



# Innovation of functional cookies for substitution of soybean flour (*Glycine max*), chicken liver and purple sweet potato (*Ipomoea batatas L.*) for pregnant women with anemia

*Inovasi kue fungsional sebagai pengganti tepung kedelai (Glycine max), hati ayam, dan ubi ungu (Ipomoea batatas L.) untuk wanita hamil yang mengalami anemia*

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## Abstract

Iron deficiency anemia remains a health problem among pregnant women, with a prevalence of 27.7% in Indonesia. Consuming iron- and vitamin C can help prevent anemia. This study aimed to develop cookies formulated with soybean flour, chicken liver, and purple sweet potato to improve their nutritional values. Soybeans and chicken liver are rich in iron, whereas purple sweet potatoes are rich in vitamin C. This study employed an experimental method with a completely randomized design. The cookies were prepared at Universitas Negeri Semarang, and their nutritional content was analyzed at Universitas Muhammadiyah Semarang in January–February 2025. Iron, vitamin C, and crude fiber were analyzed using colorimetry, iodometric titration, and enzymatic gravimetry, respectively. Data were analyzed using one-way ANOVA and Duncan's test. The results showed significant differences in the iron, vitamin C, and crude fiber contents among the formulas (F1, F2, F3, and F4) ( $p = 0.000$ ). The highest values were found in F4, with 12.48 mg/100 g iron, 43.66 mg/100 g vitamin C, and 9.88% crude fiber. In conclusion, F4 has the potential to prevent anemia during pregnancy. With a serving size of 20 g, it can provide 92.4% of the daily iron requirement and 102.7% of the vitamin C requirement per snack portion for pregnant women.

**Keywords:** Food Innovation, Functional Cookies, Nutritional Content, Pregnancy Anemia

## Abstrak

Anemia defisiensi besi masih menjadi masalah kesehatan pada ibu hamil, dengan prevalensi mencapai 27,7% di Indonesia. Mengonsumsi makanan kaya zat besi dan vitamin C dapat membantu mencegah anemia. Penelitian ini bertujuan untuk mengembangkan cookies yang diformulasikan dengan tepung kedelai, hati ayam dan ubi jalar ungu untuk meningkatkan nilai gizinya. Tepung kedelai dan hati ayam kaya akan zat besi, sementara ubi jalar ungu kaya vitamin C. Penelitian ini menggunakan metode eksperimen dengan Rancangan Acak Lengkap. Pembuatan cookies dilakukan di Universitas Negeri Semarang, sedangkan analisis kandungan gizi dilakukan di Universitas Muhammadiyah Semarang pada Januari–Februari 2025. Analisis zat besi, vitamin C dan serat kasar masing-masing menggunakan metode kolorimetri, titrasi iodometri, dan gravimetri-enzimatik. Analisis data menggunakan One Way ANOVA dan Duncan. Hasil penelitian menunjukkan terdapat perbedaan signifikan pada kandungan zat besi, vitamin C dan serat kasar antar formula (F1, F2, F3, F4) ( $p=0,000$ ). Nilai tertinggi terdapat pada F4 dengan kandungan zat besi 12,48 mg/100 g, vitamin C 43,66 mg/100 g, dan serat kasar 9,88%. Kesimpulan, F4 berpotensi digunakan untuk mencegah anemia pada kehamilan. Dengan takaran saji (20 g), cookies ini mampu memenuhi 92,4% kebutuhan zat besi dan 102,7% kebutuhan vitamin C dalam satu porsi selingan ibu hamil.

**Kata Kunci:** Inovasi Pangan, Cookies Fungsional, Kandungan Gizi, Anemia Kehamilan

## Introduction

Anemia is a condition in which hemoglobin levels are insufficient to meet the body's requirements. It can be classified based on hemoglobin levels: <13 g/dL for men, <12 g/dL for women, and <11 g/dL for pregnant women (Indonesian College of Physicians, 2024). The most common type is iron deficiency anemia (IDA), which occurs when the body lacks iron due to increased need or insufficient intake.

