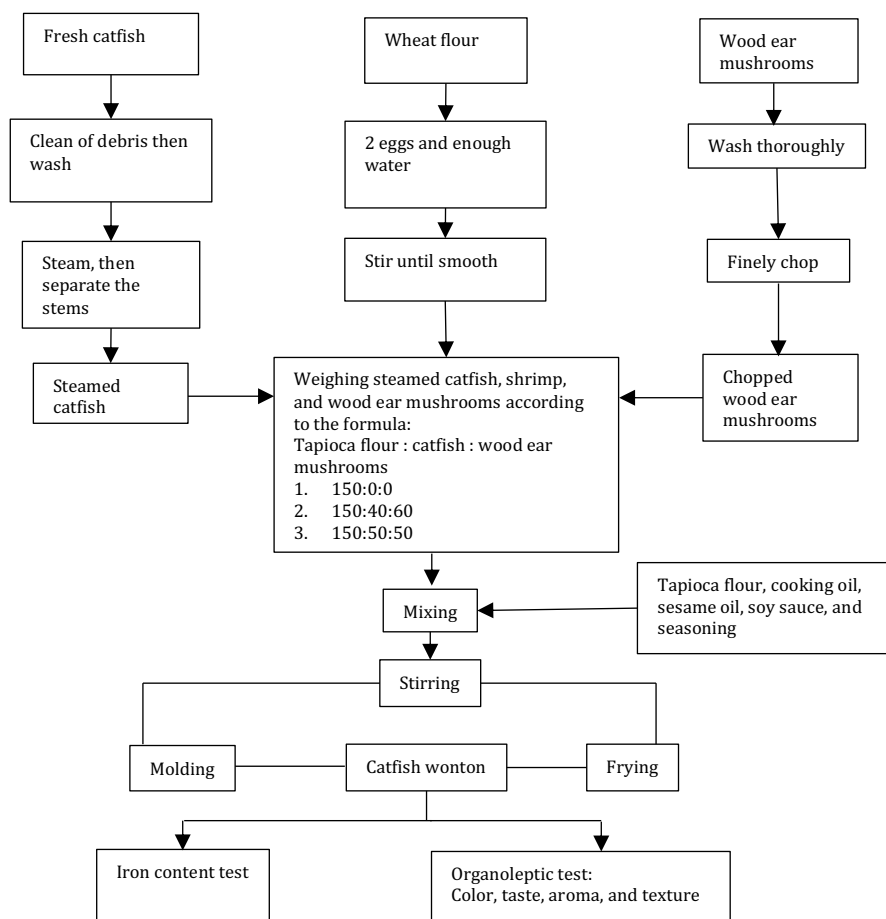


Figure 1. Operational definition of variables

This study used a completely randomized design (CRD), with the main factor being the ratio of catfish to wood ear mushrooms in the wonton dough. The ratios of tapioca flour: catfish: wood ear mushrooms in formula F1B = 150:0:0, F2B = 150:40:60, and F3B = 150:50:50, with a small amount of shrimp added to all three formulations. The selection of the three wonton formulations in this study was based on the objective of evaluating the effect of adding iron-rich ingredients on the organoleptic properties and nutritional content of the product. Formulation F1B, which only used tapioca flour without catfish or mushrooms, served as a control to assess the basic characteristics of

wontons without additives. Formulations F2B and F3B contained combinations of catfish and wood ear mushrooms in different proportions (40:60 and 50:50) to explore the effect of increasing iron-rich ingredients on taste, texture, color, aroma, and iron content. This range was chosen to remain practical for processing, suitable for consumption, and within the safe limits for additive use, while also allowing for the identification of the optimal formulation that was most preferred by the panelists and had the highest iron content. This approach provides a clear scientific basis for comparing the organoleptic and nutritional results between formulations, thereby

supporting the research objective of developing alternative snacks to prevent anemia in adolescent girls and finding the optimal formulation that produces catfish wontons with the best sensory quality and high iron content.

This research protocol was reviewed and approved by the Health Research Ethics Committee of the Surabaya Ministry of Health Polytechnic (No. EA/4007/KEPK-Poltekkes_Sby/V/2025). The sensory panelists participated voluntarily and signed informed consent forms prior to the evaluation.

Result and Discussion

Organoleptic Properties of Catfish Wonton Products

Based on the results of the catfish wonton acceptance test, organoleptic testing (color, aroma, texture, and taste) showed that the most preferred formula was F3B with a ratio of tapioca flour: catfish: wood ear mushrooms (150:50:50) and an average score of 4.06.

