Jurnal Pijar MIPA
https://jurnalfkip.unram.ac.id/index.php/JPM

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

The Substitution of Wheat Flour with Moringa Leaf Flour in Making Brownies with High Iron Content

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Received: October 9, 2025. Accepted: December 16, 2025. Published: December 31, 2025

Abstract: Brownies are a popular bakery product, but their nutritional profile is generally low, especially in iron content. This condition contrasts with the high prevalence of anemia among adolescent girls in Indonesia. This study aims to investigate the effect of substituting wheat flour with moringa leaf flour (Moringa oleifera) as an alternative natural fortification to increase iron levels in brownies, while also determining the optimal formulation. The method used was an experiment with a Completely Randomized Design (CRD), and data were analyzed using Analysis of Variance (ANOVA) followed by Duncan's test. The results showed that the addition of moringa leaf flour had a significant effect on increasing iron levels, as well as affecting other chemical characteristics (water, ash, protein, fat, and carbohydrate content). The best formulation was the T5K5 treatment (75% substitution of moringa leaf flour), which produced the highest iron content of 1376.58 ppm, along with a measurable macro composition (water content: 12.26%, ash: 0.94%, protein: 7.39%, fat: 20.83%, carbohydrate: 57.16%). Fundamentally, these findings imply the success of natural food fortification using local raw materials. These results are relevant for the development of functional food products as an acceptable food-based nutritional intervention strategy in addressing anemia in adolescents, as well as providing an important contribution to health education and nutritional literacy.

Keywords: Brownies; Iron Content Analysis; Moringa Leaf; Proximate Analysis.

Introduction

Brownies are one type of family cake that is popular and has a characteristic brown color and does not expand, the texture is soft and moist (moist) on the inside, while the top feels dry. Brownies have a sweet taste and a strong characteristic aroma of chocolate [1]. Most of the brownies on the market tend to focus more on taste and texture, without considering their nutritional value. This is an opportunity to develop brownies with higher nutritional content.

Nutritional problems, especially anemia due to iron deficiency, are a significant health issue, especially in developing countries such as Indonesia. Based on data from the Ministry of Health, the prevalence of anemia, especially in adolescent women of childbearing age, continues to be a major concern. Anemia in adolescent girls is a condition where the Hemoglobin (Hb) level in red blood cells is below the normal limit, namely <12 g/dL [2]. Based on Basic Health Research Data 2018, the proportion of anemia with the age group of 15-24 years was 32% in 2018 where anemia in women was higher at 27.2%, while in men it was 20.3% [3]. Anemia has an impact on growth with symptoms of weakness and fatigue [4].

Iron deficiency anemia can be prevented by improving diet, namely by consuming local foods that are rich in iron [5]. Domestically produced local food ingredients can improve nutritional quality in product development [6]. One way to overcome this problem is to develop food products based on local ingredients that are rich in iron, namely moringa plants (Moringa oleifera) [7].One of the innovations to extend the shelf life of moringa leaves is by processing them into flour [8]. In 100 g of moringa flour has an iron content of 28.2 g [9]. The high iron content in moringa leaves can provide efforts to treat anemia increasing iron [10]. The use of moringa leaves in the form of flour as a substitute ingredient in making brownies can be an innovative alternative to increase iron content without reducing the taste and texture expected from the product.

Research Methods

Research Location and Time

This research was conducted at the Food Technology Laboratory, Faculty of Technology and Health, Bali, and the Integrated Services Laboratory, Faculty of Agricultural Technology, Udayana University, Bali. This research was conducted in March-May 2025

Materials and Tools

The ingredients used in making brownies are medium protein wheat flour (Blue Triangle), Moringa leaves obtained from the market, cocoa powder (Cocoa Powder), chocolate bar (Galetto dark), Butter Margarine (Royal Palmia), chicken eggs, powdered sugar (Rose Brand), Vanilla (Koepoe Koepoe), Salt and vegetable oil (Bimoli). Materials

How to Cite:
M. S. B. Nango, A. A. N. D. A. W. Putra, P. R. Sintyadewi, I. G. A. Y. Rabani RS, and I. A. P. A. Widnyani, "The Substitution of Wheat Flour with Moringa Leaf Flour in Making Brownies with High Iron Content", *J. Pijar.MIPA*, vol. 20, no. 8, pp. 1563–1569, Dec. 2025. https://doi.org/10.29303/jpm.v20i8.10170

used in proximate analysis and iron (Fe) brownies are aquadest, alcohol, hexan solvent, H2SO4, NaOH 50%, HCI, boric acid, HCIO4, HNO3, and demineralised water.