Pregnant women are at a high risk of developing IDA because iron requirements increase up to threefold due to fetal growth and increased blood volume. Iron deficiency can disrupt hemoglobin formation and placental development, increasing the risk of low birth weight (LBW) and contributing to maternal death (Dary et al., 2021; Farhan & Dhanny, 2021).

National data show that the prevalence of LBW in 2023 was 3.9% among 84.3% of babies (Ministry of Health of the Republic of Indonesia, 2024). Haryanti et al. (2019) also found that pregnant women with anemia were 9.3 times more likely to give birth to LBW infants than non-anemic pregnant women. In addition, in 2021, there were 7,389 cases of maternal deaths, with bleeding being the second leading cause (1,320 cases), some of which were associated with anemia (Ministry of Health of Indonesia, 2022).

Globally, the prevalence of anemia among pregnant women is 36.5%, with the highest rates in Asia (47.8%) (World Health Organization, 2019). The proportion of anemia cases caused by iron deficiency ranges from 35 to 75%, and the prevalence increases as the mother ages (Sjahriani & Faridah, 2019; World Health Organization, 2019). Based on the 2023 Indonesian Health Survey, 27.7% of pregnant women in Indonesia were anemic, with the highest incidence among those aged 35–44 years (39.6%) (Ministry of Health of the Republic of Indonesia, 2024).

Anemia prevention during pregnancy can be achieved through pharmacological and non-pharmacological approaches. Pharmacological efforts include the administration of 90 blood supplement tablets during pregnancy as recommended by the government (Carolin et al., 2023). However, this program has not been optimally implemented due to low compliance among pregnant women, primarily caused by forgetfulness (27%) and nausea or vomiting

(22.4%) (Ministry of Health of the Republic of Indonesia, 2023). Syolehda et al. (2021) also reported that 80% of pregnant women were non-compliant in consuming blood supplement tablets and experienced moderate anemia. Side effects, such as nausea, vomiting, and heartburn, are among the main causes of non-compliance. Therefore, non-pharmacological measures can be taken through the consumption of foods rich in iron and vitamin C.

Cookies are snack foods that can be widely accepted and enjoyed by various groups due to their sweet taste and crunchy texture (Herawati et al., 2018; Utami & Prasetyawati, 2020). One effort to enhance the nutritional value of cookies is by adding local ingredients such as soybean flour, chicken liver, and purple sweet potato.

Soybeans are legumes containing 6.9 mg/100 g of iron, surpassing other types of beans such as kidney beans, peanuts, and tolo beans (Ministry of Health of the Republic of Indonesia, 2020). Soybeans are processed into flour to facilitate their use in food products and to extend their shelf life. The drying process significantly affects the functional properties of flour (Rosiana et al., 2023). However, soybeans contain antinutrient compounds, such as phytic acid, which can inhibit the absorption of proteins and minerals (Perdani & Utama, 2020). This limitation can be mitigated through washing treatments, which have been proven to reduce the phytate levels in rice (Liu et al., 2019).

Chicken liver is also a rich source of iron, containing 15.8 mg/100 g, which is 16.5 times higher than that in skipjack liver and three times higher than that in beef liver (Annisa & Suryaalamshah, 2023; Ministry of Health of the Republic of Indonesia, 2020). The heme iron in chicken liver is more easily absorbed than nonheme iron sources (Tenrirawe et al., 2022).

Purple sweet potatoes are a source of vitamin C, containing 20.1 mg/100 g. It provides a higher vitamin C content than other carbohydrate sources, such as rice and wheat (Ministry of Health of the Republic of Indonesia, 2020; Syarfaini et al., 2017). Vitamin C converts non-heme iron into a form of iron (Fe<sup>2+</sup>) that is more easily absorbed by the intestines (Rieny et al., 2021).

