



## **Physicochemical and sensory characteristics of iron rich macarons based on red rice and moringa leaf flour**

Nurul Wahyu Utami, Nani Ratnaningsih

Family Welfare Education Study Program, Postgraduate Program, Universitas Negeri Yogyakarta, Jl. Colombo No.1, Karang Malang, Caturtunggal, Depok, Sleman, Yogyakarta 55281, Indonesia

\*Correspondence: [nurulwahyu.2024@student.uny.ac.id](mailto:nurulwahyu.2024@student.uny.ac.id)

### **ABSTRAK**

**Latar Belakang:** Remaja putri di Indonesia beresiko tinggi mengalami anemia akibat kekurangan zat besi dengan prevalensi 32,0%. Konsumsi pangan sumber zat besi dapat mencegah anemia, misalnya beras merah dan daun kelor. Namun pengembangan kukis dari beras merah dan daun kelor masih terbatas, termasuk pada produk macaron yang terbuat dari tepung almond dan putih telur.

**Tujuan:** Penelitian ini bertujuan untuk menemukan formula, menguji kadar proksimat dan zat besi, serta tingkat kesukaan remaja terhadap macaron substitusi tepung beras merah dan tepung kelor.

**Metode:** Penelitian RnD untuk menguji kadar proksimat dan kadar besi. Macaron yang diuji adalah F0 (0% tepung beras merah, 0% tepung kelor), F1 (60% tepung beras merah, 0% tepung kelor), dan F2 (60% tepung beras merah, 3% tepung kelor). Analisis statistik menggunakan uji One-Way Anova dan uji lanjutan Tukey HSD.

**Hasil:** Macaron dengan substitusi 60% tepung beras merah dan 3% tepung kelor memiliki kandungan gizi per 100 g berupa 3.28±0.11 g air, 1.58±0.28 g abu, 19.56±0.00 g lemak, 18.21±0.54 g protein, 70.61±0.71 g karbohidrat, dan 11.49±0.05 mg zat besi. Kadar zat besi macaron per porsi (45 gram) memenuhi 34.47% kebutuhan zat besi remaja sehingga dikategorikan sebagai pangan tinggi zat besi. Hasil uji hedonik menunjukkan macaron substitusi 60% tepung beras merah dan 3% tepung kelor disukai oleh remaja dan berbeda nyata dengan produk acuan.

**Kesimpulan:** Macaron substitusi 60% tepung beras merah dan 3% tepung kelor dikategorikan sebagai kukis tinggi zat besi karena dapat memenuhi 34.47% angka kecukupan zat besi remaja sehingga berpotensi sebagai pangan fungsional untuk mencegah anemia pada remaja.

**KATA KUNCI:** macaron; remaja; tepung beras merah; tepung kelor; zat besi

## ABSTRACT

**Background:** Adolescent girls in Indonesia face a high risk of iron-deficiency anemia, with a prevalence of 32%. Anemia is characterized by low hemoglobin or red blood cell levels, and consuming iron-rich foods can help prevent it. Moringa leaves contain 28.2 mg of iron, while macarons are cookies made from almond flour and egg whites. Substituting almond flour with red rice and moringa flour is expected to increase the product's iron content.

**Objectives:** This study aims to analyze the proximate composition, iron content, and acceptability of macarons substituted with red rice flour and moringa flour.

**Methods:** Research and Development was conducted to test the proximate composition and iron content. The macarons tested were F0 (0% red rice flour, 0% moringa flour), F1 (60% red rice flour, 0% moringa flour), and F2 (60% red rice flour, 3% moringa flour). Statistical analysis was performed using One-Way ANOVA and Tukey HSD.

**Results:** Macarons with 60% red rice flour and 3% moringa flour contain  $3.28 \pm 0.11$  g water,  $1.58 \pm 0.28$  g ash,  $19.56 \pm 0.00$  g fat,  $18.21 \pm 0.54$  g protein,  $70.61 \pm 0.71$  g carbohydrates, and  $11.49 \pm 0.05$  mg iron per 100 g. A 45 g serving provides 34.47% of adolescents' daily iron needs, classifying the product as iron-rich. Hedonic testing showed that this formula was preferred by adolescents and significantly different from the reference product.

**Conclusions:** Macarons with 60% red rice flour and 3% moringa flour are categorized as iron-rich cookies because they meet 34.47% of adolescents' iron requirements, indicating their potential as a functional food to help prevent anemia.

**KEYWORDS:** adolescents; iron; macaron; moringa flour; red rice flour

Article info: Received July 07, 2025; 1<sup>st</sup> revision July 10, 2025; 2<sup>nd</sup> revision July 16, 2025; 3<sup>rd</sup> revision July 28, 2025; 4<sup>th</sup> August 28, 2025; 5<sup>th</sup> October 20, 2025; accepted November 04, 2025; available online January 30, 2026; published January 31, 2026.

## INTRODUCTION

Adolescence is a transitional phase from childhood to adulthood between the ages of 10 and 18 that requires special attention in terms of health and nutritional status (1) (2) Adolescence teenagers tend to have unhealthy eating habits because they like to consume foods high in sugar and salt, but do not consume enough vegetables and fruits (1). Factors that can influence eating patterns in adolescents include knowledge, gender, environment, the internet, income level, and food sources(1). Unhealthy eating patterns and low intake of essential nutrients such as iron contribute to high rates of anemia among adolescent girls. Adolescent girls are at high risk of anemia caused by several conditions, such as blood loss during menstruation, iron deficiency, and early pregnancy (2).

Anemia is a condition in which the body lacks hemoglobin or red blood cells that are far below normal levels (3). The prevalence of anemia in women is 27.2% higher than in men (20.3%), while in adolescents aged 15-24 years it is 32.0% (4). Anemia in adolescent girls is caused by low iron intake and other nutrients such as vitamin A, vitamin C, folate, riboflavin, and vitamin B12 (5).

Protein deficiency can also cause anemia. Protein plays a role in transporting iron to the spinal cord for the formation of hemoglobin (6). Anemia in adolescents causes serious effects on the immune system, concentration, fitness, and productivity. Anemia in adolescent girls poses a high risk when they become mothers, potentially leading to premature birth, risk of death during childbirth, and low birth weight babies (5).