Tools used in brownie-making research include digital scales, a flour sieve, a basin, a mixer, a plastic spatula, a spoon, an oven, a brownie pan, a napkin, aluminium foil, a stove, glass, plastic, baking paper, and label paper. Tools used in proximate analysis and iron (Fe) brownies are a porcelain cup, oven, analytical scales (Kern and Shon ACJ 200-4M), desiccator, furnace, Soxhlet flask, Kjedahl flask, Erlenmeyer (Duran), measuring cup, dropper pipette, beaker, burette, and Atomic Absorption Spectroscopy (AAS).

Research Design

This study was conducted using brownies with different additions of moringa leaf flour. This study used one control treatment (100% wheat flour) and five treatments with ratios of wheat flour (T) and moringa leaf flour (K) in making brownies: T1K1 (95% wheat flour: 5% moringa leaf flour), T2K2 (90% wheat flour: 10% moringa leaf flour), T3K3 (85% wheat flour: 15% moringa flour), T4K4 (80% wheat flour: 20% moringa leaf flour), and T5K5 (75% wheat flour: 25% moringa leaf). Each treatment was replicated three times, resulting in a total of 18 experimental units.

Research Procedure

Moringa Leaf Flour Production

The process of producing moringa leaf flour begins with preparing the tools and ingredients, followed by the preparation of the moringa leaves. The moringa leaves selected are uniform in color, neither too old nor too young. Before separating the leaves from their stems, they are washed and then drained. The moringa leaves are separated from the stems and sorted for yellowing, dryness, or visible dirt. The moringa leaves, separated from the stems, are arranged on a tray, ensuring no leaves are piled up. Then, the dehydrator is turned on and set to 50°C. Once the target temperature has been reached, the moringa leaves are inserted into the tray and left to sit for 4 hours. Once the moringa leaves are dry, they are ground using a blender until they are uniform in size. The ground moringa leaves are then sieved through an 80-mesh sieve [11].

Making Brownies

The process of making brownies begins with preparing the dough, which involves mixing 180 grams of sugar with 3 eggs, then stirring the mixture until it is fluffy for approximately 12 minutes. Add 5 grams of cocoa powder, 100 grams of melted chocolate bars, together with 50 ml of vegetable oil and 90 grams of butter margarine, then stir until the dough becomes homogeneous for ± 1 minute. Then add ¼ teaspoon of vanilla extract, wheat flour, and moringa leaf flour according to each treatment, and stir until homogeneous for approximately 3 minutes. Pour the dough into a baking pan lined with parchment paper and spread it evenly across the surface. Bake the brownie dough in the oven at 175ºC for ± 30 minutes [12].

Testing Stage

The tests conducted in this study included proximate tests (moisture content, ash content, protein content, fat content, and carbohydrate content), as well as Fe content tests. Analysis of moisture content, ash content, protein content, fat content, carbohydrate content, and Fe content used the AOAC standard method [13], and analysis of carbohydrates used the by-difference method.

Data Analysis

The research data from each test were analyzed using the Statistical Program for Social Science (SPSS). The research data from each test were analyzed using the Statistical Program for Social Science (SPSS). The first step was to check the data distribution or normality. The results of the normality test were then followed by Analysis of Variance (ANOVA). If the results were significant at $p < 0.05$, Duncan's test was used to determine differences between treatments.

Results and Discussion

Water Content

Based on the ANOVA test results, the treatment had a highly significant effect on the water content of brownies ($P < 0.01$), which ranged from 16.37% to 12.26%. The average water content of brownies with the addition of moringa leaf flour can be seen in Table 1, while the results of ANOVA and Duncan's test can be seen in Tables 2 and 3.

Table 1. Water Content Test Results

Code	Average Water Content (%)
Control	16.37f
T1K1	15.08e
T2K2	13.67d
T3K3	12.90c
T4K4	12.55bc
T5K5	12.26a*

Description: Different notations indicate that the interaction between treatments has a very significant effect.

