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Production of Dry Cakes (Cookies) Based on a Combination Between Millets Flour with Wheat

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Abstract: The perfect diet to achieve sustainable nutrition, health, and well-being goals requires information on the quality of food sources Millet (*Panicum miliaceum* L.) also has an energy value comparable to that of staple cereals, and more significant health benefits due to its high fiber, minerals, vitamins, macro and micronutrients, and phytochemical compounds that are useful for chronic disorders. This research aims to analyze the production of dry cakes (Cookies) based on a combination of millet flour with wheat. This study used a Factorial Randomized Block Design with 3 (three) factors each with 2 (two) levels, repeated 2 (two) times, namely: Factors of Wheat Flour (TT), namely: TT1 = 250 gram and TT2 = 350gram, Millet flour factor (TM), namely: TM1 = 250 gram and TM2 150 gram. Refined Sugar Factor (GH): GH1 = 100 grams and GH2 = 1 gram. A protein content of 8.29%, a fat content of 24.42%, a crude fiber content of 1.766%, an ash content of 1.75%, and a preference level above scale 3 (like) is obtained by optimizing the cookie-making process by replacing wheat flour with millet flour. Additionally, one gram of sucrose sugar is added.

Keywords: Factorial randomized block design; Millet flour; Optimization; Wheat flour

Introduction

The perfect diet to achieve sustainable nutrition, health, and well-being goals requires information on the quality of food sources (Chadalavada et al., 2022). Millet is the main source of food supply in arid and semi-arid areas, millet must fulfill its integrity by creating geographical indicator areas and determining the origin of the plant. Visible Near-Infrared Spectroscopy (Vis-NIR) and machine learning techniques were used to test 16 varieties of Millet (Kabir et al., 2021). Millet has the potential to be developed into a functional cereal product. To increase the number of bioactive compounds, with high-intensity ultrasound treatment, the results showed that with an amplitude of 80% for 12.5 minutes, the number of antioxidants increased by 15% (Mustac et al., 2019). Archaeobotanical studies of the Iron Age in Central Italy using SEM-EDS, ATR/FT-IR, and Py-GC/MS show that millet (*Panicum miliaceum*) has become the plant of choice for food besides wheat (Fundurulic et al., 2022). Millet flour as a food raw material has been a tradition since 202 BC, the result of the characterization of leftovers from cereals, meat, and kebabs found in Changle Cemetery (202SM-220M) using Fourier Transform Infrared Spectroscopy (FTIR), starch grain, phytolith, stable isotope analysis, and proteomics show that the food is made from millet seeds and millet flour with the addition of barley flour and beef (Ren et al., 2022).

Food and nutrition security is still a global problem, food that is healthy, nutritious, and affordable for everyone is strongly correlated with food processing techniques. The process of millet fermentation and germination showed an improvement in the nutritional character of the millet (Nanje Gowda et al., 2022). Millet (*Panicum miliaceum L.*) has resistance to heat stress and limited water requirements, from 80 accessions during 2 years of field trials showed that the parameters of plant height, grain yield, total dry biomass, harvest index, days of growing degree, and days to ripening were important parameters for selecting plant elders (Calamai et al., 2020).

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Millet (*Panicum miliaceum* L.) also has an energy value comparable to that of staple cereals, and more significant health benefits due to its high fiber, minerals, vitamins, macro and micronutrients, and phytochemical compounds that are useful for chronic disorders. Processing technologies such as soaking, germination, and fermentation can overcome malnutrition problems, and increase protein digestibility and mineral bioavailability (Nanje Gowda et al., 2022). In perspective, millet nutrition has complete proteins, phenolic compounds, and flavonoids, prebiotic fiber, essential micronutrients, minerals, vitamins, bioactive peptides from proteins showing antihypertensive, antidiabetic, and anticancer properties (Balakrishnan, 2022). The results of the analysis of proso millet seeds have a higher amounts of phenolic compounds and starch than amaranth, as well as the lowest amount of crude dietary fiber and fat, as well as being a source of micro and macro components, especially potassium, calcium, magnesium, and phosphorus (Piłat et al., 2016). Flake emergency food with a composition of 60% proso millet flour and 40% snakehead fish meal-tempeh koya showed the best physical, chemical, and sensory properties (Anandito et al., 2019).

