AgriHealth
Journal of Agri-food, Nutrition and Public Health
ISSN 2722-0656 (Print) 2722-0648 (Online)

AgriHealth: Journal of Agri-food, Nutrition and Public Health. 7(1), 19-28, 2026
URL: https://jurnal.uns.ac.id/agrihealth/article/view/109597
DOI: http://dx.doi.org/10.20961/agrihealth.v7i1.109597

Optimization of Sorghum, Moringa Leaf, and Bran Flours in the Making of Cookies High in Protein and Fiber

Endah Wulandari*, Putri Widyanti Harlina, Heni Radiani Arifin and Yufi Anandia Salsabila

Department of Food Industrial Technology, Faculty of Agricultural Industrial Technology, Universitas Padjadjaran, Bandung, Indonesia

Received: October 6, 2025; **Revised**: January 18, 2026; **Accepted**: January 19, 2026

Abstract

The high prevalence of stunting and low fiber intake among toddlers in Indonesia led to the development of cookies as a supplementary food to support adequate protein and fiber intake. Therefore, this study aims to determine the optimal cookie formulation based on sorghum, moringa leaf, and bran flours. This study used an experimental method based on response surface methodology (RSM) with a central composite design (CCD). The resulting responses were protein (Y1) and crude fiber (Y2), which were maximized. The optimal formula for cookies was 29.04% sorghum, 2.34% moringa leaf, and 18.74% bran flours. This formulation produces cookies with protein content of 10.01%, crude fiber of 2.36%, moisture of 4.89%, ash of 3.21%, fat of 22.29%, and carbohydrate of 59.61%. The physical characteristics were hardness 4,219.53 g, fracturability 5.62 mm, °hue 84.15, and sensory with an attractive overall appearance. The results indicate that the cookies' protein and fiber content met the supplementary food requirements of the Ministry of Health, Republic of Indonesia. However, the values were lower than predicted by the optimization, while maintaining favorable physical, chemical, and sensory characteristics.

Keywords: response surface method; substituted flour; supplementary food

INTRODUCTION

Nutritional content, such as protein and fiber, is vital for toddlers and pregnant women because it affects fetal growth. Poor nutrition can lead to babies being born with low birth weight or stunting. According to the Indonesian Nutrition Status Survey (SSGI) in 2024, the stunting rate among toddlers is 19.8%, which affects a child's physique, intelligence, and productivity (Wulandari and Kusumastuti, 2020). According to Statistics Indonesia, the average protein consumption in Indonesia is 62.3 g, exceeding the daily limit of 57 g. However, Indonesia still has a lower average than other countries, such as the Philippines (73.1 g) and Malaysia (89.1 g) (Statistics Indonesia, 2023). The effects of protein deficiency are stunted growth, increased disease susceptibility, and decreased cognitive and motor development (Yuliantini et al., 2022). Furthermore, fiber intake in Indonesia is also insufficient, averaging 10.5 g per day compared to the recommended 29 to 37 g per day (Djojosaputro and Prihantini, 2023). Fiber affects children's digestive system, maintains healthy gastrointestinal function, and prevents constipation (Salvatore et al., 2023).

To meet protein and fiber requirements, this can be achieved by providing supplementary foods such as cookies. The use of cookies is deemed suitable in terms of consumer acceptance and practicality, and they have a prolonged

* **Corresponding author**: endah.wulandari@unpad.ac.id

Cite this as: Wulandari, E., Harlina, P. W., Arifin, H. R., & Salsabila, Y. A. (2026). Optimization of Sorghum, Moringa Leaf, and Bran Flours in the Making of Cookies High in Protein and Fiber. *AgriHealth: Journal of Agri-food, Nutrition and Public Health*, *7*(1), 19-28. doi: http://dx.doi.org/10.20961/agrihealth.v7i1.109597

shelf life (Mileiva et al., 2017). However, it should be noted that cookie production typically involves wheat flour, which contains gluten. So an alternative main ingredient is sorghum flour. Sorghum flour has a content similar to that of wheat flour, and is even superior in fiber and minerals. Compared to rice, sorghum contains 1.5 times more protein, 4.8 times more fat, and 2.3 times more fiber (Dhanasatya et al., 2021).

Regarding protein content, the protein limit of cookies for the supplementary feeding program (*Pemberian Makanan Tambahan*/PMT), according to the Ministry of Health of the Republic of Indonesia, is 8 to 12% (Ministry of Health of the Republic of Indonesia, 2016). One ingredient that can increase the protein content of cookies is moringa leaves. Moringa leaf flour contains 28.25% protein per 100 g (Aryani et al., 2019). According to Adi et al. (2024), the addition of 3% moringa leaf powder to gluten-free cookies increased protein content to 8.69%, compared with 4.44% in the control formulation. Meanwhile, fiber intake can be increased by using rice bran. Rice bran contains various nutrients, such as 4.97% of crude fiber and 13.11 to 10.13% protein (Auliana and Rahmawati, 2023). Furthermore, rice bran is rich in vitamin B, especially B1 (thiamin) (Luthfianto et al., 2022). Sofianti et al. (2021) reported that rice bran flour substantially increased fiber content; substituting 30% rice bran flour increased cookie fiber content from 0.45 to 8.47 g.