Table 1 shows that the highest water content of brownies with the addition of moringa leaf flour was obtained in the control treatment, at 16.37%, and the lowest in the T5K5 treatment, at 12.26%. Based on the water content test, according to SNI 01-3840-1995, the range of quality requirements for semi-wet product water content is a maximum of 40%, so it can be seen that the results obtained in brownies with the addition of moringa leaf flour are in accordance with the specified quality requirements. This shows that the higher the addition of moringa leaf flour, the lower the water content in brownies. This is because moringa leaf flour has a lower water absorption capacity than wheat flour, so that the higher the substitution of moringa leaf flour, the lower the water content in the product. The addition of high-fibre ingredients, such as moringa leaves, can reduce water content due to their ability to absorb water more efficiently during the baking process [14].

Baked brownies with the addition of moringa leaf flour produced the highest water content in treatment A, at 25.21%, and the lowest in treatment F, at 18.35% [15]. This is directly proportional to the research, which states that the higher the addition of moringa leaf flour, the lower the resulting water content, because the water content in moringa leaf flour is lower when compared to wheat flour.

Table 2. Anova Test Results of Water Content

		Sum of Squares	df	Mean Square	F	Sig.
Water Content	Between Groups	38.927	5	7.785	185.701	.000
	Within Groups	503	12	.042		
	Total	39.430	17			

Table 3. Duncan Test Results of Water Content Subset for alpha=0.05

Code	N	1	2	3	4	5
T5K5	3	12.2699				
T4K4	3	12.5514	12.5514			
T3K3	3		12.9014			
T2K2	3			13.6766		
T1K1	3				15.0839	
Control	3					16.3700
Sig.		.118	.058	1.000	1.000	1,000

Ash Content

Based on the ANOVA test results, the treatment had a highly significant effect on the ash content of brownies ($P < 0.01$), with values ranging from 0.94% to 2.33%. The average ash content of brownies with the addition of moringa leaf flour can be seen in Table 4, while the results of ANOVA and Duncan's test can be seen in Tables 5 and 6.

Table 4. Ash Content Test Results

Code	Average Ash Content (%)
Control	0.94%a*
T1K1	1.22%a
T2K2	1.56%b
T3K3	1.85%c
T4K4	2.09%cd
T5K5	2.33%d

Description: Different notations indicate that the interaction between treatments has a very significant effect.

Table 5. Anova Test Results of Ash Content

		Sum of Squares	df	Mean Square	F	Sig.
Ash Content	Between Groups	4.169	5	.834	32.173	.000
	Within Groups	.311	12	.026		
	Total	4.480	17			

Table 6. Duncan Test Results of Ash Content Subset for alpha=0.05

Code	N	1	2	3	4
Control	3	.9489			
T1K1	3	1.2239			
T2K2	3		1.5619		
T3K3	3			1.8583	
T4K4	3			2.0976	2.0976
T5K5	3				2.3339
Sig.		.058	1.000	.094	.097

Table 4 shows that the highest ash content in the brownies with the addition of moringa flour was obtained in the T5K5 treatment, at 2.33%, and the lowest in the control treatment, at 0.94%. Table 5 shows that the highest ash content in the brownies with the addition of moringa flour was obtained in the T5K5 treatment, at 2.33%, and the lowest in the control treatment, at 0.94%. Based on Ash content testing, according to SNI 01-3840-1995, the range of ash content quality requirements for semi-wet products is a maximum of 1% so it can be seen that the treatment that meets the SNI quality requirements based on the water content test in brownies is in the control treatment, which is 0.94%.

The low ash content in the control treatment is due to the absence of mineral-rich raw materials, such as moringa leaf flour, in the addition. Treatments T1K1 (1.22%), T2K2 (1.56%), T3K3 (1.85%), T4K4 (2.09%), and T5K5 (2.33%) have not met the SNI quality requirements. Based on the ash content quality requirements for semi-wet products (SNI 01-3840-1995), the maximum allowed content is 1%. This means that brownies with the addition of moringa leaf flour for all treatments have not met the SNI quality standards.

Table 4 shows that the higher the use of moringa leaf flour, the higher the ash content of the resulting brownies. The increase in ash content is due to the raw material used, namely, moringa leaf flour, which has a high ash content [16]. Determining ash content is closely related to the mineral content in food ingredients, as it enhances the purity and cleanliness of the resulting ingredients. The lower the ash content, the better the processing. The amount of ash content in food products depends on the mineral content of the ingredients used [17]. This occurs because the basic ingredients for making brownies have mineral content in 100 grams of dried moringa leaves contain 20.03 mg of calcium and 28.2 mg of iron [18].