Method

The materials used in the study included: Millet Flour, Wheat Flour, Butter, Chicken Eggs, Refined Sugar, Cheese, Pineapple Jam, and Powdered Milk. This study used a Factorial Randomized Block Design with 3 (three) factors each with 2 (two) levels, repeated 2 (two) times, namely: Factors of Wheat Flour (TT), namely: TT1 = 250 gram and TT2 = 350 grams, Millet flour factor (TM), namely: TM1 = 250 gram and TM2 150 gram. Refined Sugar Factor mely: GH1 = 100 grams GH2 = 1 gram. The arrangement of the factorial randomized block design with 3 (three) treatments and 2 (two) blocks can be seen in table below.

Table 1. Factorial Randomized Block Design with 3 (Three) Treatments and 2 (Two) Blocks

STD	Block	Run	Factor 1	Factor 2	Factor 3	Response
			Wheat	Millet	Sugar	1.2.3.4.5.6.7.8
9	Block 1	1	250	150	100	
11	Block 1	2	350	150	100	
15	Block 1	3	350	250	100	
3	Block 1	4	350	150	1	
13	Block 1	5	250	250	100	
1	Block 1	6	250	150	1	
7	Block 1	7	350	250	1	
5	Block 1	8	250	250	1	
16	Block 2	9	350	250	100	
6	Block 2	10	250	250	1	
4	Block 2	11	350	150	1	
14	Block 2	12	250	250	100	
10	Block 2	13	250	150	100	
12	Block 2	14	350	150	100	
2	Block 2	15	350	150	1	
8	Block 2	16	350	250	1	

Parameters observed (response) in this study include protein content, ash content, fiber content, and fat content. Analysis of variance from this study has 3 (three) sources of diversity, namely group, treatment, and experimental error, then optimization calculations are carried out with the 4 (four) observation parameters. The data from this study were analyzed using the Design-Expert® software version 11 application.

Result and Discussion

Results of Crude Protein Analysis

The results of crude protein analysis from dry cakes treated with 250 grams of wheat flour, 250 grams of millet flour, and 100 grams of sucrose sugar produced a maximum value of crude protein content of 9.4%. The minimum value of crude protein analysis for cookies treated with 250 grams of wheat flour, 250 grams of millet flour and grams of sucrose sugar produces a crude protein of 7.2%. The average value of crude protein content analysis results from 16 experimental units was 8.28% with a standard deviation of 0.5785%. Cakes and pastries made using up to 30% whole wheat flour made from barley, rye, millet, or sorghum instead of wheat flour do not significantly suffer in quality (Ragaee & Abdel-Aal, 2006). It is possible to manufacture cookies with improved nutritionalprofilese and acceptable physical qualities by substituting some or all of the wheat flour (Zucco et al., 2011).

Table 2. Actual Value and Predicted Value of Crude Protein Analysis (%) from Cookies

Standard Order (STD)	Run Order	Actual Value	Predicted Value[1]	Residual	Leverage	Cook's Distance
7	1	8.21	8.39	-0.18	0.12	0.01
11	2	8.36	8.39	-0.03	0.12	0
15	3	8.27	8.39	-0.12	0.12	0.01
1	4	7.62	8.39	-0.77	0.12	0.14
13	5	9.4	8.39	1.01	0.12	0.24
5	6	7.89	8.39	-0.5	0.12	0.06
9	7	8.46	8.39	0.07	0.12	0.00
3	8	8.91	8.39	0.52	0.12	0.07
6	9	8.3	8.17	0.1262	0.12	0.00
4	10	8.75	8.17	0.5762	0.12	0.08
8	11	9.14	8.17	0.9662	0.12	0.22
10	12	7.2	8.17	-0.9738	0.12	0.22
2	13	7.62	8.17	-0.5538	0.12	0.07
14	14	7.99	8.17	-0.1838	0.12	0.01
12	15	8	8.17	-0.1738	0.12	0.01
16	16	8.39	8.17	0.2162	0.12	0.01

It is advised for those who suffer from obesity to utilize millet flour in cookie formulations as it linearly reduces fat content. These findings are consistent with studies on patients who suffer from obesity. Instead, one of the main traits of human obesity disorders may be a preference for significant food sources of fat as opposed to carbohydrates (Drewnowski et al., 1992).