Despite the acknowledged potential of the ingredients, no research has been conducted on the use of a combination of those 3 flours as local food substitutes for wheat flour in functional products for supplementary foods. This study aimed to determine the optimal formulation of sorghum, moringa leaf, and bran flours for the production of high-protein, high-fiber cookies using the response surface method (RSM), along with their effects on physical, chemical, and organoleptic characteristics.

MATERIALS AND METHOD

Materials

The materials used in this study were sorghum flour from TanahKita.co, moringa leaf from Bandung (Indonesia), rice bran flour from Sumedang (Indonesia), margarine from Blue Band, egg yolk, milk powder from Dancow, powdered sugar from Superindo, and baking powder and vanilla essence from Koepoe Koepoe.

Experimental design

The study used RSM-based optimization with a central composite design (CCD) via Design Expert 13 software. The 3 independent variables are sorghum flour (X1), moringa leaf flour (X2), and rice bran flour (X3). Determination of the upper and lower limits of the independent variables was based on a literature review. To produce cookies with good physical, chemical, and organoleptic qualities, sorghum flour can be used in a range of 50 to 60% (Hermeni et al., 2023; Syifahaque et al., 2023), moringa leaf flour 3 to 5% (Amadi, 2017; Adi et al., 2024), and rice bran flour 30 to 40% (Mulyani et al., 2015; Sofianti et al., 2021). The cookie dough also contained additional ingredients, including margarine, sugar, egg yolks, powdered milk, baking powder, and vanilla essence as fixed variables. For all materials, the upper and lower limit percentages for the factors are shown in Table 1.

Table 1. The upper and lower limits of the independent variables

Variable	Upper limit (%)	Lower limit (%)
Sorghum flour (X1)	29.04	23.42
Moringa leaf flour (X2)	2.34	1.41
Bran flour (X3)	18.74	14.05

Based on the limits of each independent variable, the data were processed, and 19 runs were generated. The resulting responses were protein (Y1) and crude fiber (Y2). Testing protein and crude fiber levels in response to 19 formula variations was performed by calculating mass balance using ingredient content as inputs.

Proximate and physical analysis

The optimized cookies were analyzed for chemical composition, including protein content, crude fiber, water, ash, fat, and carbohydrates, using standard methods described by the Association of Official Analytical Chemists (AOAC, 2005). Physical analysis included color using a spectrophotometer (Marta et al., 2024) and hardness and fracturability using a texture analyzer (Indrianti et al., 2021). Sensory evaluation was conducted by 50 semi-trained panelists from the Department of Food Industrial Technology, Universitas Padjadjaran, using a 5-point scale for quantitative descriptive analysis to assess color, aroma, texture, bitterness, aftertaste, and overall appearance.

Cookies-making

All ingredients were weighed according to the optimized formula. Margarine and powdered sugar were creamed for 2 minutes, then egg yolk and vanilla essence were added. Dry ingredients, including sorghum flour, moringa leaf flour, rice bran flour, milk powder, and baking powder, were mixed to form a dough. The dough was rolled and shaped, and baked at 130 °C for 25 minutes. After baking, the cookies were cooled to room temperature.

Statistical analysis and ethics

The data was entered and analyzed using Microsoft Excel version 2509 to determine the mean, standard deviation, and relative standard deviation. Ethical clearance was obtained from the Research Ethics Committee of Universitas Padjadjaran, Bandung (ethical approval number: 681/UN6.KEP/EC/2025).

RESULTS AND DISCUSSION

Optimization of cookie formulation

The optimization results showed that the higher the flour concentration, the greater the increase in protein and crude fiber. The data were then processed using Design Expert 13 to obtain the equation model, ANOVA results, and the optimal point. Data analysis of composite flour optimization results is presented in Table 2.

The optimization responses presented in Table 2 demonstrate that variations in ingredient composition influenced the measured parameters across formulations. Minor variations among reactions may be attributed to the relatively narrow range between the upper and lower limits of the variables. The optimal formulation consisted of 29.04% sorghum flour, 2.34% moringa leaf flour, and 18.74% rice bran flour, achieving a desirability value of 0.999. The high desirability value indicates that the optimized formulation successfully met the predefined criteria (Montgomery, 2017).