Protein Content

Based on the ANOVA test results, the treatment had a significant effect on the protein content of brownies ($P < 0.01$), with values ranging from 5.82% to 7.39%. The average protein content of brownies with the addition of moringa leaf flour can be seen in Table 7, while the results of ANOVA and Duncan's test can be seen in Tables 8 and 9.

Table 7. Protein Content Test Results

Code	Average Protein Content (%)
Control	5.82c
T1K1	6.02c
T2K2	6.71b
T3K3	6.82b
T4K4	7.19a
T5K5	7.39a*

Description: Different notations indicate that the interaction between treatments has a very significant effect.

Table 8. Anova Test Results of Protein Content

		Sum of Squares	df	Mean Square	F	Sig.
Protein Content	Between Groups	5.850	5	1.170	27.633	.000
	Within Groups	.508	12	.042		
	Total	6.359	17			

Table 9. Duncan Test Results of Protein Content Subset for alpha=0.05

Code	N	1	2	3
Control	3	5.8399		
T1K1	3	6.0243		
T2K2	3		6.7120	
T3K3	3		6.8261	
T4K4	3			7.1956
T5K5	3			7.3948
Sig.		.270	.510	.259

Table 7 shows that the highest protein content in brownies with the addition of moringa leaf flour was obtained in the treatment with code T5K5, at 7.39%. The lowest protein content was observed in the control treatment, at 5.82%. Based on SNI 01-3840-1995, the quality requirement range for semi-wet product protein content is a maximum of 9%, so in this study, the protein content of brownies with the addition of moringa leaf flour met the specified requirements. This indicates that the higher the addition of moringa leaf flour, the higher the resulting protein content. The protein content of the brownies in this study came largely from moringa leaf flour and the use of eggs.

Moringa leaves can be used as an alternative source of protein because they contain three times more protein than full cream milk powder, so the addition of Moringa leaf flour to the product can affect the increase in the protein content of the product [15].

Fat Content

Based on the ANOVA test results, the treatment had a highly significant effect on the fat content of brownies ($P < 0.01$), ranging from 17.68% to 20.83%. The average fat content of brownies with the addition of moringa leaf flour can be seen in Table 10, while the results of ANOVA and Duncan's test can be seen in Tables 11 and 12.

Table 10. Fat Content Test Results

Code	Average Fat Content (%)
Control	17.68e
T1K1	18.20d
T2K2	19.75c
T3K3	19.95bc
T4K4	20.23b
T5K5	20.83a*

Description: Different notations indicate that the interaction between treatments has a highly significant effect.

Table 11. Anova Results of Fat Content

		Sum of Squares	df	Mean Square	F	Sig.
Fat Content	Between Groups	22.451	5	4.490	81.805	.000
	Within Groups	.659	12	.055		
	Total	23.110	17			

Table 12. Duncan Results of Fat Content Subset for alpha=0.05

Code	N	1	2	3	4	5
Control	3	17.6987				
T1K1	3		18.2090			
T2K2	3			19.7542		
T3K3	3			19.9550	19.9550	
T4K4	3				20.2325	
T5K5	3					20.8344
Sig.		1.000	1.000	.315	.173	1.000

Table 10 shows that the highest fat content of brownies with the addition of moringa leaf flour was obtained from the T5K5 treatment, at 20.83%, and the lowest was in the control treatment, at 17.68%. Based on SNI 01-3840-1995, the maximum fat content requirement for semi-moist products is 25%. Therefore, in this study, the fat content of brownies with the addition of moringa leaf flour met the specified quality requirements. The high fat content of the brownies in this study was influenced by several factors, one of which was the addition of moringa leaf flour, which has a higher fat content of approximately 2.74% compared to wheat flour, which contains approximately 1% [16].

On steamed brownies made from moringa leaf flour found the highest fat content was found in treatment E (100% moringa leaf flour: 50% wheat flour), which was 27.97%, while the lowest fat content was in treatment A (75% moringa leaf flour: 75% wheat flour), which was 19.91%. This shows that the addition of moringa leaf flour can increase the fat content in steamed brownies [19].

Carbohydrate Content

Based on the ANOVA test results, the treatment had a highly significant effect on the carbohydrate content of brownies (P < 0.01), with values ranging from 59.16% to 57.16%. The average carbohydrate content of brownies with the addition of moringa leaf flour can be seen in Table 13, while the results of ANOVA and Duncan's test can be seen in Tables 14 and 15.