Consuming iron-rich foods can help treat anemia. Iron-rich foods are divided into two categories: animal-based and plant-based (7). Animal-based foods that contain iron include eggs, chicken liver, red meat, and fish (8). Plant-based foods that contain iron include various nuts, seaweed, brown rice, and moringa leaves. One food that can be used as a source of iron is red rice flour and moringa leaves (9). Red rice (*Oryza nivara*) is obtained from a milling process without polishing, so it still has its bran (10). In 100 g of red rice flour, there are 352 kcal, 0.9 g of fat, 7.3 g of protein, 76.2 g of carbohydrates, 4.2 milligrams of iron, and 0.8 g of fiber (11). Moringa leaves (*Moringa oleifera*) belong to the Moringaceae family, originating from the western and sub-

Himalayan regions (12). Moringa leaves are known as the "Miracle Tree" because they are one of the superfoods rich in nutrients. In 100 g of moringa flour, there are 205 kcal, 27.1 g of protein, 2.3 g of fat, 38.2 g of carbohydrates, and 28.2 milligrams of iron (13,14). Moringa powder is known for its high iron (Fe) content.

Efforts to increase iron intake in adolescents can be done by substituting food products, such as bakery products. Bakery products are food products made from processed flour, eggs, sugar, and other ingredients (15). Baked goods include bread, cake, pastry, and cookies. Cookies are small baked goods (15). Cookies are made from soft dough, are high in fat, crispy, and have a less dense texture (16). Based on their texture, cookies are classified into crispy, chewy, and soft cookies (15). Macarons are known as cookies made from egg whites, almond flour, and sugar, with a chewy texture (17). Macarons are desserts that were first made in Italy with a crunchy texture. Based on the method used to make them, macarons are divided into French meringue method, Italian meringue method, and Swiss meringue method (18). Macarons have the advantages of a unique texture, being gluten-free, and having high selling value. However, macarons have the disadvantages of being difficult to make and prone to failure, the raw materials used are relatively expensive, they do not last long, and environmental conditions greatly affect the final result of the macaron shell (18).

Macarons have the potential to be developed in Indonesia despite various challenges in the manufacturing process. The Indonesian confectionery market is projected to reach USD 7.776 billion by 2025, with an annual consumption of 4.5 kg per person (19). Additionally, data from Euromonitor (20) reveals that the high demand for bakery products in Indonesia amounts to USD 5.3 billion. Public interest in macarons is evident on the e-commerce platform Shopee, where some stores sell over 10.000 pieces of macarons (21–23). This highlights a significant opportunity to develop innovative products such as macarons using substitutes like red rice flour and moringa flour.

The development of cookies with red rice flour and moringa leaf substitutes has been published. Research by Zaddana et al (24) reports

that biscuits made with a combination of red rice flour and moringa flour contain 5.74 g of fiber and 5.28 mg of iron. Therefore, the biscuit product is categorized as a source of fiber and iron (25). Research by Yulia Nabilla et al (9) reports the development of biscuits made with a mixture of purple sweet potato flour, soybeans, moringa leaves, and mackerel, containing 11.18 g of protein and 2.73 g of iron. Therefore, the product can be categorized as a food source of protein and iron (25). Khofifah et al (26) also reported that the development of moringa leaf biscuits can affect hemoglobin levels in adolescent girls after intervention, namely 12.9 g/dl. However, to date, the development of macarons with red rice flour and moringa leaf substitution has not been reported. Therefore, this study aims to determine the formula, test the proximate composition and iron content, as well as the acceptability of macarons made with red rice flour and moringa leaf flour among adolescents. The results of this study are expected to provide healthy iron-rich cookies for the prevention of anemia in adolescents.

## **MATERIALS AND METHODS**

The ingredients used in this study were almond flour, red rice flour, moringa flour, Gulus brand icing sugar, Gulaku brand caster sugar, egg whites, and Tulip brand chocolate filling. The equipment used in this study included scales, a sieve, a mixer, a dough bowl, a spatula, a silpat, a piping bag, and an electric oven. This study was conducted from January to June 2025. The production process was carried out at the Chemistry Laboratory of the Faculty of Engineering, Yogyakarta State University. Proximate analysis and iron content testing were conducted at the PAU Center for Food and Nutrition Studies, Gadjah Mada University.

### **Determination of macaron recipes with red rice flour and moringa flour substitutes**

#### **Define stage**

In the define stage, three macaron recipes from different sources were tested. The selected macaron recipe was used as a reference recipe to be substituted with red rice flour and moringa flour. Macaron shells have unique characteristics and a complicated manufacturing process (18). The

accuracy of the raw material quantities and the technique used to mix the macarons affect the final result of the macarons (15) (15). The main ingredients in making macaron shells are almond flour, icing sugar, caster sugar, and egg whites. Macaron dough that is too moist causes the dough to be too flat and spread out (15).

### Design stage

The design stage aims to determine the development recipe from the reference recipe selected in the define stage by substituting red rice flour and moringa flour. The amount of red rice flour substitution used is 20%, 40%, and 60%. The selected red rice flour substitution result is 60%. The next step is to add moringa flour at 1%, 3%, and 5% of the total amount of almond flour. The development stage was validated by the expert lecturer. There was a suggestion to replace the vanilla filling with chocolate filling. The dissemination stage was conducted to determine the level of preference by 80 female teenage panelists. The results of the organoleptic test were

conducted by 80 female teenage panelists aged 16-18 years.

### The process of making macarons

The process of making macarons with red rice flour and moringa flour substitutes begins with weighing the ingredients using a scale accurate to 0.001 g. The next step is to beat the egg whites with caster sugar using a high-speed mixer until they reach a soft peak consistency. Then add the sifted dry ingredients, namely almond flour, icing sugar, red rice flour, and moringa flour. Mix the dough thoroughly using the folding technique until it falls into a ribbon shape.

Put the dough into a piping bag, then pipe it onto a silpat. Let the dough rest for 45 minutes to 1 hour until the surface of the macarons is dry. Bake the macarons in an oven preheated to 135°C for 40-50 minutes. Remove the macarons once they have cooled and hardened. Next, fill the macarons with chocolate filling. The macaron making process can be seen in (Figure 1).