Several studies support the potential of these food combinations. Annisa & Suryaalamshah (2023) reported that cookies formulated with 25 g of chicken liver flour and 25 g of soybean flour contained 6.745 mg/100 g of iron, meeting the

criteria for iron source foods (>15% Adequate Intake Level for adolescent girls). Syarfaini et al. (2017) showed that biscuits with 25 g of wheat flour and 75 g of purple sweet potato flour contained 107.57 µg/g of iron and 66.89 mg of vitamin C. According to the Recommended Dietary Allowance (RDA), the iron requirement for pregnant women is 15–18 mg/day and 24–27 mg/day in the first, second, and third trimesters, respectively, while the vitamin C requirement throughout pregnancy is 85 mg/day (Ministry of Health of the Republic of Indonesia, 2019). Combining soybean flour, chicken liver, and purple sweet potato can enrich the iron and vitamin C content of cookies, potentially making them effective in preventing anemia during pregnancy.

Based on the above explanation, this study aimed to analyze the iron, vitamin C, and crude fiber contents of cookies made with soybean flour, chicken liver, and purple sweet potato as potential foods to prevent anemia in pregnant women.

## Methods

### Research Design

This study employed an experimental method using a Completely Randomized Design (CRD) with four treatments, two repetitions, and duplicate analyses. Repetition was conducted to assess the consistency of the results between treatments, while duplicate analyses aimed to improve accuracy and reduce potential errors from both tools and human factors. Thus, two repetitions with duplicate analyses were considered sufficient to obtain reliable results.

The formulations of the main ingredients wheat flour, soybean flour, chicken liver, and purple sweet potato were as follows: F1 (150 g: 50 g: 37.5 g: 12.5 g), F2 (100 g: 75 g: 50 g: 25 g), F3 (50 g: 100 g: 62.5 g: 37.5 g), and F4 (0 g: 125 g: 75 g: 50 g) (Annisa & Suryaalamasah, 2023; Fitria & Prameswari, 2022). Each formulation was prepared twice, resulting in a total of eight samples. Each sample was analyzed in duplicate.

The research was conducted from January to February 2025 at the Culinary Laboratory of the State University of Semarang for cookie preparation and at the Laboratory of Nutrient Analysis of the University of Muhammadiyah Semarang for the analysis of iron, vitamin C, and crude fiber content.

### Preparation of Raw Materials

Soybean flour was prepared by washing the soybeans with clean water, followed by drying in an oven at 50°C for 3 h. Next, the soybeans were roasted for approximately 2 min, ground using a chopper, and sieved with an 80 mesh sieve. The preparation of chicken liver purée began with washing fresh chicken liver, followed by coating it with lime juice equivalent to 1% of its wet weight for approximately 2 min. The liver was then coated with vanilla at 0.2% of its wet weight. The mixture was subsequently boiled for approximately 15 min and mashed using a chopper. The preparation of purple sweet potato purée began with peeling the skin and washing it with clean water. The sweet potatoes were then cut into pieces approximately 5 cm thick and steamed for 30 min at 70°C (after the water boiled). After cooking, the sweet potatoes were cooled until the temperature decreased and then mashed using a chopper.

### Creation of Cookies

The cookie manufacturing procedure included the following steps: preparation of ingredients such as wheat flour, soybean flour, chicken liver, purple sweet potato, margarine, eggs, powdered sugar, milk powder, cornstarch, cocoa powder, vanilla, baking powder, and chocolate chips. The proteins in eggs contribute to the mixture and binding properties of the dough, allowing the use of soybean flour as the main ingredient, with or without wheat flour, to maintain proper consistency (Yudhistira et al., 2019). The margarine and powdered sugar were then mixed using a mixer. Eggs and vanilla were added, and mixing continued. Next, the formula and complementary ingredients (milk powder, cornstarch, cocoa powder, baking powder, and chocolate chips) were added and stirred with a spatula. The mixed batter was then weighed and molded. Subsequently, the dough was baked at 150°C for approximately 15 min. The cookies were then cooled. The detailed composition of the cookies is as follows:

**Table 1.** Composition of ingredients for making cookies

Material	Material Weight (gr)			
	F1	F2	F3	F4
<b>Main Ingredients</b>				
Flour	150	100	50	0
Soybean flour	50	75	100	125
Chicken liver	37,5	50	62,5	75