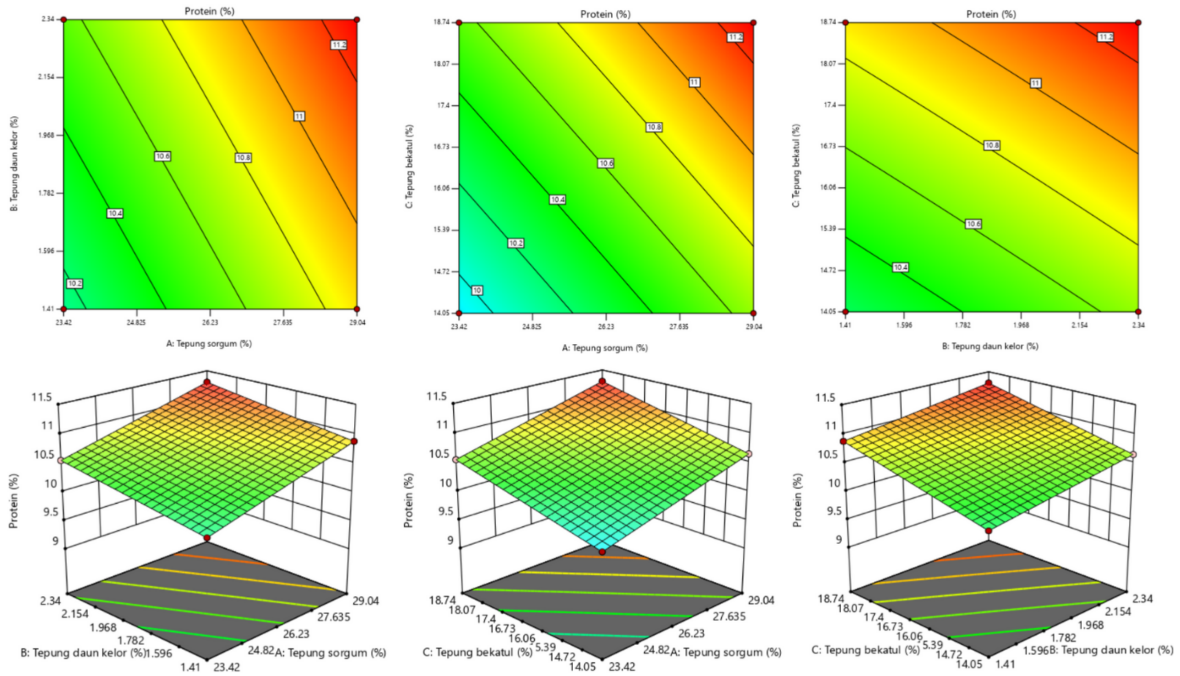
Analysis of protein response

The protein content was analyzed using the software, which yielded a selected model. The recommended model is quadratic because it has the best *p*-value and an adjusted R^2 of 1.000. All 3 variables have *p*-values < 0.05 and a significant effect on the response. Equation 1 is the linear regression of protein response.

$$Y1 = 10.39 + 0.3691A + 0.2082B + 0.3218C - 0.0007AB - 0.0015AC - 0.0030BC + 0.0010A^2 + 0.0012B^2 + 0.0008C^2 \quad (1)$$

Table 2. Data analysis of optimization responses

Run	Variable			Response	
	Sorghum flour (%)	Moringa leaf flour (%)	Rice bran flour (%)	Protein content (%)	Crude fiber content (%)
1	21.50	1.88	16.40	9.77	2.62
2	29.04	1.41	14.05	10.23	2.55
3	26.23	1.88	16.40	10.39	2.77
4	26.23	1.88	16.40	10.39	2.77
5	26.23	1.88	20.34	10.93	3.16
6	26.23	1.88	12.45	9.85	2.38
7	26.23	1.88	16.40	10.39	2.77
8	23.42	2.34	18.74	10.55	2.99
9	29.04	2.34	14.05	10.65	2.71
10	26.23	2.66	16.40	10.74	2.90
11	26.23	1.09	16.40	10.04	2.64
12	23.42	2.34	14.05	9.91	2.53
13	23.42	1.41	18.74	10.14	2.84
14	29.04	1.41	18.74	10.88	3.02
15	23.42	1.41	14.05	9.49	2.37
16	26.23	1.88	16.40	10.39	2.77
17	30.96	1.88	16.40	11.01	2.92
18	29.04	2.34	18.74	11.29	3.17
19	26.23	1.88	16.40	10.39	2.77



a. b. c.

Figure 1. Contour plot and 3D graph of protein response interaction AB (a), AC (b), BC (c)

The effect of variables on protein content of cookies in order is sorghum flour (A) > rice bran flour (C) > moringa leaf flour (B). This relates to the percentages of the ingredients in the cookie formulation. The contour plot and 3D graph (Figure 1) show a color progression from green (lower response) to red (highest response). The contour patterns tend to be parallel across the 3 factor combinations tested (AB, AC, and BC), indicating that changes in protein levels are influenced more by each ingredient's effects than by simultaneous changes across multiple ingredients.

The software-based formula showed lower protein levels than the prediction would suggest (Table 3), possibly due to thermal processing. Baking at 130 °C for 25 minutes may have induced protein denaturation and Maillard reactions, which alter both structure and nutritional quality (Ibe et al., 2025). In addition, the composition of the raw materials contributed significantly. While moringa leaf flour and egg yolk are known to have relatively high protein levels, their impact was limited because they were used in lower proportions than sorghum flour.