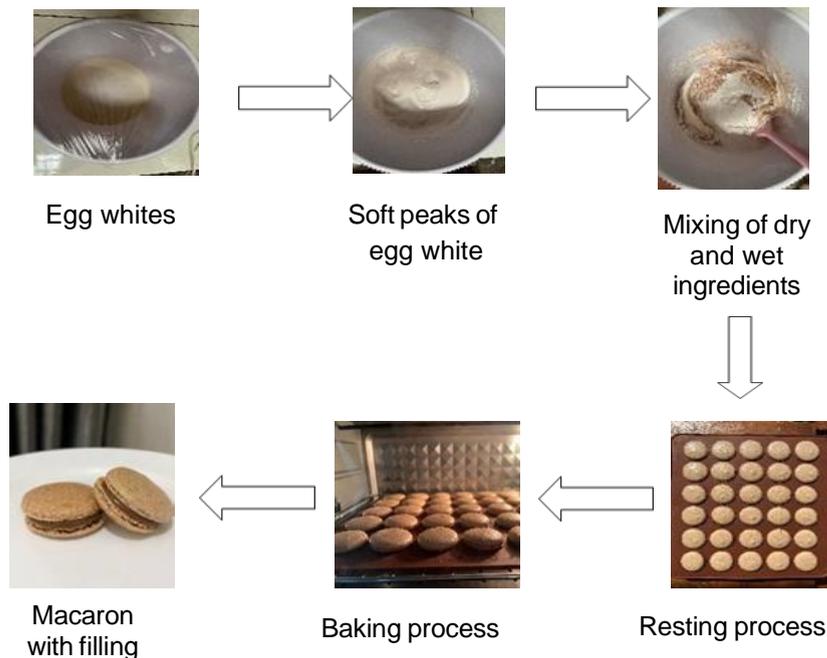


Figure 1. Process of making macarons substituted with red rice flour and moringa flour

### Proximate analysis

Moisture content is measured using the gravimetric method. The equipment used is an analytical balance with a sensitivity of 0.1 mg and an oven. Moisture is determined by heating the sample in an oven at a temperature of 100–105°C until a constant weight is achieved. The weight measured is the moisture content of the sample. Ash content is measured using the gravimetric method. The equipment used is an analytical balance with a sensitivity of 0.1 mg and an ash crucible. The macaron sample is incinerated until free of carbon, and the remaining ash is the ash content of the sample. Fat content is measured using the Soxhlet method with Weibull modification. The equipment used is a Soxhlet extraction apparatus and a balance with a sensitivity of 0,1 mg. The reagents used are 8 N hydrochloric acid (HCl) (65%) and diethyl ether or petroleum ether at a temperature of 40–60°C. The macaron sample is hydrolyzed with hydrochloric acid (HCl) to release the bound fat. The fat is then extracted with diethyl ether in a Soxhlet extraction apparatus. The diethyl ether is evaporated, and the fat residue in the Soxhlet flask is weighed.

The protein content is measured using the Kjeldahl method (27). The equipment used is a 500 ml Kjeldahl flask, a distillation apparatus, and a scale with a sensitivity of 0,1 mg. The reagents used are concentrated sulfuric acid ( $H_2SO_4$ ), anhydrous potassium sulfate ( $K_2SO_4$ ), mercury oxide (HgO) or copper sulfate ( $CuSO_4 \cdot 5H_2O$ ), 60% sodium hydroxide (NaOH), 0.1 N hydrochloric acid (HCl), 3% boric acid, and a mixture of blue and red metal indicators (1:2) in 95% ethanol. The sample was destroyed with concentrated sulfuric acid using potassium sulfate and mercury oxide as catalysts. The organic nitrogen in the sample was converted into ammonium ions and then distilled with the addition

of sodium hydroxide. The nitrogen content in the sample was determined by standard acid titration. The carbohydrate content was measured using the difference method, which involves subtracting 100% from the results of water, ash, fat, and protein.

### Iron content testing

Iron content is measured using spectrophotometry. The equipment used includes a muffle furnace, Erlenmeyer flasks, porcelain crucibles, and a balance with an analytical sensitivity of 0.1 mg. The reagents used are  $HNO_3$ , ammonium thiocyanate, and distilled water.

### Preference testing

Eighty female adolescents aged 10–18 years conducted a sensory test by filling out a form to determine the preference level of red rice flour and moringa flour substitute macarons. The parameters measured were color, aroma, taste, texture, and overall characteristics, with scores ranging from 1 = strongly dislike, 2 = dislike, 3 = somewhat like, 4 = like, and 5 = strongly like.

### Data Analysis Techniques

Data were analyzed using SPSS 26 software. An ANOVA test was conducted, followed by a Tukey HSD test (significance level 0.05).

## RESULTS AND DISCUSSIONS

### Define stage

In the define stage, the best recipe was selected from three reference recipes. The recipes were obtained from books. The reference recipes were selected based on color, aroma, taste, texture, and overall product quality. The three reference recipes can be seen in (**Table 1**).

**Tabel 1. Reference Recipe for Macaron**

Ingredients	Amount		
	Recipe A	Recipe B	Recipe C
Almond flour	100 g	165 g	125 g
Egg whites	80 g	115 g	100 g
Icing sugar	100g	165 g	200 g
Castor sugar	100 g	150 g	40 g

\* Source: *Primarasa (A)*, *Wayne Gisslen (B)* (*C*)