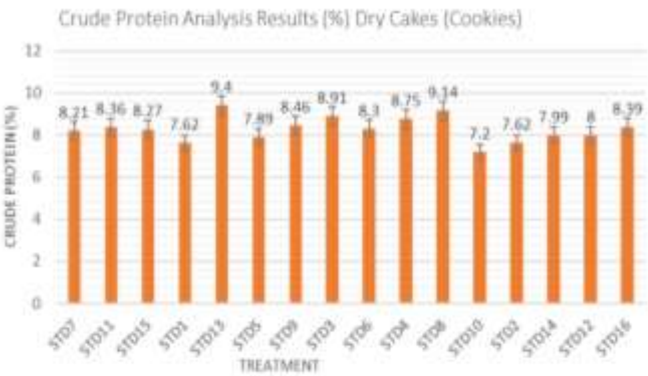

Figure 1. Bar Diagram of the results of crude protein content analysis for 16 experimental units

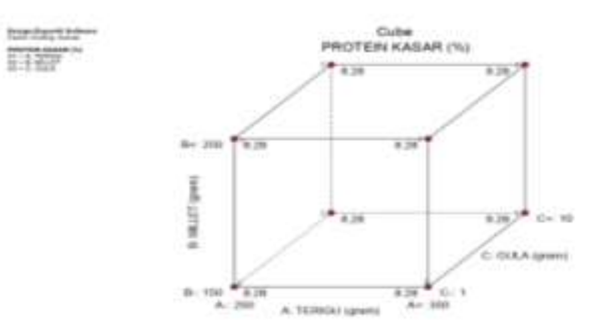

Figure 2. Relationship between factors using wheat flour, millet flour, and sucrose sugar in a cubic diagram on crude protein parameters

Substituting 250 grams to 350 grams of wheat flour with 150 grams to 250 grams of millet flour and 1 gram to 100 grams of sucrose sugar will produce a crude protein of 8.2% cookies as shown in Figure 2.

Results of Crude Fat Analysis

The crude fat analysis results (%) from 16 experimental units, with a standard deviation of 3.13% and a mean of 24.42%. 31% was the highest value of the crude fat analysis data obtained from combining 250 grams of millet flour and 350 grams of wheat flour with sucrose sugar. One gram and a minimum of 20.29% from the combination of one hundred grams of sucrose sugar, 250 grams of millet flour, and 350 grams of wheat flour.

The amount of fat in cookies has a significant impact on their final quality. The quality of the final product depends on several ingredients in addition to flour, including sugar, water, and shortening (fat) (Pareyt & Delcour, 2008). When sugar or fat content rose, cookie diameter reduced and cookie height climbed. Porosities and cell sizes in X-ray microfocus computed tomography increased with fat content (Pareyt et al., 2009). The oil-containing cookies spread more quickly at first and for a longer periperiode texture of oil-containing cookies was comparatively tougher, most likely due to inadequate air trapping during creaming (Jacob & Leelavathi, 2007). It has proven possible to successfully manufacture cakes, cookies, pasta, a product similar to parboiled rice, and snack foods from sorghum and, occasionally, millets (Taylor et al., 2006).

Table 3. Actual Value and Predicted Value of Crude Fat Analysis (%) from Cookies

Standard Order (STD)	Run Order	Actual Value	Predicted Value[1]	Residual	Leverage	Cook's Distance
7	1	31	25.52	5.48	0.12	0.27
11	2	20.70	25.52	-4.82	0.12	0.21
15	3	29.60	25.52	4.08	0.12	0.15
1	4	23.78	25.52	-1.74	0.12	0.03
13	5	20.87	25.52	-4.65	0.12	0.12
5	6	27.76	25.52	2.24	0.12	0.05
9	7	24.48	25.52	-1.04	0.12	0.01
3	8	25.99	25.52	0.47	0.12	0.00
6	9	25.3	23.32	1.98	0.12	0.03
4	10	26.02	23.32	2.70	0.12	0.06
8	11	22.95	23.32	-0.37	0.12	0.00
10	12	23.76	23.32	0.43	0.12	0.00
2	13	23.78	23.32	0.46	0.12	0.00
14	14	20.88	23.32	-2.44	0.12	0.05
12	15	23.60	23.32	0.28	0.12	0.00
16	16	20.29	23.32	-3.03	0.12	0.09