Table 3. Optimum model and validation of protein content cookies

Protein content (%)		
Prediction	Actual	Percentage
11.29	10.01	88.66

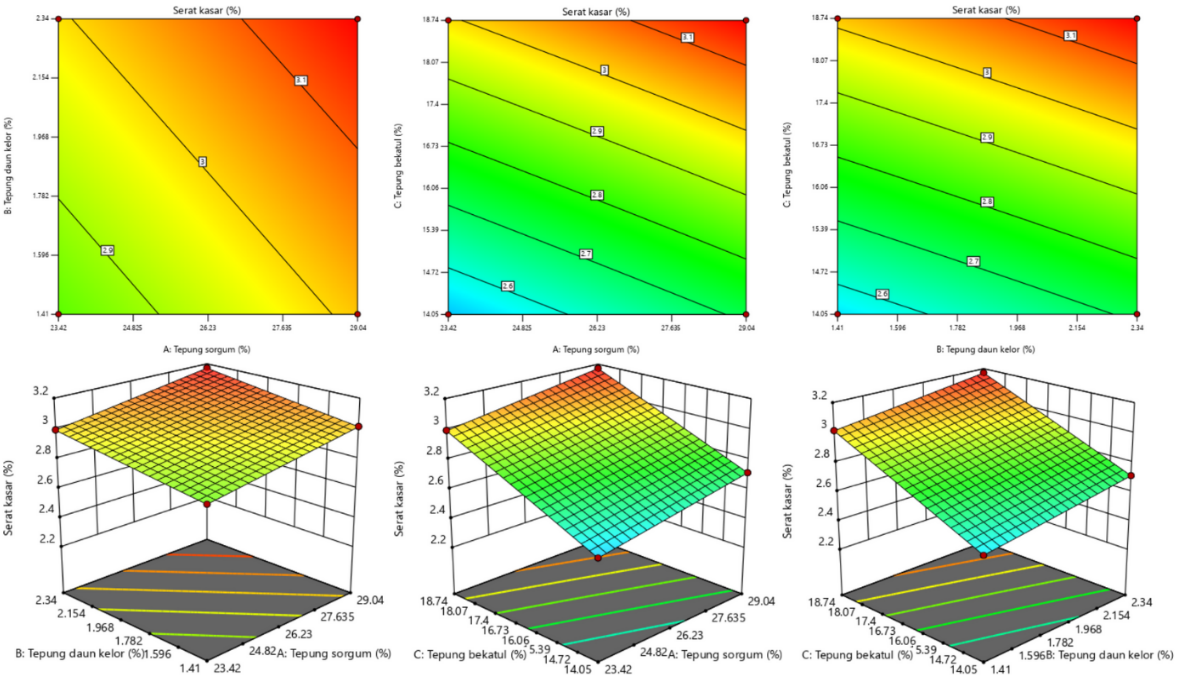
The optimized cookies contained 10.01% protein. This value falls within the 8 to 12% range recommended by the Ministry of Health of the Republic of Indonesia (2016) for PMT. These results indicate that the optimized cookie formulation successfully achieved the desired balance of ingredients, producing a product that meets both regulatory standards and nutritional requirements.

Analysis of crude fiber response

The recommended model for crude fiber content, based on software, is quadratic, with an adjusted R^2 of 0.999. All 3 variables have *p*-values < 0.05 and a significant effect on the response. The impact of variables on the crude fiber content of cookies, in order, is rice bran flour (C) > sorghum flour (A) > moringa leaf flour (B). This relates to the crude fiber content and the ingredient percentages in the cookie formulation. Equation 2 is the linear regression of crude fiber response.

$$Y2 = 2.77 + 0.0901A + 0.0775B + 0.2323C + 0.0011AB - 0.0029AC - 0.0016BC + 0.0004A^2 + 0.0011B^2 - 0.0017C^2 \quad (2)$$

The contour plot and 3D graph (Figure 2) show a relatively uniform pattern across the 3 factor combinations, with almost parallel contour lines



a. b. c.

Figure 2. Contour plot and 3D graph of crude fiber response interaction AB (a), AC (b), BC (c)

and regular color gradation from low (blue) to high (red) values. Increasing the proportion of each ingredient increases crude fiber content, with linear or individual effects rather than interaction effects.

The software-based formula yielded crude fiber below the predicted value (Table 4). Baking conditions significantly influence fiber levels. Elevated temperatures reduce moisture and soluble components, increasing the concentration of heat-resistant crude fiber fractions. At the same time, the evaporation of volatile substances during heating increases the relative fiber content. Nevertheless, excessive baking temperatures can cause thermal degradation, reducing fiber availability. Dough thickness is another factor, as thicker dough often results in uneven heat distribution, leading to less optimal fiber retention (Ibe et al., 2025).

However, according to the Indonesian Ministry of Health Regulation No. 51/2016, this value remains below the 5% upper threshold for supplementary foods. Although crude fiber accounts for only part of dietary fiber, its relatively high level suggests these cookies have the potential to contribute to meeting daily fiber intake.

Table 4. Optimum model and validation of crude fiber content in cookies

Crude fiber content (%)		
Prediction	Prediction	Prediction
3.17	2.36	74.45

The physical characteristics of cookies

Texture

The texture of cookies has an average hardness of 4,219.53±113.71 g and fracturability of 5.62±0.09 mm. Cookies made with gluten-free flour generally have a hard texture and a less hollow structure that doesn't expand completely (Purnamasari et al., 2022). Higher protein content strengthens starch-protein bonds, making cookies denser (Subaktilah et al., 2023). The fiber content also makes the cookies less crisp due to the hard cellulose structure (Jagat et al., 2017). On the other hand, adding high-lipid ingredients such as margarine can improve cookie texture (Rifada and Kurnia, 2024).