Purple sweet potato	12,5	25	37,5	50
Additional Ingredients				
Margarine	140	140	140	140
Chicken eggs	60	60	60	60
Refined sugar	100	100	100	100
Milk powder	40	40	40	40
Cornstarch	50	50	50	50
Chocolate powder	20	20	20	20
Vanilla	2,5	2,5	2,5	2,5
Baking powder	2,5	2,5	2,5	2,5
Choco chips	5	5	5	5

### Iron Content Analysis

Iron content analysis was conducted using the colorimetric method with a UV-Vis spectrophotometer at a wavelength of 510-520 nm. This method was validated with a precision of <5% (RSD), accuracy of 97-101%, LOD of 0,004 µg/mL, and LOQ of 0,01 µg/mL. The analysis procedure was as follows: the sample was weighed and digested using an acid mixture until a clear solution was achieved. The Fe<sup>3+</sup> ions in the sample were reduced to Fe<sup>2+</sup> using a reducing agent and reacted with a 1.10-phenanthroline reagent to form a red-orange complex. Color intensity was measured using a UV-Vis spectrophotometer at 510 nm. Iron levels were determined by comparing the sample absorbance values to the Fe<sup>2+</sup> standard curve. Iron levels were calculated as follows:

$$\text{Iron} \left( \frac{\text{mg}}{100 \text{ g}} \right) = \frac{C \times V}{W} \times 100$$

Where C is the concentration (mg/L), V is the final volume (L), and W is the sample weight (g). The results were expressed in mg/100 g (National Standardization Agency, 2002; Silva et al., 2018).

### Vitamin C Content Analysis

Vitamin C content was analyzed using the iodometric titration method. A 5 g blended sample was placed in an Erlenmeyer flask, and 25 mL of distilled water was added to it. A 0.01 N iodine solution was prepared in a 25 mL burette and titrated until a blackish blue endpoint was reached. One ml of 0,1 N iodine solution is equivalent to 8.806 g of vitamin C. Method validation showed a precision of <5% and an accuracy of 95-105% (Association of Official Analytical Chemists, 2016). Vitamin C levels were calculated using the following formula:

$$\text{Vitamin C (mg/100g)} = \frac{V \times N \times 88 \times 100}{W}$$

where V is the titrant volume (mL), N is the normality of iodine, 88 is the ascorbic acid equivalent weight (mg), and W is the sample weight (g). The results were expressed in mg/100 g (National Standardization Agency, 1992).

### Analysis of Crude Fiber Content

The crude fiber content was analyzed using the enzymatic gravimetric method. Approximately 2 g of the food sample was weighed and refluxed with a 1,25% H<sub>2</sub>SO<sub>4</sub> solution for 30 min. After filtration, the residue was washed with hot water, ethanol, and ether and then dried to a constant weight at 105°C. The obtained residue was then roasted at 550°C to remove the mineral content. The crude fiber content was calculated using the following formula:

$$\text{Crude Fiber (\%)} \times 100 = \frac{W_1 - W_2}{\text{sample weight (g)}}$$

The following were used: W<sub>1</sub> = weight of residue after drying (g) and W<sub>2</sub> = weight of ash after combustion (g). The results are expressed as a percentage (AOAC International, 2005; National Standards Agency, 1992).

### Data Analysis

Data on iron, vitamin C, and crude fiber were entered into the SPSS program. Statistical analysis began with a normality test using the Shapiro-Wilk test, followed by a homogeneity test using Levene's test. If the data were normally distributed (p >0.05) and homogeneous (p >0.05), they were analyzed using a one-way ANOVA. A p-value > 0.05 indicated no significant difference; conversely, a p-value < 0.05 indicated a significant difference, which was then followed by the Duncan test. In this study, the Duncan post hoc test was used because it is more sensitive in detecting small differences between treatments than the Tukey test.