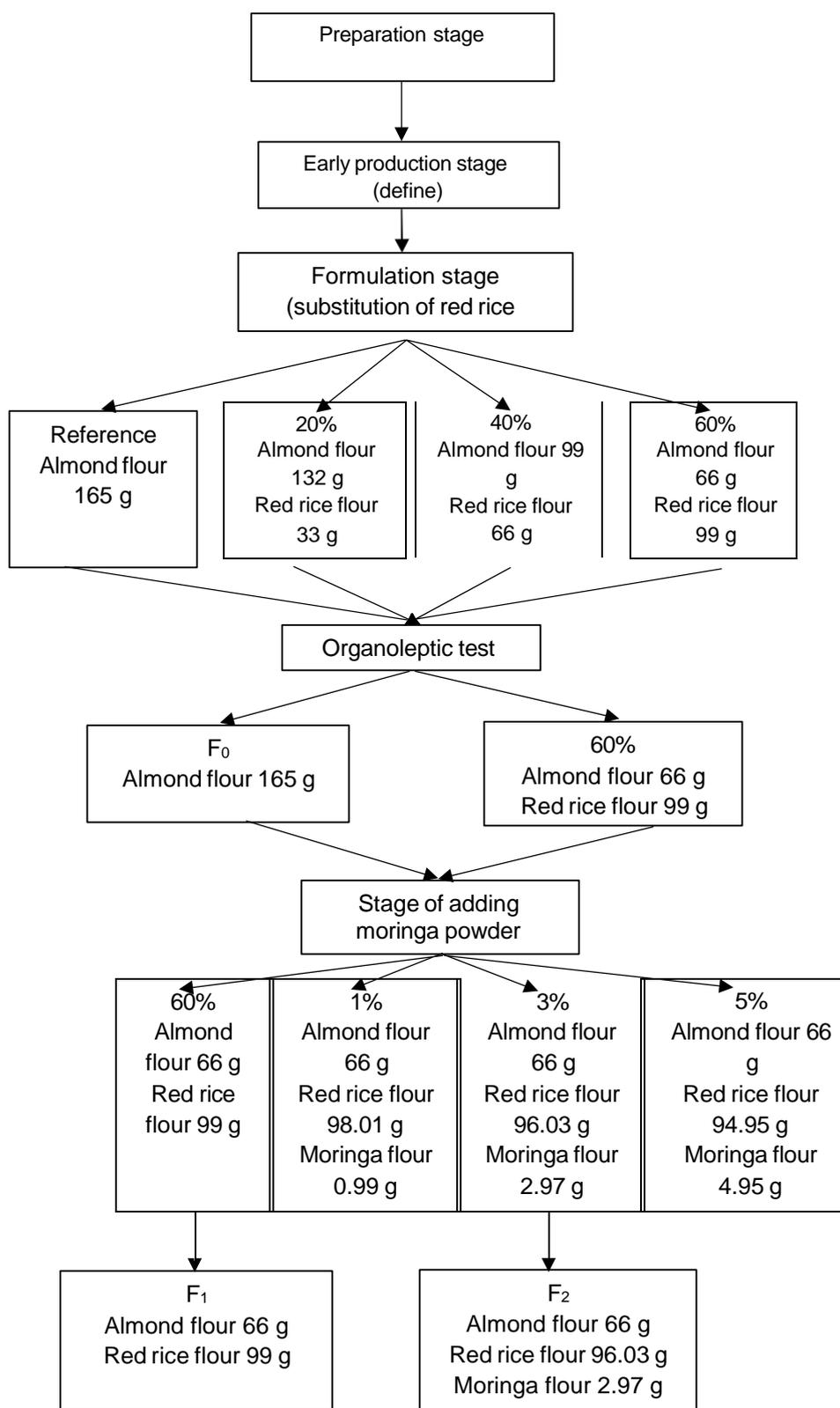


Figure 2. Comparison of red rice flour substitution and moringa flour in the formula

Recipe A is sourced from Primarasa (18), recipe B and C sourced from Wayne Gisslen (15). Recipe B has the best shape among the three recipes. The crust is flat and thin, the taste is sweet, the color is the whitest, the aroma is sugary, and the texture is crispy and chewy. Therefore, the selected recipe at the define stage is Recipe B, sourced from Wayne Gisslen (15).

**Design stage**

In the design stage, the recipe selected in the previous stage (define stage) will be used as a reference in substituting the substitute ingredient, namely red rice flour, in the development of macarons. Recipe B, sourced from the book Professional Baking Seventh Edition by Wayne Gisslen, was selected as the reference recipe. The comparison of red rice flour substitution and moringa flour in the formula can be seen in **Figure 2**. Macarons with 3% moringa flour have a balanced sweet and bitter taste, making them acceptable to validators. Meanwhile, macarons with 5% moringa flour have a taste that is too bitter. Therefore, the formula selected at the design stage is macarons with 60% red rice flour and a 3% substitution of moringa flour. After the product was selected, proximate analysis and iron content testing were conducted to determine the nutritional content of the macarons with a substitution of 60% red rice flour and 3% moringa flour.

**Macaron recipe substituting 60% red rice flour and 3% moringa flour**

A picture of the macaron product obtained from the 4D stage can be seen in **Figure 3**.



**Figure 3. Macarons substituted with 60% red rice and 3% moringa flour**

**Proximate and iron content of macarons**

The highest moisture content was obtained from macarons without substitution of red rice flour and moringa flour (F0), while the lowest moisture content was obtained from macarons with 60% substitution of red rice flour and 0% substitution of moringa flour (F1). This indicates that the substitution of red rice flour and moringa flour has a significant effect on moisture content. Moisture content in food determines several important factors, namely acceptability, freshness, shelf life, chemical reactions, enzyme activity, and microorganism growth (28). When compared to SNI 2973:2022, the moisture content of macaron F0, F1, and F2 is below 5% (29).

**Table 2. Proximate and iron content of macaron with red rice flour and moringa flour substitution**

Proximate level	Macaron			p-value
	F <sub>0</sub>	F <sub>1</sub>	F <sub>2</sub>	
Water Content %	3.76 ± 0.19 <sup>a</sup>	2.58 ± 0.13 <sup>b</sup>	3.28 ± 0.11 <sup>a</sup>	0.009
Ash Content %	2.03 ± 0.01 <sup>a</sup>	1.66 ± 0.09 <sup>a</sup>	1.58 ± 0.28 <sup>a</sup>	0.139
Fat Content %	26.04 ± 0.18 <sup>c</sup>	19.56 ± 0.29 <sup>b</sup>	6.33 ± 0.00 <sup>a</sup>	0.000
Protein Content %	7.62 ± 0.60 <sup>b</sup>	6.15 ± 0.04 <sup>a</sup>	18.21 ± 0.54 <sup>c</sup>	0.044
Carbohydrate Content %	60.57 ± 0.58 <sup>a</sup>	70.06 ± 0.21 <sup>b</sup>	70.61 ± 0.71 <sup>b</sup>	0.001
Iron Content %	5.79 ± 0.05 <sup>c</sup>	8.76 ± 0.09 <sup>b</sup>	11.49 ± 0.05 <sup>a</sup>	0.000
Energy (kcal)	186.73	186.21	236.95	

Description:

F<sub>0</sub> = Macaron without substitution of red rice flour and moringa flour

F<sub>1</sub> = Macaron substituted with 60% red rice flour and 0% moringa flour

F<sub>2</sub> = Macaron substituted with 60% red rice flour and 3% moringa flour

Therefore, following SNI, macarons with the highest moisture content can cause undesirable changes. This is because high moisture content

causes the growth of bacteria, fungi, and yeast. Several factors that affect the moisture content in macarons are the initial moisture content of the

raw materials, the cooking process, the shape, the temperature, and the water evaporation during baking (30).