Color

The color profile of the sample collected data is read in L*, a*, and b* values (Table 5). The cookies exhibited a lower L* value (50.85) compared to sorghum and rice bran flours, indicating a darker appearance after baking. This decrease in L* may be attributed to the combined effects of naturally pigmented raw materials and non-enzymatic browning during baking. The positive a* value (2.95) and relatively high b* value (28.82) indicate a tendency toward reddish-yellow coloration, which is consistent with the Yellow Red (YR) °hue value of 84.15. Sorghum flour contributes a darker, reddish tone due to its tannin protein content (Rahayu et al., 2019). Rice bran flour also changes the color due to its yellowish brown natural color, and moringa leaf flour darkens due to its chlorophyll oxidation (Idora et al., 2017; Azzahra and Suryaalamsah, 2024).

The chemical characteristics of cookies

The cookies with the optimal formulation had an average water content of 4.89%, which was below the maximum threshold of 5% set by the Indonesian Ministry of Health Regulation No. 51/2016, thus meeting the quality requirement. This amount affects the texture of the cookies, making them hard and dry, which is associated with a longer shelf life. Moisture levels are influenced by the physicochemical properties of the ingredients, particularly fiber and starch, which can bind water during baking. Sorghum flour, the primary raw material, has relatively low amylose content, which contributes to higher water retention (Suarti, 2024). Baking conditions further affect moisture, as higher temperatures and longer baking times increase water evaporation (Setyaningsih et al., 2019).

The ash content of the cookies was 3.21%. The elevated ash content was primarily derived from sorghum, moringa leaf, and rice bran flours (Table 6), as well as contributions from margarine, powdered sugar, egg yolks, and milk powder. This ash content may influence the nutritional profile of the cookies by contributing to the mineral value (Al-Marazeeq et al., 2024).

The fat content averaged 22.29%, exceeding the specified range of 10 to 18% (w/w) under Indonesian Ministry of Health Regulation No. 51/2016. This level was strongly influenced by margarine (80 to 81% fat) and egg yolks (31% fat) (Rosida et al., 2020; Wulandari and Arief, 2022). Additional contributions came from sorghum flour, rice bran, and moringa leaves (Table 6). This relatively high fat content is essential for maintaining product moisture, a soft texture, and a longer shelf life (Rifada and Kurnia, 2024). For toddlers, a higher fat content may help meet energy needs for physical and cognitive activities. However, adherence to portion control is essential to ensure a balanced diet for toddlers (Yuliana et al., 2025).

The carbohydrate content, determined by difference, was 59.61%. The carbohydrate level reflects the composition of the raw material (Table 6). As carbohydrates are calculated inversely to other components, the higher fat and ash contents in this formulation contributed to the lower carbohydrate value (Syifahaque et al., 2023). However, the amount contained in the cookies may contribute to daily energy intake as a supplementary food.

The sensory evaluation of cookies

The spider web graph and the average sensory evaluations for 6 cookie attributes are shown in Figure 3. The color value of the cookies averages 3.54 (brownish green). The green color

Table 5. Color profile of flours and cookies

Notation	Sorghum flour	Moringa leaf flour	Rice bran flour	Cookies
L*(D65)	87.05±0.00	44.55±0.03	75.94±0.01	50.85±0.84
a*(D65)	0.72±0.01	-4.26±0.01	1.96±0.01	2.95±0.04
b*(D65)	12.62±0.01	22.52±0.11	15.60±0.01	28.82±0.47
°Hue	86.76±0.03	100.71±0.02	82.85±0.02	84.15±0.02
Interpretation	Yellow Red (YR)	Yellow (Y)	Yellow Red (YR)	Yellow Red (YR)

Note: Values are presented as mean±standard deviation

Table 6. Chemical characteristics of flours and cookies

Parameter	Sorghum flour	Moringa leaf flour	Rice bran flour	Cookies
Water	10.45±0.33	7.68±0.05	7.62±0.08	4.89±0.01
Ash	1.56±0.04	5.22±0.04	7.64±0.01	3.21±0.08
Protein	11.92±0.01	41.34±1.68	12.73±0.01	10.01±0.02
Fat	3.34±0.09	10.46±0.20	10.15±0.27	22.29±0.08
Carbohydrate	72.74±0.22	35.30±2.12	61.86±0.24	59.61±0.02

Note: Values are presented as mean±standard deviation

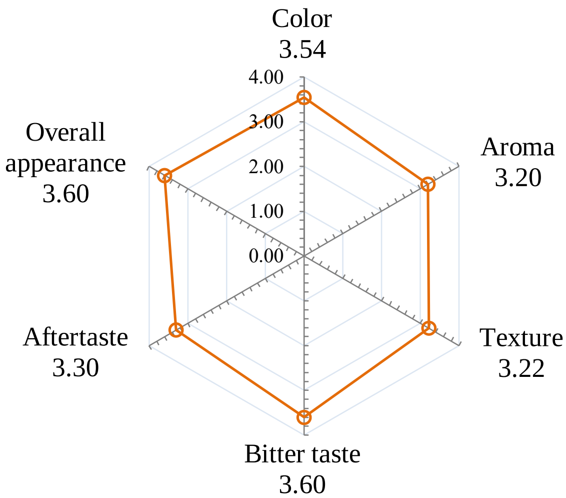


Figure 3. Spider web graph of sensory evaluation

of moringa leaves is influenced by chlorophyll, which darkens upon heating due to oxidation (Azzahra and Suryaalamsah, 2024). The brown color of cookies is due to the Maillard reaction triggered by baking, which produces melanoidin compounds and intensifies surface color (Medho and Mohamad, 2024). Additionally, rice bran flour has a slightly brown tint and contains phytochemical compounds (Idora et al., 2017).