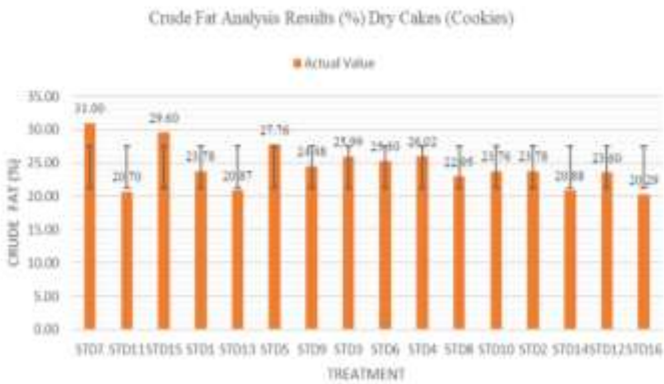

Figure 3. Bar Diagram of the results of crude fat content analysis for 16 experimental units

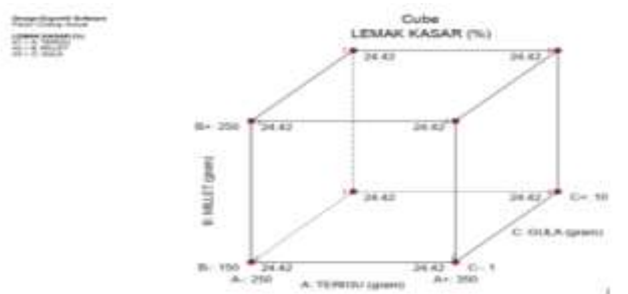

Figure 4. Relationship between factors using wheat flour, millet flour, and sucrose sugar in a cubic diagra on crude fat parameters

Substituting 250 grams to 350 grams of wheat flour with 150 grams to 250 grams of millet flour and 1 gram to 100 grams of sucrose sugar will produce a crude fat of 24.42% cookies as shown in Figure 4.

Results of Crude Fiber Analysis

Results of the treatment of 350 grams of wheat flour, 250 grams of millet flour, and 1 gram of sucrose sugar with a minimum value of 1.18% for the crude fiber content from 16 experimental units. After treating 250 grams of wheat flour, 250 grams of millet flour, and 1 gram of sucrose sugar, the maximum value of crude fiber content was 2.29%. With a standard deviation of 0.3669%, the average value of the crude fiber analysis data from 16 experimental units was 1.77%. Both polished and unpolished barnyard millet had a total dietary fiber content of 8.5 grams and 14.2 grams, respectively. The amount of crude fiber in 11.2 grams of unpolished barnyard millet and 4.5 grams of polished barnyard millet, respectively, was recorded (Rajeswari & Priyadharshini, 2021). The nutri-cereals known as millet have the potential to be extremely important in the fight against malnutrition and food poverty. Nutri cerealsare a rich source of dietary fiber, fats, protein, carbs, and phytochemicals, as well as important macro- and micronutrients (Nanje Gowda et al., 2022).

Dietary fiber from foxtail millet bran has a lot of promise for usage as an important ingredient in food items (Zhu et al., 2018). Because of its high levels of dietary fiber (18%), phenolic compounds (0.3–3%), and calcium (0.38%), millet is a significant source of nutrients. Additionally, they are well-known for their anti-diabetic, anti-tumorigenic, anti-atherosclerogenic, antioxidant, and antibacterial qualities, among other positive health impacts (Devi et al., 2014).