The highest ash content was obtained from macarons without substitution of red rice flour and moringa flour (F0). Meanwhile, the lowest level was obtained from macarons with 60% red rice flour without moringa flour (F1). This shows that substituting red rice flour can reduce the ash content in a food product. Macarons with 60% red rice flour and 3% moringa flour substitution (F2) have a higher ash content than those with red rice flour substitutes (F1). The ash content in food is influenced by environmental factors, raw materials, and temperature (31). When compared to Indonesian National Standard SNI 2973:2022, the ash content of macaron F0, F1, and F2 is above 0,1, making it non-compliant with Indonesian National Standard (29).

The fat content of the macarons decreased. The highest fat content was obtained from macarons without red rice flour and moringa flour substitution (F0). Meanwhile, the lowest fat content was obtained from macarons with 60% red rice flour and 3% moringa flour substitution (F2). Adding fat to food can slow down the hardening of texture (making it softer) and enhance flavor (32). However, to date, there are no SNI standards regulating the fat content of cookies. The source of fat in macarons is almond flour.

The highest protein content was obtained from macarons without substitution of red rice flour and moringa flour (F0). Meanwhile, the lowest protein content was obtained from macarons with 60% substitution of red rice flour (F1). Macarons with 60% red rice flour and 3% moringa flour substituted (F2) have a higher protein content than macarons substituting 60% red rice flour (F1), but lower than macarons without red rice flour and moringa flour substitutions (F0). In addition to raw materials, heating temperature also affects the protein content of food (33). When compared to Indonesian National Standard 2973:2022, the protein content of macaron F0, F1, and F2 is > 4,5, thus complying with Indonesian National Standard (29).

The carbohydrate content of macarons increased. The highest carbohydrate content was obtained from macarons with 60% substitution of red rice flour and 3% moringa flour (F2).

Meanwhile, the lowest carbohydrate content was obtained from macarons without substitutes for red rice flour and moringa flour (F0). To date, there are no SNI standards regulating the carbohydrate content of cookies.

The highest iron content was obtained from macarons with 60% red rice flour and a 3% substitution of moringa flour (F2). Meanwhile, the lowest iron content was obtained from macarons without red rice flour and moringa flour substitution (F0). This demonstrates that moringa flour substitution significantly contributes to increasing iron content in macarons, making red rice flour and moringa flour-substituted macarons a potential functional food for preventing anemia. The analysis results show that the iron content in the best macaron formulation (F2) reached  $11.49 \pm 0.05$  mg per 45 g. This value is higher than the results of a study Setyawati et al (34) which reported iron content in a similar moringa flour based product of 2.108 mg per 100 g. Based on the Indonesian National Agency of Drug and Food Control Regulation No.1 of 2022 (25), food products with a minimum iron content can be claimed as high in iron. Thus, the macarons in this study meet the criteria for iron-rich foods, which have the potential to be developed as functional foods to help prevent anemia. Although there is currently no Indonesian National Standard (SNI) that specifically regulates iron content in baked goods, the results of this study provide a scientific basis for the development of similar iron-rich products.

### **Nutritional Information**

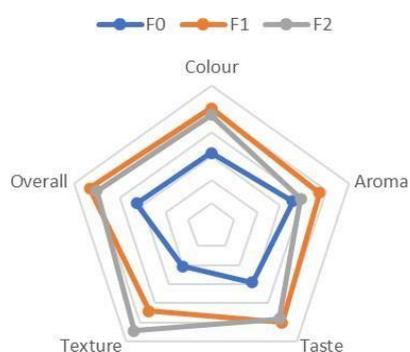
Nutritional value information is compiled based on laboratory test data in grams and milligrams. Nutritional value information is compiled based on the nutritional adequacy figures for adolescent girls aged 16–18 years. The nutritional value information can be seen in Table 3. The nutritional value contained in macarons substituted with 60% red rice flour and 3% moringa flour consists of 236 kilocalories, 13.54% total fat, 11.70% protein, 10.59% carbohydrates, and 34.47% iron (35). The nutritional requirements for adolescent girls aged 16–18 years for macronutrients include 2.100 kcal of energy, 65 g of protein, 70 g of fat, and 300 g of carbohydrates. The micronutrient requirement for iron is 15 mg.

**Table 3. Nutritional information of macaron substitutes with 60% red rice flour and 3% moringa flour**

NUTRITIONAL INFORMATION		
Serving size 45 g 3 serving per packgae		
AMOUNT PER SERVING		
Total Energy	236 kcal	
Total Fat	8.80 g	%AKG 13.54 %
Protein	8.19 g	11.70 %
Total Carbohydrate	31.77 g	10.59 %
Iron	5.17 mg	34.47 %
*Percent of Daily Value based a 2.100 calorie diet. Your energy needs may be higher or lower		

The macaron product with 60% red rice flour and 3% moringa flour substitution contains 5.17 mg of iron per serving. Meanwhile, the iron requirement for adolescent girls aged 16-18 years is 15 mg/day. Therefore, the consumption of macarons substituted with red rice flour and moringa flour contributes 34.5% of the total daily

iron requirement. Based on the Indonesian National Agency of Drug and Food Control Regulation No. 1 of 2022 regarding nutrient claims, it can be concluded that macarons substituted with 60% red rice flour and 3% moringa flour (F2) fall under the category of iron-rich foods (25).



Description:

F0 = Macaron without substitution of red rice flour and moringa flour

F1 = Macaron substituted with 60% red rice flour and 0% moringa flour

F2 = Macaron substituted with 60% red rice flour and 3% moringa flour

**Figure 3. Level of preference for macarons**

**Level of preference**

Figure 3 shows the results of the level for macaron F0, F1, and F2. The ANOVA test results for color parameters showed a significant difference with a p-value of 0.001. Further testing showed that macarons without red rice flour and moringa flour substitutions (F0) were significantly different from macarons substituted with 60% red rice flour and 0% moringa (F1) and macarons substituted with 60% red rice flour and 3% moringa flour (F2). The reference product (F0) has a pinkish color, while the development product (F1

& F2) a greenish color is caused by the substitution of moringa flour. Based on hedonic testing, macarons with 60% red rice flour and 3% moringa flour (F2) produced an average score of 4,15, meaning that the product was liked by the community.