The cookies' aroma is slightly off, likely due to compounds in rice bran and moringa leaf flours. Bran flours contain lipase and lipoxidase enzymes that can hydrolyze fats into rancid compounds, even at low concentrations (Damayanti et al., 2020). High levels of moringa flour help mask the unpleasant odor caused by secondary metabolites, such as saponins (Mazidah et al., 2018).

The texture of the cookies is a bit hard, with an average score of 3.22. According to Medho and Mohamad (2024), high levels of protein and fiber contribute to dough structure, resulting in a denser, firmer final texture. This aligns with the physical testing of cookies using a texture analyzer, which yields a high hardness value.

The bitterness is weak (3.60), but the aftertaste is slightly strong (3.30), due to tannin and saponin compounds in the flour. Tannins in the moringa leaf are astringent that produce a dry and smooth taste after consumption (Mazidah et al., 2018). The same thing happens with rice bran flour: the higher the concentration, the lower the level of panelist liking due to a bitter aftertaste associated with saponin content (Damayanti et al., 2020).

The cookies' overall appearance is considered attractive (3.60). The quality assessment of cookies' appearance is impacted by factors such as uniform coloration, the absence of shape defects, appropriate proportions, and adequate surface texture. Sensory evaluation was not conducted in the primary target population, which may limit the representation of actual cookie acceptance.

CONCLUSIONS

The optimal formula for adding 29.04% sorghum flour, 2.34% moringa leaf flour, and 18.74% bran flour to gluten-free cookies resulted in protein and crude fiber contents of 10.01% and 2.36%, respectively. The cookies contained 4.89% moisture, 3.21% ash, 22.29% fat, and 59.61% carbohydrates. Physical characteristics were 4,219.53 g hardness, 5.62 mm fracturability, and 84.15 °hue. The sensory was acceptable, as the overall appearance received an attractive score. Further research is recommended to refine the optimized cookie formulation by reducing protein and fiber losses and to evaluate digestibility for a more robust nutritional quality assessment.

ACKNOWLEDGEMENTS

The authors are grateful to the financial support provided by Universitas Padjadjaran for the Fiscal Year 2025.

REFERENCES

Adi, M. R. B. H., Puspawati, G. A. K. D., & Arihantana, N. M. I. H. (2024). Pengaruh penambahan tepung daun kelor (*Moringa oleifera* L.) terhadap kadar protein, kapasitas antioksidan dan sensori kukis bebas gluten. *Jurnal Ilmu dan Teknologi Pangan (ITEPA)*, *13*(1), 218–229. https://doi.org/10.24843/ITEPA.2024.V13.I01.P15

Al-Marazeeq, K., Saleh, M., Angor, M., & Lee, Y. (2024). Cookie dough functional properties of partially replaced all-purpose wheat flour with powdered fruit skins and the hedonic perception of the resulting cookies. *Frontiers in Sustainable Food Systems*, *8*, 1445206. https://doi.org/10.3389/fsufs.2024.1445206

Amadi, J. A. (2017). Production, chemical and sensory evaluation of cookies fortified with *Moringa oleifera* leaves. *Journal of Dietitians Association of Nigeria*, *8*, 104–111. Retrieved from https://scholar.google.com/scholar?cites=11739794941371674555&as_sdt=2005&sciodt=0,5&hl=en

AOAC. (2005). *Official method of analysis of the association of analytical chemists*. Association of Official Analytical Chemists, Inc. Retrieved from https://books.google.co.id/books/about/Official_Methods_of_Analysis_of_AOAC_Int.html?id=AEExAQAAIAAJ&redir_esc=y

Aryani, N. S., Mustofa, A., & Wulandari, Y. W. (2019). Karakteristik roti tawar subtitusi tepung kentang (*Solanum tuberosum* L.) dengan penambahan tepung daun kelor (*Moringa oleifera* Lamk.). *JITIPARI (Jurnal Ilmiah Teknologi dan Industri Pangan UNISRI)*, *4*(2), 65–73. https://doi.org/10.33061/jitipari.v4i2.3148

Auliana, R., & Rahmawati, F. (2023). Kajian organoleptik dan kandungan gizi cookies bekatul. *Ilmu Gizi Indonesia*, *7*(1), 95–106. https://doi.org/10.35842/ilgi.v7i1.410

Azzahra, A., & Suryaalamsah, I. I. (2024). 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)*, *5*(1), 1–12. https://doi.org/10.24853/mjnf.5.1.1-12

Damayanti, S., Bintoro, V. P., & Setiani, B. E. (2020). Pengaruh penambahan tepung komposit terigu, bekatul dan kacang merah terhadap sifat fisik cookies. *Journal of Nutrition College*, *9*(3), 180–186. https://doi.org/10.14710/jnc.v9i3.27046