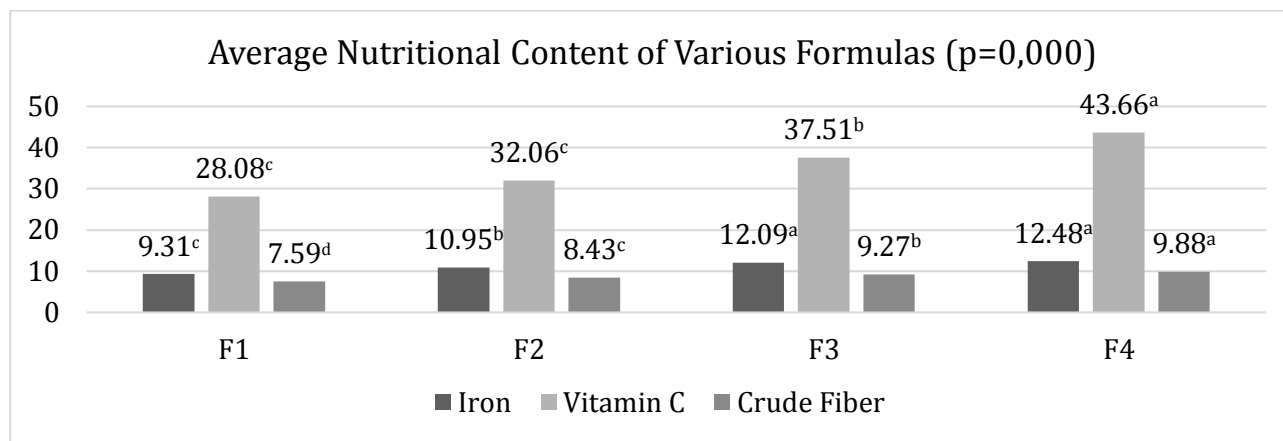
## Result and Discussion

Cookies made from soybean flour, chicken liver, and purple sweet potato are shown in figure 1. This study did not include a sensory evaluation; therefore, the sensory characteristics of the cookies were not identified. Each cookie weighed 10 g.



**Figure 1.** Soybean flour cookies, chicken liver and purple sweet potato

The addition of soybean flour, chicken liver, and purple sweet potato significantly increased the iron, vitamin C, and crude fiber contents, as shown in Figure 2.



**Figure 2.** Graph of the average nutritional content of various formulas

The One-Way ANOVA test results showed a significant difference in the iron, vitamin C, and crude fiber contents of the cookies, with a significance value of  $0.000 < 0.05$  for each. Therefore, Duncan's post hoc test was conducted to determine which groups had significant differences in their means, as indicated by the difference in letter notation across treatments.

### Iron Content

Based on the statistical analysis results, there was a significant difference between F1 and F2, F3, and F4. Formula F2 was significantly different from F3 and F4, whereas F3 was not significantly different from F4. The iron content in the cookies increased with higher proportions of soybean flour and chicken liver and decreased use of wheat flour. This is because soybeans are a type of legume with a higher iron content than other legumes, such as kidney beans, mung beans, and peanuts, containing 6.9 mg/100 g (Khoirunnisa et al., 2021). In addition, chicken liver contains more iron than other parts of the chicken, with an iron content of 15.8 mg/100 g. The iron content in the cookies is also contributed by the iron content in purple sweet potatoes, which amounts to 0.5 mg/100 g of ingredients (Ministry of Health, Republic of Indonesia, 2020). Wheat flour contains only 1.3 mg/100 g. These findings align with those of Tyas et al. (2025), who developed cookies using chicken liver and mung bean flours.

The control formula (using 100% wheat flour) showed a lower iron level of 0.588 mg/100 g compared to the P3 cookie formula, which used a ratio of 25% wheat flour, 30% chicken liver flour, and 45% mung bean flour, resulting in an iron content of 3.267 mg/100 g. The addition of soybean flour, chicken liver, and purple sweet potato, which contain micronutrients such as iron, increases the iron content of the final product (Laili et al., 2023). Therefore, cookies made from soybean flour, chicken liver, and purple sweet potato without the addition of wheat flour had the highest iron content in this study.