The ANOVA test results for the aroma parameter showed no significant difference with a p-value of 0,167. Further tests also showed that there were no significant differences. This means that the use of red rice flour and moringa flour does not affect the final aroma of the product.

Based on the hedonic test of macarons with a substitution of 60% red rice flour and 3% moringa (F2), the average score was 3,98, indicating that the product is liked by the public.

The results of the ANOVA test on taste parameters showed a significant difference with a p-value of 0,001. Further tests showed that macarons without substitution of red rice flour and moringa flour (F0) were significantly different from macarons substituted with 60% red rice flour and 0% moringa flour (F1) and macarons substituted with 60% red rice flour and 3% moringa flour (F2). However, there was no significant difference between macarons substituted with 60% red rice flour and 0% moringa flour (F1) and macarons substituted with 60% red rice flour and 3% moringa flour (F2). Based on the hedonic test, macarons with 60% red rice flour and 3% moringa flour (F2) produced an average score of 4,16, indicating that the product was liked by the community.

The results of the ANOVA test on texture parameters showed significant differences with a p-value of 0,000. Further analysis revealed that macarons without substitution of red rice flour and moringa flour (F0) were significantly different from macarons substituted with 60% red rice flour and 0% moringa flour (F1) and macarons substituted with 60% red rice flour and 3% moringa flour (F2). However, there was no significant difference between macarons with 60% red rice flour and 0% moringa flour (F1) and macarons with 60% red rice flour and 3% moringa flour (F2). This means that the substitution of moringa flour does not affect the texture of the product. Based on the hedonic test, macarons with 60% red rice flour and 3% moringa flour produced an average score of 4,29, indicating that the product is liked by the public

The ANOVA test results for the overall parameters showed a significant difference with a p-value of 0,000. Further tests showed that macarons without substitution of red rice flour and moringa flour (F0) were significantly different from macarons substituted with 60% red rice flour and 0% moringa flour (F1) and macarons substituted with 60% red rice flour and 3% moringa flour (F2). However, there was no significant difference between macarons with 60% red rice flour and 0% moringa flour (F1) and macarons with 60% red rice flour and 3% moringa flour (F2). This means that

substituting 3% moringa flour does not reduce product acceptance. Based on the hedonic test, the substitution of 60% red rice flour and 3% moringa produced an average score of 4,2, indicating that the product was liked by teenagers.

Several previous studies on the use of moringa flour in cookie production have been published and show varying levels of iron content. Azzahra et al (36) reported that adding moringa flour and sorghum flour in cookie production resulted in a cookie with 4.08 mg of iron per 100 grams. Therefore, it was categorized as a source of iron biscuit product. Parwati et al (37) reported that replacing some flour in brownies with moringa flour and mung bean flour resulted in a product containing 2.15 mg of iron per serving. This amount does not meet the minimum requirement of 15% of Recommended Daily Allowance.

Therefore, the product cannot be classified as a source of iron. Puspita Dewi et al (38) reported that substituting moringa flour in cookies resulted in 3.15 mg of iron per 100 grams. Therefore, the cookie product was categorized as a source of iron. Meanwhile, Hari Paraswati et al (39) reported that cat tongue cookies substituted with sorghum flour and added moringa leaves contained 2.37 mg of iron per 100 grams. Therefore, the product cannot yet be categorized as an iron source product.

The macarons developed in this study have the advantage of containing iron with 5.17 mg per serving or 11.49 mg per 100 grams, which is higher than in some previous studies. This amount exceeds 30% of the Nutrient Adequacy Rate for adolescent girls aged 16-18 years. Thus, macaron products with red rice flour and moringa flour substitutes qualify as high-iron products. The findings of this study indicate that macarons made with red rice flour and moringa flour have the potential to serve as functional foods that can help meet the iron needs of adolescent girls

## **CONCLUSION AND RECOMMENDATION**

The study reveals that most participants possess an inadequate level of nutritional knowledge and only a quarter of them make nutritionally balanced food choices while using online food delivery applications. The research shows that there is no significant relationship found between students' nutritional knowledge

and their food choices. Moreover, more than half of the respondents rarely use online food delivery services but still consume excessive sugar while maintaining adequate fat and sodium intake. Interestingly, a significant relationship exists between the frequency of online food delivery service usage and fat intake, but no such association is observed between the frequency of online food delivery service usage and sugar and sodium intake.

The strength of this study holds particular importance as it is the first of its kind to investigate the relationship between the use of online food delivery services and sugar, sodium, and fat consumption among UGM students, thereby adding value to the existing knowledge in this domain. However, it is pertinent to acknowledge that the study has certain limitations, including the potential for bias introduced by the online SQ-FFQ and the possibility that some subjects may not have fully adhered to instructions or provided honest data, which could impact the accuracy of the calculated intake levels for fat, sugar, and sodium among respondents.

The findings of this research have significant implications for developing nutrition education programs and designing effective strategies to promote healthy food choices among college students. Nutrition education efforts should be aimed not only at OFD users, but also at the wider population of college students. The study emphasizes the importance of maintaining a nutritionally balanced diet, in compliance with the stipulated guidelines for nutrition and restricting the intake of fat, sugar, and sodium. College students, regardless of their OFD usage, should pay close attention to their food intake, both at home and from online delivery services, and follow the Balanced Nutrition Guidelines. To promote healthier food choices, companies providing online food delivery services must expand their network of restaurants/outlets that offer healthy, nutritionally balanced food and provide more promotions for these options compared to less healthy alternatives.