Based on the results of the descriptive analysis, the F3B formulation showed the highest acceptability value (4.12 ± 0.33), followed by F1B (3.82 ± 0.32) and F2B (3.70 ± 0.24). Effect size calculations showed that the difference between F3B and F2B was very large ($d = 1.45$), whereas the difference between F3B and F1B was large ($d = 0.91$). In contrast, the difference between F1B

and F2B was relatively small to moderate ($d = 0.43$). These findings indicate that the F3B formulation has a substantial advantage in terms of acceptability compared to the other two formulations, making it more suitable for further development in practical terms.

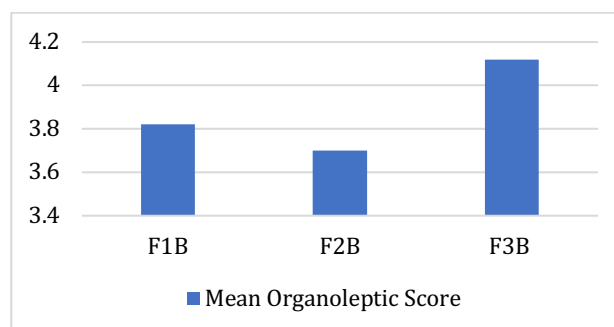


Figure 1. Average scores of organoleptic testing results for the 3 formulations

The results also showed no significant differences among the three catfish wonton formulations in terms of color, aroma, and texture. However, there are differences in their taste. The Kruskal-Wallis test (Table 1) confirmed significant differences in taste preference ($p < 0.05$). These results are in line with the effect size values, which indicate a very large difference between the two formulations; therefore, it can be concluded that taste is the dominant factor that distinguishes the panelists' acceptance of the product.

Table 1. Descriptive statistics of sensory attributes in formulation F3B

Sensory Attributes	Mean	Median	SD	Min	Maximum	p-value
Color	4.16	4	0.80	3	5	0.269
Aroma	3.92	4	0.73	3	5	0.230
Texture	3.93	4	0.77	2	5	0.292
Taste	3.44	4	0.70	2	4	0.005

* *Kruskal-Wallis test*

Table 2. Iron content of catfish wonton

Product Code	Iron Content (mg)	Weight (g)	URT
F3B (150 : 50 : 50)	2.22	100	1 Serving

As in other fish processing studies, variations in the ingredients can affect the final texture and taste, which greatly influence sensory preferences (Utami et al., 2023). The combination of all attractive appearance attributes (color), appealing aroma, pleasant

texture, and delicious taste makes F3B comprehensively meet multisensory needs, making the F3B formula preferred by panelists. Because the panelists evaluate all these aspects together, a balanced formulation that excels in all aspects tends to be the most accepted. With an average score of 4.06, F3B was the optimal formulation in this study.

This study found differences in taste indicators among the three catfish wonton formulations ($p < 0.05$). Although there are significant differences in taste, nutritional parameters, such as iron content, need to be

considered to ensure that the preferred formulation also provides nutritional benefits. In addition, sensory tests were conducted on a limited number of trained panelists; therefore, the sensory preferences of the general population may differ. The non-parametric factorial test method is appropriate for ordinal data; however, it does not explore ingredient interactions in depth. Further research using consumer panelists, iron bioavailability analysis, and advanced formulation development is needed to strengthen the potential of this product as a food intervention for anemia. Since taste is a determining factor in preference, formulations with the best taste have the potential to be more accepted and consumed regularly by adolescent girls, thereby supporting increased iron intake through food consumption. This is important considering that adolescents tend to choose foods based on taste rather than on nutritional content. Thus, formulations with the most preferred taste have the potential to be more effective as alternative snacks to help prevent anemia, especially if they also have a higher iron content.

Similar results were also reported for nuggets or other processed fish products, as in the article on the Sensory and Hedonic Characteristics of Fermented Pacid Kule Carp, which showed significant differences in aroma and taste between treatments (Pramesti et al., 2024). These findings are consistent with previous studies showing that in processed fish products, taste is often the most decisive factor in stickiness or acceptance tests, whereas other parameters, such as color, aroma, or texture, tend to be more stable between formulations when the base ingredients and processes are consistent. Other studies have also reported that partial substitution of flour/skin with fish flour produces fish *sticks* with good acceptance levels, and that changes in composition affect preferences, indicating that sensory aspects (including taste) are important when using fish as an alternative protein source (Ayundra Putri et al., 2022). Thus, the catfish wonton formulation product is consistent with the literature that taste is the most responsive parameter to formulation changes in fish products.