Women of childbearing age require a daily iron intake of 15-18 mg/day, with 15 mg/day for ages 16-18 years and 18 mg/day for ages 19-49 years. During pregnancy, iron requirements increase; there is no rise in the first trimester, but in the second and third trimesters, the need increases by 9 mg/day. Thus, the total iron requirement for pregnant women aged 16-49 years is 15-18 mg/day in the first trimester and 24-27 mg/day in the second and third trimesters. The proportion of snack consumption per meal is equivalent to 10% of the RDA, meaning that the iron requirement for one snack serving for pregnant women is approximately 2.7 mg (Ministry of Health of the Republic of Indonesia, 2019; Khaffifah & Oktafa, 2022).

A product can be labeled as an iron-rich food when its content reaches 30% of the

Nutrition Label Reference (ALG), while a content of 15% ALG is categorized as an iron source food (Fauziah et al., 2019). Based on the Nutrition Label Reference (ALG) Number 9 of 2016, the iron requirement for pregnant women is 34 mg per day. Thus, 15% of the ALG value for iron in pregnant women is equivalent to 5.1 mg, and 30% of the ALG value is equivalent to 10.2 mg (Food and Drug Supervisory Agency of the Republic of Indonesia, 2016).

The results of the nutritional content analysis in this study showed that F1, with the lowest iron content of 9.31 mg/100 g, met 15% of the reference iron requirement for pregnant women according to the Nutrition Label Reference and can thus be claimed as a source of iron. F2, F3, and F4 met 30% of the reference iron requirement for pregnant women, with iron contents of 10.95 mg/100 g, 12.09 mg/100 g, and 12.48 mg/100 g, respectively, and therefore can be claimed as iron-rich foods.

### Vitamin C

Based on the statistical analysis, there was a significant difference between F1 and F3, as well as between F1 and F4. Formula F2 was significantly different from F3 and F4, and F3 was significantly different from F4. However, F1 was not significantly different from F2. The vitamin C content in the cookie increased with a higher proportion of purple sweet potatoes, which have a higher vitamin C content than other varieties, containing 24 mg per 100 g (Ministry of Health of the Republic of Indonesia, 2020). This aligns with research by Syarfaini et al. (2017), which found that biscuits with a 1:3 formulation of 25 grams of wheat flour and 75 grams of purple sweet potato flour had the highest vitamin C content compared to the 1:0, 1:1, and 3:1 formulations, amounting to 66.89 mg/100 g of purple sweet potato biscuits. The vitamin C content of a product may decrease during processing. However, despite heating, the vitamin C content in the cookie product remained relatively high owing to the use of purple sweet potato.

This finding aligns with that of Lee et al. (2018), who reported that microwave heating has a smaller impact on vitamin C content in spinach, carrots, sweet potatoes, and broccoli, with a high retention of >90%. Women of childbearing age (16-49 years) require approximately 75 mg/day of vitamin C. During pregnancy, the iron requirement increases by 10

mg from the first to the third trimester. Thus, the vitamin C requirement for pregnant women aged 16-49 years is 85 mg/day. The proportion of interlude food per meal is equivalent to 10% of the Recommended Dietary Allowance (RDA); thus, the vitamin C requirement from one interlude meal for pregnant women is 8.5 mg/day (Ministry of Health of the Republic of Indonesia, 2019).

A food product can be claimed to be high in vitamin C if it increases iron absorption or meets 15% of the vitamin C reference value. Thus, 15% of the Nutrition Label Reference (ALG) for vitamin C in pregnant women is equivalent to 13.5 mg (Food and Drug Supervisory Agency of the Republic of Indonesia, 2016). In this study, the vitamin C content in F1 (28.08 mg), F2 (32.06 mg), F3 (37.51 mg), and F4 (43.66 mg) met 15% of the vitamin C reference value in accordance with the Nutrition Label Reference (ALG) for pregnant women. Thus, all four formulas can be classified as foods rich in vitamin C.