Dhanasatya, L., Lesmana, D., Elkiyat, W., Hartati, Fathoni, A., & Mayasti, N. K. I. (2021). Karakterisasi kandungan kimia dan organoleptik produk kukis dari tepung komposit berbasis mocaf dan tepung sorgum. *Jurnal Riset Industri*, *13*(1), 23–33. https://doi.org/10.26578/JRTI.V15I1.6169

Djojosaputro, M., & Prihantini, N. N. (2023). The relationship between knowledge, attitude, and behavior of fiber food consumption with defection pattern. *Asian Journal of Medicine and Health*, *21*(10), 84–97. https://doi.org/10.9734/ajmah/2023/v21i10881

Hermeni, H., Jumiyati, J., & Yulianti, R. (2023). Daya terima, mutu hedonik dan profil nilai gizi kukis substitusi tepung sorgum (*Sorghum bicolor*). *Ghidza: Jurnal Gizi dan Kesehatan*, *7*(2), 234–244. https://doi.org/10.22487/ghidza.v7i2.1036

Ibe, P., Agu, H., Ikegwu, T., Ishiwu, C., & Emembolu, L. (2025). Effect of dough thickness and baking temperatures on the proximate composition of optimized cookies from wheat-white yam flour using response surface methodology. *Applied Food Research*, *5*(2), 101134. https://doi.org/10.1016/j.afres.2025.101134

Idora, M., Prarudiyanto, A., & Alamsyah, A. (2017). Pengaruh kombinasi tepung bekatul dan tepung menir C4 terhadap beberapa komponen mutu cookies. *Pro Food*, *3*(2), 207–216. https://doi.org/10.29303/profood.v3i2.50

Indrianti, N., Ratnawati, L., Ekafitri, R., Mayasti, N. K. I., & Sirait, D. N. (2021). Pengaruh jenis dan rasio penambahan pati terhadap karakteristik biskuit MP-ASI berbasis mocaf. *Indonesian Journal of Industrial Research*, *15*(2), 135–146. https://doi.org/10.26578/jrti.v15i2.6858

Jagat, A. N., Pramono, Y. B., & Nurwantoro. (2017). Pengkayaan serat pada pembuatan biskuit dengan substitusi tepung ubi jalar kuning (*Ipomea batatas* L.). *Jurnal Aplikasi Teknologi Pangan*, *6*(2), 1–4. https://doi.org/10.17728/jatp.190

Luthfianto, D., Noviyanti, R. D., & Kurniawati, I. (2022). Efektivitas pemberian kastengel bekatul Situbagendit dan IR64 terhadap kadar gula darah penderita diabetes mellitus non insulin. *Jurnal Ilmiah Kesehatan Keperawatan*, *18*(1), 13–17. https://doi.org/10.26753/jikk.v18i1.765

Marta, H., Yusnia, S. A., Fetriyuna, F., Arifin, H. R., Cahyana, Y., & Sondari, D. (2024). Application of flour blends from modified cassava and suweg flours in gluten-free steamed brownies. *Polish Journal of Food and Nutrition Sciences*, *74*(2), 188–196. https://doi.org/10.31883/pjfns/188615

Mazidah, Y. F., Kusumaningrum, I., & Safitri, D. E. (2018). Aplication of flour *Moringa oleifera* leaves in the making of calcium source crackers. *ARGIPA (Arsip Gizi dan Pangan)*, *3*(2), 67–79. https://doi.org/10.22236/argipa.v3i2.2462

Medho, M. S., & Mohamad, E. V. (2024). Characteristics of modified timor white corn flour and its cookies enriched with *Moringa leaves*. *Jurnal Teknik Pertanian Lampung (Journal of Agricultural Engineering)*, *13*(2), 581–591. https://doi.org/10.23960/jtep-l.v13i2.581-591

Mileiva, S., Palupi, N. S., & Kusnandar, F. (2017). Evaluasi mutu cookies Garut yang digunakan pada program pemberian makanan tambahan (PTM) untuk ibu hamil. *Jurnal Mutu Pangan : Indonesian Journal of Food Quality*, *4*(2), 70–76. Retrieved from https://journal.ipb.ac.id/index.php/jmpi/article/view/26442

Ministry of Health the Republic of Indonesia. (2016). *Ministry of Health Regulation No. 51 Standard for Nutritional Supplementation Products*. Retrieved from https://peraturan.bpk.go.id/Details/114009/permenkes-no-51-tahun-2016

Montgomery, D. C. (2017). *Design and analysis of experiments* (9th edition). John Wiley & Sons, Inc. Retrieved from https://books.google.co.id/books?hl=id&lr=&id=Py7bDgAAQBAJ&oi=fnd&pg=PA1&dq=Design+and+analysis+of+experiments+(9th+edition)&ots=X8v7q3ST_b&sig=LlrAEXlUap9iKHjj3yOYwGwVpS0&redir_esc=y#v=onepage&q&f=false

Mulyani, T., Djajati, S., & Rahayu, L. D. (2015). Pembuatan cookies bekatul (kajian proporsi tepung bekatul dan tepung mocaf) dengan penambahan margarine. *Jurnal Teknologi Pangan*, *9*(2), 1–8. https://doi.org/10.33005/jtp.v9i2.507