Figure 5. Bar diagram of the results of crude fiber content analysis for 16 experimental units

Table 4. Actual Value and Predicted Value of Crude Fiber Analysis (%) from Cookies

Standard Order (STD)	Run Order	Actual Value	Predicted Value(1)	Residual	Leverage	Cook's Distance
7	1	1.2	1.68	-0.48	0.12	0.14
11	2	1.18	1.68	-0.50	0.12	0.15
15	3	1.71	1.68	0.03	0.12	0.00
1	4	2.04	1.68	0.37	0.12	0.08
13	5	1.95	1.68	0.28	0.12	0.04
5	6	2.29	1.68	0.61	0.12	0.23
9	7	1.48	1.68	-0.12	0.12	0.02
3	8	1.56	1.68	-0.17	0.12	0.01
6	9	2.15	1.86	0.30	0.12	0.05
4	10	1.98	1.86	0.12	0.12	0.01
8	11	2.12	1.86	0.27	0.12	0.04
10	12	1.32	1.86	-0.53	0.12	0.17
2	13	2.04	1.86	0.19	0.12	0.02
14	14	1.99	1.86	0.13	0.12	0.01
12	15	1.34	1.86	-0.52	0.12	0.16
16	16	1.91	1.86	0.05	0.12	0.00

Substituting 250 grams to 350 grams of wheat flour with 150 grams to 250 grams of millet flour and 1 gram to 100 grams of sucrose sugar will produce a crude fiber of 1.77% cookies as shown in Figure 6.

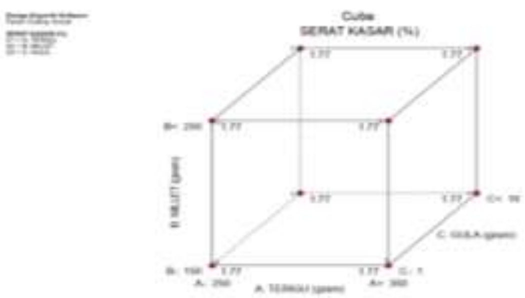

Figure 6. Relationship between factors using wheat flour, millet flour, and sucrose sugar in a cubic diagra on crude fiber parameters

Ash Content Analysis Results

A minimum value of 1.42% was observed in the ash content analysis findings from 16 experimental units after 350 grams of wheat flour, 150 grams of millet flour, and 100 grams of sucrose sugar were treated. The highest possible value of 2.17% was observed in the ash content analysis findings from 16 experimental units when 250 grams of wheat flour, 250 grams of millet flour, and 1 gram of sucrose sugar were treated. With a standard deviation of 0.1960%, the average ash content analytical result from 16 testing units was 1.75%. A reduction in dough flexibility and an increase in water absorption capacity are observed in biscuits manufactured from wheat flour, wheat, rice, oats, and barley with an ash concentration of between 4% and 10%, with biscuit breaking strength values ranging from 1.34 kg to 3.83 kg (Sudha et al., 2007).

Table 5. Actual Value and Predicted Value of Ash Content Analysis (%) from Cookies

Standard Order (STD)	Run Order	Actual Value	Predicted Value(1)	Residual	Leverage	Cook's Distance
7	1	1.76	1.74	0.02	0.12	0.00
11	2	1.42	1.74	-0.32	0.12	0.20
15	3	1.88	1.74	0.14	0.12	0.04
1	4	1.83	1.74	0.09	0.12	0.02
13	5	1.80	1.74	0.06	0.12	0.01
5	6	2.17	1.74	0.43	0.12	0.37
9	7	1.46	1.74	-0.29	0.12	0.16
3	8	1.61	1.74	-0.13	0.12	0.03
6	9	1.94	1.75	0.19	0.12	0.08
4	10	1.78	1.75	0.03	0.12	0.00
8	11	1.83	1.75	0.08	0.12	0.01
10	12	1.54	1.75	-0.21	0.12	0.10
2	13	1.83	1.75	0.08	0.12	0.01
14	14	1.79	1.75	0.04	0.12	0.00
12	15	1.50	1.75	-0.25	0.12	0.13
16	16	1.81	1.75	0.06	0.12	0.01

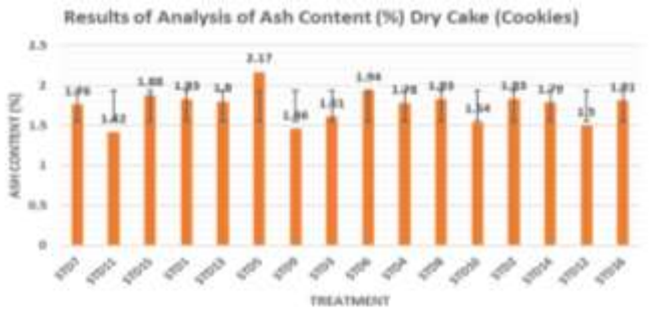

Figure 7. Bar diagram of ash content analysis results from 16 experimental units

Substituting 250 grams to 350 grams of wheat flour with 150 grams to 250 grams of millet flour and 1 gram to 100 grams of sucrose sugar will producean ash content of 1.75% cookies as shown Figure 8.