## REFERENCES

1. Hanum FN, Maulida F. Pengaruh Media Sosial, Body Image dan Pola Makan pada Remaja Penari Bukittinggi. *Amerta Nutrition* [Internet]. 2023 Nov 28;7(4):546–54. <https://doi.org/10.20473/amnt.v7i4.2023.546554>
2. Utami A, Margawati A, Pramono D, Wulandari DR. Prevalence of Anemia and Correlation with Knowledge, Nutritional Status, Dietary Habits among Adolescent Girls at Islamic Boarding School. *Jurnal Gizi Indonesia (The Indonesian Journal of Nutrition)* [Internet]. 2022 Jun 1;10(2):114–21. <https://doi.org/10.14710/jgi.10.2.114-121>
3. Ekayanti I, Kusumawati D, Rimbawan. Faktor Risiko Anemia Pada Santri Putri Di Pondok Pesantren Darusalam Bogor. *Media Gizi Indonesia* [Internet]. 2020 May 6;15(2):79–87. <https://doi.org/10.204736/mgi.v15i2.79-87>
4. Kementerian Kesehatan Republik Indonesia. Laporan Riset Dasar Kesehatan Dasar (Riskesdas) 2018 Nasional. Jakarta; 2018.
5. Julaecha J. Upaya Pencegahan Anemia pada Remaja Putri. *Jurnal Abdimas Kesehatan (JAK)*. 2020 Jun 16;2(2):109. <https://doi.org/10.36565/jak.v2i2.105>
6. Astuti D, Kulsum U. Pola Menstruasi Dengan Terjadinya Anemia Pada Remaja Putri. *Jurnal Ilmu Keperawatan dan Kebidanan* [Internet]. 2020 [cited 2025 Jul 16];11(2):314–27. <https://doi.org/10.26751/jikk.v11i2.832>
7. Qurniawati D, Ratnaningsih N, Lastariwati B. Tortilla wrap dari tepung kacang hijau dengan isian ikan patin sebagai makanan selingan untuk ibu hamil. *Agrointek : Jurnal Teknologi Industri Pertanian* [Internet]. 2024 Nov 19;18(4):891–9. <https://doi.org/10.21107/agrointek.v18i4.13670>
8. Arifin EB, Setiawan B, Nasution Z. Pengembangan Sosis Ikan Kembang dengan Substitusi Tepung Daun Kelor Sebagai Sumber Protein dan Zat Besi untuk Ibu Hamil. *Jurnal Ilmu Gizi dan Dietetik*. 2023 Jun 29;2(2):125–32.
9. Yulia Nabilla D, Sabta Aji A, Nufaisah A, Saputri W, Aprilia V, Kusuma Rahayu H, et al. Pengembangan Biskuit “Prozi” Tinggi Protein dan Kaya Zat Besi untuk Ibu Hamil sebagai Upaya Pencegahan. *Amerta Nutrition*. 2022 Dec;6(1):2580–1163.

- <https://doi.org/10.20473/amnt.v6i1SP.2022.79-84>
10. Nuri Arum Anugrahati CDPS. Penentuan Formulasi Kue Kembang Goyang Hasil Substitusi Tepung Beras Merah Organik Berdasarkan Kadar Serat Pangan dan Tekstur. *Amerta Nutrition*. 2023 Dec;7(4):512–9. <https://doi.org/10.20473/amnt.v7i4.2023.512-519>
  11. Kementerian Kesehatan Republik Indonesia. Tabel Komposisi Pangan Indonesia. Jakarta; 2020.
  12. Gharsallah K, Rezig L, Rajoka MSR, Mehwish HM, Ali MA, Chew SC. Moringa oleifera: Processing, phytochemical composition, and industrial application. Vol. 160, *South African Journal of Botany*. Elsevier B.V.; 2023. p. 180–93. <https://doi.org/10.1016/j.sajb.2020.11.014>
  13. Giuberti G, Rocchetti G, Montesano D, Lucini L. The potential of Moringa oleifera in food formulation: a promising source of functional compounds with health-promoting properties. Vol. 42, *Current Opinion in Food Science*. Elsevier Ltd; 2021. p. 257–69. <https://doi.org/10.1016/j.cofs.2021.09.001>
  14. Ahmawati YA, Ma'rifah B, Muhlshoh A. Formulasi Mie Kering Substitusi Tepung Kacang Hijau dan Tepung Daun Kelor sebagai Makanan Tinggi Zat Besi dan Kalsium untuk Remaja. *Muhammadiyah Journal of Nutrition and Food Science (MJNF)* [Internet]. 2024 Nov 29;5(1):74. <https://doi.org/10.24853/mjnf.5.1.74-91>
  15. Gisslen W. *Professional Baking Seventh Edition*. 7th ed. Wiley J, Sons, editors. New Jersey; 2017. 484–492 p.
  16. Ishak AT, Srimularahmah A, IrfanTaufan Asfar AM, Iqbal Akbar Asfar AM, Nasrul Aziz M, Handayani F. *Pengolahan Limbah Ampas Tahu Menjadi Tepung Dan Kukis*. 1st ed. Amalia R, editor. Vol. 1. Purbalingga: CV. Eureka Media Aksara; 2023. 1–32 p.
  17. Bissar S, Özcan MM. Determination of quality parameters and gluten free macaron production from carob fruit and sorghum. *Int J Gastron Food Sci*. 2022 Mar 1;27. <https://doi.org/10.1016/j.ijgfs.2021.100460>
  18. Primarasa T. *Serba Manis : Macaron*. Kartohadiprodo M, editor. Jakarta: PT.Gaya Favorit Press; 2018.
  19. Statista [Internet]. [cited 2025 Jul 19]. Market Confectionery in Indonesia. Available from: <https://www.statista.com/outlook/cmo/food/confectionery-snacks/indonesia>
  20. Euromonitor International. *Euromonitor International*. 2024 [cited 2025 Jul 16]. Bakery Products in Indonesia: ISIC 1541. Available from: <https://www.euromonitor.com/bakery-products-in-indonesia-isic-1541/report#>
  21. Macaron Lux. *Shopee Macaron\_Lux*. [cited 2025 Aug 2]. Macaron Lux menjual lebih dari 13 ribu baby macaron gift. Available from: [https://shopee.co.id/macaron\\_lux?categoryId=100629&entryPoint=ShopByPDP&itemId=2311061814&upstream=search](https://shopee.co.id/macaron_lux?categoryId=100629&entryPoint=ShopByPDP&itemId=2311061814&upstream=search)
  22. Macaron Tuffero. *Shopee Macaron Tuffero*. 2025 [cited 2025 Aug 2]. Macaron Tuffero lebih dari 10 ribu macaron mini terjual. Available from: <https://shopee.co.id/macaron.tuffero?categoryId=100629&entryPoint=ShopByPDP&itemId=19223453499&upstream=search>
  23. *Shopee Macaron id*. *Shopee Indonesia*. 2025 [cited 2025 Jul 31]. Penjualan Macaron di E Commerce Shopee Macaron id. Available from: [https://shopee.co.id/macaron\\_id#product\\_list](https://shopee.co.id/macaron_id#product_list)
  24. Zaddana C, Amalia D, Rusli Z, Wahyuningrum C. Kandungan Serat dan Zat Besi Biskuit Tepung Beras Merah (*Oryza Nivara*) dan Tepung Daun Kelor (*Moringa Oleifera*) Fiber and Iron Content of Brown Rice (*Oryza Nivara*) and Moringa Leaf Flour Biscuits (*Moringa Oleifera*). *Amerta Nutrition*. 2022 Dec;6(1):71–8. <https://doi.org/10.20473/amnt.v6i1SP.2022.71-78>
  25. Badan Pengawas Obat dan Makanan. *B POM. Label dan Iklan. Pangan Olahan. Pengawasan Klaim*. Pencabutan. Jakarta; 2, 2022. p. 1–91.
  26. Khofifah N, Mardiana M. Biskuit daun kelor (*Moringa oleifera*) berpengaruh terhadap kadar hemoglobin pada remaja putri yang anemia. *AcTion: Aceh Nutrition Journal*. 2023