Purnamasari, P., Susilawati, Astuti, S., & Suharyono, S. (2022). Pengaruh penambahan puree labu kuning (*Cucurbita moschata* Duch) terhadap sifat sensori dan fisikokimia cookies berbahan dasar campuran tepung mocaf dan tepung terigu. *Jurnal Agroindustri Berkelanjutan*, *1*(2), 187–197. https://doi.org/10.23960/jab.v1i2.6326

Rahayu, A. P., Istianah, N., & Ali, D. Y. (2019). Pengaruh proporsi tepung sorgum dan tepung sagu aren terhadap sifat fisik mi kering bebas gluten. *Jurnal Pangan dan Agroindustri*, *7*(4), 22–30. https://doi.org/10.21776/ub.jpa.2019.007.04.3

Rifada, A., & Kurnia, P. (2024). Kadar protein dan lemak pada cookies cokelat bebas gluten berbahan dasar tepung mocaf dengan subtitusi tepung ganyong dan tepung sorgum. *Ranah Research : Journal of Multidisciplinary Research and Development*, *6*(6), 2728–2733. https://doi.org/10.38035/RRJ.V6I6.1141

Rosida, D. F., Putri, N. A., & Oktafiani, M. (2020). Karakteristik cookies tepung kimpul termodifikasi (*Xanthosoma sagittifolium*) dengan penambahan tapioka. *Agrointek : Jurnal Teknologi Industri Pertanian*, *14*(1), 45–56. https://doi.org/10.21107/agrointek.v14i1.6309

Salvatore, S., Battigaglia, M. S., Murone, E., Dozio, E., Pensabene, L., & Agosti, M. (2023). Dietary fibers in healthy children and in pediatric gastrointestinal disorders: A practical guide. *Nutrients*, *15*(9), 2208. https://doi.org/10.3390/nu15092208

Setyaningsih, D. N., Fathonah, S., Putro, R. D. A., Auda, A. K., & Solekah, N. (2019). The influence of baking duration on the sensory quality and the nutrient content of mung bean biscuits. *Journal Homepage*, *3*(6), 777–782. https://doi.org/10.26656/fr.2017.3(6).089

Sofianti, N., Supriatiningrum, D. N., & Prayitno, S. A. (2021). Pemanfaatan tepung bekatul terhadap sifat sensori dan kimia produk cookies. *Ghidza Media Jurnal*, *1*(2), 81–86. https://doi.org/10.30587/ghidzamediajurnal.v1i2.2165

Statistics Indonesia. (2023). *Consumption of calorie and protein of Indonesia and province, March 2023.* Retrieved from https://www.bps.go.id/id/publication/2023/10/20/bc49f9e37fe51852b8b0115c/konsumsi-kalori-dan-protein-penduduk-indonesia-dan-provinsi--maret-2023.html

Suarti, B. (2024). *Pati modifikasi dan aplikasinya* (M. Arifin, Ed.). Medan, Indonesia: UMSU Press. Retrieved from https://books.google.co.id/books?hl=id&lr=&id=OFU4EQAAQBAJ&oi=fnd&pg=PA63&dq=Pati+Modifikasi+dan+Aplikasinya+&ots=Vuu2A70lzE&sig=9MfNvTTCcIjSvdWk2fa-er1HbmM&redir_esc=y#v=onepage&q=Pati%20Modifikasi%20dan%20Aplikasinya&f=false

Subaktilah, Y., Apriliyanti, M. W., & Sasmita, I. R. A. (2023). Pengaruh tepung tape singkong dan tepung jamur tiram terhadap tekstur dan daya kembang cookie. *NaCIA (National Conference on Innovative Agriculture),* 295–300. Retrieved from https://ocs.polije.ac.id/index.php/pnacia/article/view/86

Syifahaque, A.-N., Siswanti, S., & Atmaka, W. (2023). The effect of sorghum flour substitution on the chemical, physical, and organoleptic characteristics of cookies with avocado as fat substitute. *Jurnal Teknologi Hasil Pertanian*, *15*(2), 119–133. https://doi.org/10.20961/jthp.v15i2.57912

Wulandari, H. W., & Kusumastuti, I. (2020). Pengaruh peran bidan, peran kader, dukungan keluarga dan motivasi ibu terhadap perilaku ibu dalam pencegahan stunting pada balitanya. *Jurnal Ilmiah Kesehatan*, *19*(02), 73–80. https://doi.org/10.33221/jikes.v19i02.548

Wulandari, Z., & Arief, I. I. (2022). Review: Tepung telur ayam: Nilai gizi, sifat fungsional dan manfaat. *Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan*, *10*(2), 62–68. https://doi.org/10.29244/jipthp.10.2.62-68

Yuliana, Holinesti, R., Tasrif, N., Rahayu, I., Hasanah, A. N., Helmizar, ... & Halipah, S. (2025). Formulation, nutritional profile, and sensory acceptability of cookies incorporating locally sourced ingredients as complementary foods for toddlers: A strategy for stunting prevention. *Food Chemistry Advances*, *7*, 101017. https://doi.org/10.1016/j.focha.2025.101017

Yuliantini, E., Kamsiah, K., Maigoda, T. C., & Ahmad, A. (2022). Asupan makanan dengan kejadian stunting pada keluarga nelayan di Kota Bengkulu. *AcTion: Aceh Nutrition Journal*, *7*(1), 79–88. http://dx.doi.org/10.30867/action.v7i1.579