Vitamin C, a micronutrient, increases iron absorption, especially non-heme iron, which is mainly found in plant foods. Its increasing effect is due to the formation of iron-ascorbate complexes that remain soluble even at higher pH levels. Thus, pregnant women are highly recommended to take vitamin C along with food. Vitamin C facilitates iron absorption by reducing ferric ions ( $\text{Fe}^{3+}$ ) to ferrous ions ( $\text{Fe}^{2+}$ ), which are more easily absorbed by the intestinal lining. Once absorbed, iron binds to the protein apoferritin to form ferritin. In the bloodstream, ferrous iron is transported by transferrin, a protein that carries approximately 3–4 mg of iron. Iron is mainly stored in the liver, spleen, and bone marrow. Approximately 20–25 mg of iron per day is used in the production of hemoglobin and the replacement of degraded hemoglobin, with iron accounting for 60–70% of the hemoglobin structure. Therefore, if a pregnant woman's vitamin C intake is insufficient or not accompanied by adequate iron consumption, vitamin C cannot effectively support iron levels. This imbalance leads to a decrease in hemoglobin levels (Rieny et al., 2021). Consistent with the research by Saputri & Soimah (2024), who stated that the average results of the administration of Fe tablets and vitamin C were 11.6 mmHg higher than those of the group that was only given Fe tablets at 10.6 mmHg, it can be concluded that the administration of Fe tablets along with vitamin C

is more optimal in increasing hemoglobin levels. Therefore, cookies with 125 g of soybean flour, 75 g of chicken liver, and 50 g of purple sweet potato (without wheat flour) had the highest vitamin C content, which potentially increases iron absorption to prevent anemia in pregnant women.

### Crude Fiber

The results of the statistical analysis indicated a significant difference between F1 and F2, as well as between F3 and F4. Formula F2 significantly differed from F3 and F4, whereas formula F3 significantly differed from F4. Based on the cookie quality requirements in SNI 01-2973-1992, the maximum limit of crude fiber content in cookies is 0.5% (National Standardization Agency, 1992b). The crude fiber content test results of the four cookie formulations substituted with soybean flour, chicken liver, and purple sweet potato did not meet the quality requirements, with fiber contents of 7.59% in F1, 8.43% in F2, 9.27% in F3, and 9.88% in F4.

The crude fiber content increased in each formulation owing to the substitution of soybean flour with purple sweet potato. According to the Indonesian Food Composition Table, 100 grams of soybeans have a fiber content of 3.2 grams, while 100 grams of purple sweet potatoes have a higher fiber content compared to wheat flour, which amounts to 4.72 grams (Ministry of Health of the Republic of Indonesia, 2020). Consistent with Wulandari & Handayani (2024), purple sweet potato cookies in the F3 treatment had the highest crude fiber content of 4.767%, with a percentage of purple sweet potato puree of 70% (Wulandari & Handayani, 2024). Apriliani et al. (2024) stated that soybean flour has a higher crude fiber content compared to sunflower seed flour, namely 18.87% for soybean flour and 11.14% for sunflower seed flour, respectively. The addition of soybean flour and purple sweet potato with crude fiber increased the crude fiber content in the products.

A high fiber content in cookies can negatively affect their texture. Mardiyanto et al. (2024) showed that increased crude fiber levels in cookies due to the addition of okara flour can affect the texture, making it more brittle. To overcome this, complementary ingredients such as margarine, eggs, and tapioca flour were added to maintain the cookie texture.

Fiber is an essential plant component that cannot be digested by the human body. The fiber content of food can change due to food

processing. In addition, fiber has the potential to inhibit the absorption of other nutrients, such as carbohydrates, proteins, and fats (Mulyanita et al., 2023). Furthermore, dietary fiber intake can affect hemoglobin levels. Fiber consumption exceeding 120% of the RDA can inhibit iron absorption, thereby reducing hemoglobin formation and leading to low hemoglobin levels (anemia) due to inhibited iron absorption in the body (Srimaharani et al., 2017). However, pregnant women require adequate fiber to prevent constipation. Fiber is essential for digestion, especially in increasing stool density, softening stool consistency, increasing stool volume, and improving bowel movement (Sangi et al., 2022).