Table 13. Carbohydrate Content Test Results

Code	Average Carbohydrate Content(%)
Control	59.16d
T1K1	59.45d
T2K2	58.29bc
T3K3	58.45c
T4K4	57.92b
T5K5	57.16a*

Description: Different notations indicate that the interaction between treatments has a highly significant effect.

Table 14. Anova Test Result of Carbohydrate Content

		Sum of Squares	df	Mean Square	F	Sig.
Carbohydrate Content	Between Groups	10.422	5	2.084	42.720	.000
	Within Groups	.586	12	.049		
	Total	11.008	17			

Table 15. Duncan Test Results of Carbohydrate Content Subset for alpha=0.05

Code	N	1	2	3	4
T5K5	3	57.1671			
T4K4	3		57.9229		
T2K2	3		58.2953	58.2953	
T3K3	3			58.4592	
Control	3				59.1691
T1K1	3				59.4589
Sig.		1.000	.061	.381	.134

Table 15 shows that the highest carbohydrate content of brownies with the addition of moringa leaf flour was found in the control treatment (100% wheat flour), at 59.16%, and the lowest in the T5K5 treatment (75% wheat flour: 25% moringa flour), at 57.16%. Based on SNI 01-3840-1995, the range of requirements for the carbohydrate content of brownies is a minimum of 40%, so in this study, the carbohydrate content of brownies with the addition of moringa leaf flour met the specified quality requirements.

The reduction in carbohydrate content was due to the addition of moringa leaf flour in each treatment. Moringa leaf flour has a higher fiber and protein content than wheat flour, resulting in a lower carbohydrate proportion in the dough (around 30-35%), and a higher content of other nutrients such as protein, crude fiber, minerals, and iron [16]. The addition of moringa leaf flour not only reduced carbohydrate content but also increased the content of functional nutrients such as fiber, protein, and iron, resulting in a shift in the chemical composition of the brownies [15].

Fe Content

Based on the results of the ANOVA test, the treatment had a highly significant effect on the Fe content of brownies (P < 0.01), with values ranging from 378.33 ppm to 1376.58 ppm. The average Fe content of brownies with the addition of moringa leaf flour can be seen in Table 16, while the results of ANOVA and Duncan's test can be seen in Tables 17 and 18.

Table 16. Fe Content Test Results

Code	Average Fe Content (ppm)
Control	378.33a
T1K1	461.59b
T2K2	581.25c
T3K3	678.21d
T4K4	859.88b
T5K5	1376.58a*

Description: Different notations indicate that the interaction between treatments has a highly significant effect.

Table 16 shows that the highest Fe content in brownies with the addition of moringa leaf flour was obtained in the T5K5 treatment, at 1376.58 ppm, and the lowest in the control treatment, at 378.33 ppm. This indicates that the higher the addition of moringa leaf flour, the greater the resulting Fe content. The increase in Fe content in the making of brownies in this study is in line with the increase in the resulting ash content, where the lowest Fe content in the control treatment was 378.33 ppm, while the highest Fe content was in the T5K5 treatment, namely 1376.58 ppm.

The iron content in moringa leaves ranges from 252-424 ppm in powder form, while fresh moringa leaves contain 2,137-3,633 ppm [20]. This increase is closely related to the high natural iron content in moringa leaves (Moringa oleifera), where every 100g of dried moringa leaves contains approximately 28.29 mg of iron [21]. The addition of moringa leaf flour to brownies significantly increases the iron content of the product. This suggests that moringa leaf flour has significant potential for enhancing iron intake.

Table 17. Anova Test Result of Fe Content

		Sum of Squares	df	Mean Square	F	Sig.
Fe Content	Between Groups	1965387.963	5	393077.593	8373250.494	.000
	Within Groups	.563	12	.047		
	Total	1965388.526	17			

Table 18. Duncan Test Result of Fe Content Subset for alpha=0.05

Code	N	1	2	3	4	5
Control	3	378.3300				
T1K1	3		461.5900			
T2K2	3			581.2500		
T3K3	3					
T4K4	3				678.2133	
T5K5	3					1376.5767
Sig.		1.000	1.000	1.000	1.000	1.000

Based on the Recommended Dietary Allowance (RDA) as recommended by the Ministry of Health of the Republic of Indonesia, Regulation Number 28 of 2019, the iron requirement for adolescent girls aged 15-24 years is 15 mg/day. In this study, the T5K5 treatment (75% moringa leaf flour: 25% wheat flour), Fe content reached 1376.58 ppm, equivalent to 137.6 mg in brownies, thus meeting the daily needs of adolescent girls aged 15-24 years [22].