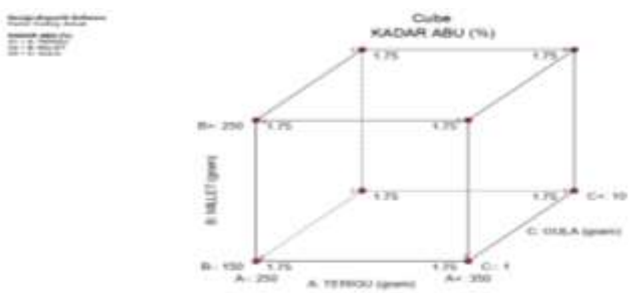

Figure 8. Relationship between factors using wheat flour, millet flour, and sucrose sugar in a cubic diagram on ash content parameter

Organoleptic Test Results for Cookies

The organoleptic test results for flavor of cookies from 16 (sixteen) experimental units showed a mean of 4.08 and a standard deviation of 0.1264, with a minimum value of 3.95 and a maximum value of 4.40. The organoleptic test findings for the color of cookies from 16 (sixteen) experimental units showed a mean of 4.02 and a standard deviation of 0.0812, with a minimum value of 3.88 and a maximum value of 4.20. The organoleptic test results for the aroma of cookies from 16 (sixteen) experimental units showed a mean of 3.53 and a standard deviation of 0.2473, with a minimum value of 3.00 and a maximum value of 3.88. The physical characteristics and acceptability of pita bread were not significantly harmed by substituting 15% of barley, rye, millet, or sorghum whole grain for wheat flour.(Ragaee & Abdel-Aal, 2006). The study's findings demonstrated that dietary fiber and 25% steamed millet flour had a significant impact on the dough's tensile and farinographic characteristics. The hardness, flexibility, and sensory acceptance of steamed bread all diminish as the amount of flour in the recipe increases (Li et al., 2020). The results showed that, in terms of texture, aftertaste, and general acceptance, the 55% foxtail millet, and 45% wheat flour sample was highly acclaimed as the best combination (Sambavi et al., 2015).

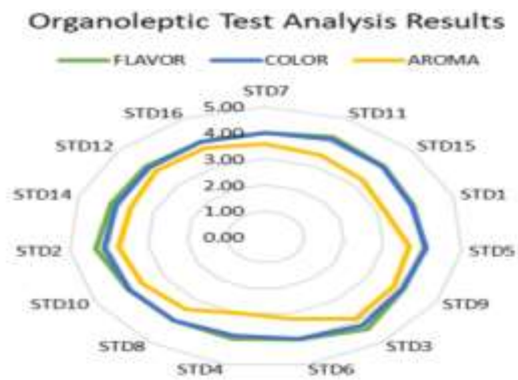

Figure 9. Radar diagram of organoleptic test analysis results

Table 6. Organoleptic Test Analysis Results

Run Order	Standard Order (STD)	Actual Flavor Value	Flavor Predicted Value(1)	Actual Color Value	Color Predicted Value(1)	Actual Aroma Value	Aroma Predicted Value(1)
1	7	4.01	4.09	4.00	4.04	3.56	3.54
2	11	4.20	4.09	4.12	4.04	3.44	3.54
3	15	4.05	4.09	4.01	4.04	3.30	3.54
4	1	3.95	4.09	3.90	4.04	3.20	3.54
5	13	4.00	4.09	4.00	4.04	3.55	3.54
6	5	4.08	4.09	4.11	4.04	3.66	3.54
7	9	4.04	4.09	4.00	4.04	3.77	3.54
8	3	4.40	4.09	4.20	4.04	3.88	3.54
9	6	4.03	4.07	4.01	4.00	3.22	3.52
10	4	3.99	4.07	3.88	4.00	3.00	3.52
11	8	3.97	4.07	3.98	4.00	3.45	3.52
12	10	4.04	4.07	4.01	4.00	3.60	3.52
13	2	4.33	4.07	4.12	4.00	3.75	3.52
14	14	4.12	4.07	4.00	4.00	3.61	3.52
15	12	4.07	4.07	3.99	4.00	3.77	3.52
16	16	4.02	4.07	4.02	4.00	3.75	3.52