The crude fiber content in food is estimated to represent approximately 0.2–0.5 of the total dietary fiber content (Widnyani et al., 2021). In one serving (20 g) of these substituted cookies, the crude fiber content ranged from 1.52% to 1.98%, which is estimated to be equivalent to a total dietary fiber of approximately 3.04–9.88 g per 20 g of cookies. According to the 2019 Recommended Dietary Allowance (RDA), the fiber requirement for pregnant women is 33 g in the first trimester and 34 g in the second and third trimesters (Ministry of Health of the Republic of Indonesia, 2019). Compared to the Recommended Dietary Allowance (RDA) for fiber, the fiber content in one serving of these cookies is 9–29% of the total daily fiber requirement for pregnant women. Thus, the fiber content per serving (20 g) of cookies remains in the normal range and does not exceed 120% of the recommended fiber intake for pregnant women; therefore, it is unlikely to inhibit iron absorption (Wahyuna et al., 2017). Therefore, all four formulas contained fiber levels suitable for pregnant women.

### Snack Alternatives for Pregnant Women

Based on the results of the calculation using the Exponential Comparison Method, the best formula for cookies substituted with soybean flour, chicken liver, and purple sweet potato was F4, with an ingredient ratio of 125 g of soybean flour, 75 g of chicken liver, and 50 g of purple sweet potato. According to the Regulation of the Food and Drug Supervisory Agency Number 26 of 2021, the recommended serving size for cookies is 15-50 g per serving. In this study, each cookie weighed 10 g. The recommended serving size for pregnant women is 20 g, equivalent to two cookies per serving, providing 2,496 mg of iron,

8,732 mg of vitamin C, and 1.976% crude fiber. This portion accounts for 10% of the total daily intake, according to the Recommended Dietary Allowance (RDA). Therefore, consuming this serving can meet 92.4% of the iron and 102.7% of the vitamin C requirements for one interlude meal (Food and Drug Supervisory Agency of the Republic of Indonesia, 2021; Inosenshia et al., 2024; Ministry of Health of the Republic of Indonesia, 2019). The estimated contribution to %RDA shows that these cookies have the potential for further testing to evaluate their effectiveness on hemoglobin levels in pregnant women.

## Conclusion

The best cookie formulation, which was made by substituting with soybean flour, chicken liver, and purple sweet potato, was F4 (125 g soybean flour: 75 g chicken liver: 50 g purple sweet potato). This formulation has the potential to be used as a functional food by pregnant women to prevent anemia. One serving of these cookies (20 g/2 pieces) provides 2.496 mg of iron, 8.732 mg of vitamin C, and 1.976% crude fiber, meeting 92.4% of the iron requirement and 102.7% of the vitamin C requirement, according to the RDA. Nutritional content analysis also showed a significant difference in iron, vitamin C, and crude fiber levels among cookies prepared with soybean flour, chicken liver, and purple sweet potato.

Further research is needed to conduct acceptance tests on cookies made with soybean flour, chicken liver, and purple sweet potato. This is important for determining consumer preferences and guiding further product development. Additionally, these cookies have the potential to be developed as fortified functional foods to support nutritional programs, especially for pregnant women. Further development can focus on optimizing the formulation to reduce the crude fiber content in F4 without compromising its iron and vitamin C levels.

This study had several limitations that should be considered when interpreting the results and planning follow-up research. In this study, no organoleptic tests were conducted; therefore, consumer preference for the cookie products could not be determined. In addition, there was no control formulation (F0) using 100% wheat flour, which prevented a thorough comparison of the substitution effects. The

content and effectiveness of vitamin C in these products were not further analyzed. Furthermore, the crude fiber content in the best formula, F4, exceeded the maximum limit set by the SNI, which may affect product quality.

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