Conclusion

Overall, this study concluded that the addition of Moringa oleifera leaf flour significantly increased the iron content of brownies. The best approach to achieve maximum iron fortification while maintaining a good nutritional profile was to substitute 75% of wheat flour with Moringa leaf flour (T5K5). These findings have important implications, particularly in the context of health education and product development. From a food technology perspective, this demonstrates the potential of Moringa as a local functional food ingredient for natural fortification and bakery product diversification. The learning implications are also highly relevant; this product can serve as a practical learning model for nutritional literacy, demonstrating that popular foods can be modified to address community nutritional issues such as anemia in adolescents, making it an attractive and acceptable food-based nutrition intervention.

Author's Contribution

Maria Saltiana Bebhe Nango as lead researcher, research implementer; Anak Agung Ngurah Dwi Ariesta Wijaya Putra as research implementer, Ida Ayu Putu Ary Widnyani, Putu Rima Sintyadewi, and I Gusti Agung Yogi Rabani RS as data collector and data analysis.

Acknowledgements

Thank you to the Bali Institute of Technology and Health for providing funding for the Internal Research Grant. Thank you also to the Food Analysis Laboratory, Faculty of Agricultural Technology, Udayana University, for providing the author with the opportunity to conduct research. We would also like to thank the PIJAR MIPA Journal for allowing this article to be published. Hopefully, this article is useful for all of us.

References

[1] A. M. Richardson, A. A. Tyuftin, K. N. Kilcawley, E. Gallagher, M. G. O'Sullivan, and J. P. Kerry, "The impact of sugar particle size manipulation on the physical and sensory properties of chocolate brownies," *Lwt*, vol. 95, pp. 51–57, 2018. https://doi.org/10.1016/j.lwt.2018.04.038

[2] P. Sari, R. T. D. Judistiani, D. M. D. Herawati, M. Dhamayanti, and D. Hilmanto, "Iron deficiency anemia and associated factors among adolescent girls and women in a rural area of Jatinangor, Indonesia," *Int. J. Womens Health*, pp. 1137–1147, 2022. https://doi.org/10.2147/IJWH.S376023

[3] O. Nainggolan, D. Hapsari, C. R. Titaley, L. Indrawati, I. Dharmayanti, and A. Y. Kristanto, "The relationship of body mass index and mid-upper arm circumference with anemia in non-pregnant women aged 19–49 years in Indonesia: Analysis of 2018 Basic Health Research data," *PloS One*, vol. 17, no. 3, p. e0264685, 2022. https://doi.org/10.1371/journal.pone.0264685

[4] P. Bhadra and A. Deb, "A review on nutritional anemia," *Indian J. Nat. Sci.*, vol. 10, no. 59, pp. 18466–18474, 2020.

[5] S. Bathla and S. Arora, "Prevalence and approaches to manage iron deficiency anemia (IDA)," *Crit. Rev. Food Sci. Nutr.*, vol. 62, no. 32, pp. 8815–8828, 2022. https://doi.org/10.1080/10408398.2021.1935442

[6] T. Marsden and E. Smith, "Ecological entrepreneurship: sustainable development in local communities through quality food production and local branding," *Geoforum*, vol. 36, no. 4, pp. 440–451, 2005. https://doi.org/10.1016/j.geoforum.2004.07.008

[7] P. G. Milla, R. Peñalver, and G. Nieto, "Health benefits of uses and applications of Moringa oleifera in bakery products," *Plants*, vol. 10, no. 2, p. 318, 2021. https://doi.org/10.3390/plants10020318

[8] R. F. Hasrini, T. Aviana, and A. Khoiriyah, "Fortification of modified cassava flour (Mocaf) cookies with rich nutrition vegetable powder," presented at the E3S Web of Conferences, EDP Sciences, 2021, p. 03009. https://doi.org/10.1051/e3sconf/202123203009

[9] I. Suriati and N. Abdullah, “The importance of Moringa oleifera leaf flour for pregnant women hemoglobin,” presented at the IOP Conference Series: Earth and Environmental Science, IOP Publishing, 2020, p. 012098. 10.1088/1755-1315/575/1/012098