In addition, nonparametric statistical test results showed differences in taste preference between the formulations. The Kruskal–Wallis

follow-up test showed no significant differences between the formulations in terms of color ($p=0.269$), aroma ($p=0.230$), and texture ($p=0.292$). The variation in the ingredient composition of each formulation showed a level of acceptance comparable to the other two formulations. This indicates that certain formulation changes can produce meaningful sensory differences, especially in taste attributes, which are a major factor in determining the acceptance of food products by consumers.

These findings are consistent with research on tilapia fish balls, which showed that differences in formulation do not always cause significant differences in all sensory attributes (Dinosa et al., 2023). Previous research on formulated soup mixes has shown that flavor or taste is the most critical attribute in determining product *acceptability*, above aroma or texture (Sugumar & Guha, 2022). Research on traditional products with ingredient substitutions, such as composite timphan, shows that ingredient variations are acceptable to consumers as long as the main sensory attributes, especially taste and texture, are within the preferred range (Fenia et al., 2019).

Nutritional Value of Catfish Wonton Products
Based on the nutritional content (Table 2), the results of iron content analysis using the ICP-OES method showed that the formulation with the addition of wood ear mushrooms and shrimp contained 2.22 mg/100 g of iron. This amount is equivalent to approximately 14–15% of the daily iron requirement for adolescent girls (± 15 mg/day). This means that this product has the potential to contribute to daily iron intake, although it does not sufficiently meet the requirement in a single consumption. Therefore, its consumption must be combined with other iron sources in a balanced diet. This study only measured total iron levels without evaluating bioavailability or its impact on clinical parameters, such as hemoglobin levels. Thus, the product is more appropriately positioned as an alternative source of iron based on local foods that support improved nutritional intake rather than as a direct intervention for anemia prevention.

The increase in iron content in formulations with the addition of catfish, wood ear mushrooms, and shrimp shows the

contribution of these food ingredients to the mineral content of the product. Catfish and shrimp are animal-based food ingredients that are sources of heme iron, which generally has a higher absorption rate than non-heme iron. Wood ear mushrooms and tapioca flour mainly contribute to non-heme iron, whose absorption is influenced by other food components in the food matrix.

Although the total iron content increased, this study did not evaluate iron bioavailability, which is the proportion of iron that can be absorbed and utilized by the body. The absorption of non-heme iron can be influenced by inhibitory factors such as phytate and tannin, as well as enhancing factors such as vitamin C and animal proteins. The complete composition of these compounds in the product has not been analyzed in this study; therefore, the physiological implications for improving iron status or preventing anemia cannot yet be concluded.

In addition, the analysis was conducted on a laboratory scale, with a limited number of samples. Therefore, further research is needed, including bioavailability testing, more specific identification of iron forms, and evaluation of food component interactions on absorption, to obtain a more comprehensive picture of the product's functional potential.

This product has the potential to be developed as an alternative source of iron using local ingredients. Its iron content of 2.22 mg/100 g is equivalent to approximately 14–15% of the daily iron requirement for adolescent girls (± 15 mg/day). This indicates that the product can contribute to daily iron intake, although it does not meet the overall requirement for a single consumption.

Thus, meeting iron requirements still requires regular consumption and a combination of other iron sources in a balanced diet. Furthermore, this study did not conduct intervention tests or hemoglobin level measurements; therefore, direct implications for the prevention or improvement of anemia cannot be concluded. Previous research by Layli (2020) showed that combining catfish with iron-rich foods, such as moringa leaves, can increase the iron content of the product without significantly reducing its organoleptic quality. These findings support a formulation approach that combines animal- and plant-based ingredients to increase the iron content of

products. However, its physiological effectiveness requires further research, which may consider bioavailability and actual consumption patterns.

Limitations of the Study

This study had several limitations. The number of panelists was relatively limited and did not represent the target consumers (adolescent girls); therefore, the generalization of the sensory test results is still limited. This study did not evaluate the shelf life and stability of the product during storage.

The nutritional analysis only covered total iron content without assessing its form or bioavailability and was not accompanied by intervention tests or measurements of biochemical parameters such as hemoglobin. Therefore, further research with a more comprehensive design is required to strengthen the validity and implications of these findings.

Conclusion

The F3B formulation (tapioca flour: catfish: wood ear mushrooms = 150:50:50) showed the highest sensory acceptance and higher iron content (2.22 mg/100 g) compared to the other formulations. These findings indicate that the product has the potential to be an alternative source of iron based on local food ingredients.

Recommendations: The development of catfish wontons supports food diversification efforts through the use of easily obtainable ingredients with high nutritional value. Furthermore, further research is needed to assess the bioavailability of iron, its contribution to the Nutrient Adequacy Rate in actual consumption patterns, and aspects of stability and shelf life to strengthen sustainable product development.

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