- Mar18;8(1):43.  
<https://doi.org/http://dx.doi.org/10.30867/acton.v8i1.614>
27. Ispitasari R, Haryanti. Pengaruh Waktu Destilasi terhadap Ketepatan Uji Protein Kasar pada Metode Kjeldahl dalam Bahan Pakan Ternak Berprotein Tinggi. *Journal Of Laboratory ISSN* [Internet]. 2022 Apr 29 [cited 2025 Oct 29];5(1):39–43.  
<https://doi.org/10.22146/ijl.v0i0.73468>
28. Fitriyanti AR, Handarsari E, Sunarto S, Asyasyifa RNA, Setiyawan TH, Sulisyaningrum H, et al. Proximate levels, physical characteristics, and sensory characteristics of mocaf brownies with the addition of snakehead fish (*Channa striata*). *Jurnal Gizi dan Dietetik Indonesia (Indonesian Journal of Nutrition and Dietetics)* [Internet]. 2025 Mar 30;13(2):78.  
[https://dx.doi.org/10.21927/ijnd.2025.13\(2\).78-87](https://dx.doi.org/10.21927/ijnd.2025.13(2).78-87)
29. Badan Standarisasi Nasional. (SNI) 2973:2022 BISKUIT. Jakarta; 2973:2022, 2022. p. 1–26.
30. Sumartini S, Harahap KS, Mujiyanti A. Brownies From Mangrove Fruit Flour: The Use Of Variation Of Flours As An Alternative To High Food Nutrition. *Indonesian Food and Nutrition Progress*. 2021 Jan 22;17(1):16.  
<https://doi.org/https://dx.doi.org/10.22146/ifn.p.55188>
31. Siskawardani DD, Warkoyo W, Onthong J. Sweet bread chemical properties optimization based on baking temperature and duration. *Canrea Journal: Food Technology, Nutritions, and Culinary Journal* [Internet]. 2021 Jun 1;4(1):1–7.  
<https://doi.org/10.20956/canrea.v4i1.416>
32. Nixon M, Made Rinayanthi N. Effect of Fat Type on Bread Making Results. *Jurnal Pariwisata dan Bisnis* [Internet]. 2023;02(5):1302–6.  
<https://doi.org/10.22334/paris.v2i5>.
33. Diniyah N, Wahyu F, Subagio A. Karakteristik Tepung Premiks Berbahan Mocaf (Modified Cassava Flour) dan Maizena Pada Pembuatan Cookies Green Tea. *Jurnal Pangan dan Agroindustri*. 2019 Jul;7(3):25–36.  
<https://doi.org/10.21776/ub.jpa.2019.007.03.4>
34. Setyawati E, Nurasmu N, Inawati I. Studi Analisis Zat Gizi Biskuit Fungsional Substitusi Tepung Kelor dan Tepung Ikan Gabus. *Jurnal Ilmiah Kesehatan Sandi Husada* [Internet]. 2021 May 14 [cited 2025 Oct 30];10(1):94–104.  
<https://doi.org/10.35816/jiskh.v10i1.516>
35. Kementerian Kesehatan Republik Indonesia. Peraturan Menteri Kesehatan Republik Indonesia Tentang Angka Kecukupan Gizi Masyarakat [Internet]. Jakarta; 2019. Available from: [www.peraturan.go.id](http://www.peraturan.go.id)
36. Azzahra A, Suryaalamsah II. Formulasi Cookies Sumber Zat Besi dengan Penambahan Tepung Daun Kelor dan Tepung Sorgum sebagai Kudapan Alternatif Pencegah Anemia Remaja Putri. *Muhammadiyah Journal of Nutrition and Food Science (MJNF)*. 2024 Jun 5;5(1):1.  
<https://doi.org/10.24853/mjnf.5.1.1-12>
37. Parwati PI, Ma'rifah B, Muhlshoh A. Formulasi Brownies Panggang dengan Substitusi Tepung Daun Kelor dan Tepung Kacang Hijau sebagai Alternatif Cemilan Sumber Zat Besi untuk Remaja Putri Anemia. *Ghidza: Jurnal Gizi dan Kesehatan*. 2023 Dec 14;7(2):184–204.  
<https://doi.org/10.22487/ghidza.v7i2.921>
38. Puspita Dewi D, Studi S- P, Gizi I, Ilmu Kesehatan F, Respati Yogyakarta U. Substitusi tepung daun kelor (*Moringa oleifera* L.) pada cookies terhadap sifat fisik, sifat organoleptik, kadar proksimat, dan kadar Fe. *Ilmu Gizi Indonesia*. 2018 Feb;1(2):104–12.  
<https://doi.org/10.35842/ilgi.v1i2.22>
39. Hari Paraswati AT, Ismawati R. Daya Terima dan Kandungan Gizi Kue Lidah Kucing yang Disubstitusi Tepung Sorgum dan Penambahan Daun Kelor (*Moringa Oleifera*) sebagai Alternatif Camilan Wanita Usia Subur (WUS) Anemia. *Antigen : Jurnal Kesehatan Masyarakat dan Ilmu Gizi*. 2025 5;3(2):90–105.  
<https://doi.org/10.57213/antigen.v3i2.644>.