[10] F. Yulastini, S. N. Makiyah, and R. Mawarti, “Effect of Moringa (Moringa oleifera) leaves on increasing hemoglobin level of female adolescents,” *J. Gizi Dan Diet. Indones. Indones. J. Nutr. Diet.*, vol. 11, no. 3, pp. 104–113, 2023. http://dx.doi.org/10.21927/ijnd.2023.11(3).104-113

[11] Y. Zhang, K. Liang, J. Wang, A. Wang, R. Pandiselvam, and H. Zhu, “Evaluation of particle size on the physicochemical properties of Moringa oleifera lam. Stem powder,” *Qual. Assur. Saf. Crops Foods*, vol. 14, no. SP1, pp. 1–11, 2022. https://doi.org/10.15586/qas.v14iSP1.1123

[12] S. B. Walker, “Physicochemical Transformations in Low-Moisture Dough During Baking,” 2013.

[13] P. Agroindustriais, “AOAC. Official methods of analysis of the Association of Official Analytical Chemists,” *Caracterização Propagação E Melhor. Genético Pitaya Comer. E Nativa Cerrado*, vol. 26, no. 74, p. 62, 2013.

[14] M. O. Eke, J. O. G. Elechı, and F. Bello, “Effect of fortification of defatted Moringa oleifera seed flour on consumers acceptability and nutritional characteristics of wheat bread,” *Eur. Food Sci. Eng.*, vol. 3, no. 1, pp. 18–25, 2022. https://doi.org/10.55147/efse.1126061

[15] P. I. Parwati, B. Ma’rifah, and A. Muhlishoh, “Formulasi Brownies Panggang dengan Substitusi Tepung Daun Kelor dan Tepung Kacang Hijau sebagai Alternatif Cemilan Sumber Zat Besi untuk Remaja Putri Anemia,” *Ghidza J. Gizi Dan Kesehat.*, vol. 7, no. 2, pp. 184–204, 2023.

[16] A. T. Zula, D. A. Ayele, and W. A. Egigayhu, “Proximate composition, antinutritional content, microbial load, and sensory acceptability of noodles formulated from moringa (Moringa oleifera) leaf powder and wheat flour blend,” *Int. J. Food Sci.*, vol. 2021, no. 1, p. 6689247, 2021. https://doi.org/10.1155/2021/6689247

[17] E. K. Pangestuti and P. Darmawan, “Analysis of Ash Contents in Wheat Flour by The Gravimetric Method: Analisis Kadar Abu dalam Tepung Terigu dengan Metode Gravimetri,” *J. Kim. Dan Rekayasa*, vol. 2, no. 1, pp. 16–21, 2021. https://doi.org/10.31001/jkireka.v2i1.22

[18] A. Nugroho, A. Rahmadi, S. Sutrio, and A. J. Sari, “Brownies daun kelor dan tempe tinggi protein serta zat besi bagi ibu hamil anemia,” *AcTion Aceh Nutr. J.*, vol. 8, no. 1, pp. 20–29, 2023. http://dx.doi.org/10.30867/action.v8i1.755

[19] R. K. Andini, E. Sumaryati, and F. D. Anggraeni, “pengaruh proporsi tepung terigu dan tepung kelor (moringa oleifera) terhadap sifat kimia dan organoleptik brownies kukus,” *J. Teknol. Pangan Dan Prod. Pertan.*, vol. 1, no. 01, pp. 28–42, 2025.

[20] S. Verghese, “Studies on quality characteristics of Moringa leaves under differents drying conditions,” *Orissa Univesrity Agric. Technol. Bhubaneswar*, 2018.

[21] D. B. Kumssa, E. J. Joy, S. D. Young, D. W. Odee, E. L. Ander, and M. R. Broadley, “Variation in the mineral element concentration of Moringa oleifera Lam. and M. stenopetala (Bak. f.) Cuf.: Role in human nutrition,” *PloS One*, vol. 12, no. 4, p. e0175503, 2017. https://doi.org/10.1371/journal.pone.0175503

[22] D. A. S. Safira and I. N. T. Komalyna, “Edukasi Gizi Anemia dengan Media Komik Terhadap Pengetahuan, Sikap dan Asupan Energi, Protein, Zat Besi Remaja Putri di MTSN 1 Kota Blitar,” *Pros. TIN PERSAGI*, pp. 131–140, 2023.