Results of the Optimization Process

The process of designing and creating an ideal cookie production method is known as process optimization. Table 7 displays the ingredient composition of wheat flour, millet flour, and sucrose sugar, which affects various aspects of cookie quality and outcome. With a neutral panelist acceptability level (scale 3), the ultimate objective of this optimization procedure is crude protein content ranging from 7.2% to 9.4%, crude fat content ranging from 20.29% to 31.00%, crude fiber content ranging from 1.18% to 2.29%, and ash content ranging from 1.42% to 2.17%. The dietary potential of biscuits was enhanced with fiber by the addition of carrot pomace and finger millet flour. Using the response surface approach, their combined effect on physiochemical attributes was optimized (Nasir et al., 2020). The nutritional and anti-nutritional components of finger millet, sorghum, and pearl millet varied significantly when the optimization process parameters were applied. Anti-nutrients, such as tannin and phytic acid, reduced maximally while quantities of protein and fiber increased dramatically(Singh et al., 2017). The goal of the study's findings was to make instant kheer mix production more efficient by using pearl millet rather than rice. Using the three-factor Central Composite Rotatable Design, the responses to powdered sugar, pearl millet, and dairy whitener were investigated (Bunkar et al., 2014).

Table 7. Focus Variables that Affect How Cookies Are Optimized for Production

Name	Goal	Lower Limit	Upper Limit	Lower Weight	Upper Weight	Importance
A: wheat	is equal to 300	250	350	1	1	3
B: Millet	is equal to 200	150	250	1	1	3
C: Sugar	is equal to 50.5	1	100	1	1	3
Ash Content	none	1.42	2.17	1	1	3
Crude Protein	none	7.20	9.40	1	1	3
Crude Fat	none	20.29	31	1	1	3
Crude Fiber	none	1.18	2.29	1	1	3
Flavor	none	3.95	4.40	1	1	3
Color	none	3.88	4.20	1	1	3
Aroma	none	3	3.88	1	1	3

Achieving the optimal result for crude protein content (8.282%), ash content (1.747%), crude fat content (24.422%), crude fiber content (1.766%), and the panelists' preferred level involves optimizing the method of producing cookies using 250 grams of wheat flour, 250 grams of millet flour, and 1 gram of sucrose sugar. suit your preferred aroma, color, and flavor. The process optimization's outcomes are displayed in Table 8 below. There are nine choices for optimization. Because option number eight uses the most millet flour, it is the most suitable option.

Table 8. Results of Optimizing the Cookie-Making Process

Flour	Millet	Sucrose Sugar	Ash Content	Crude Protein	Crude Fat	Crude Fiber	Flavor	Color	Aroma
350	150	100	1.74	8.29	24.42	1.77	4.08	4.02	3.53
350	250	100	1.74	8.29	24.42	1.77	4.08	4.02	3.53
250	150	100	1.74	8.29	24.42	1.77	4.08	4.02	3.53
350	150	1	1.74	8.29	24.42	1.77	4.08	4.02	3.53
350	250	1	1.74	8.29	24.42	1.77	4.08	4.02	3.53
250	150	1	1.74	8.29	24.42	1.77	4.08	4.02	3.53
250	250	100	1.74	8.29	24.42	1.77	4.08	4.02	3.53
250	250	1	1.74	8.29	24.42	1.77	4.08	4.02	3.53
300	200	50.50	1.74	8.29	24.42	1.77	4.08	4.02	3.53

Conclusion

The following conclusions can be drawn from this research: There are nine possibilities for improving the cookie-making process when millet flour is used in place of wheat flour. Option number 8 should be selected if the amount of wheat flour substituted with millet flour is the primary deciding factor.

Acknowledgments

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Author Contributions

Conceptualization; M., T. R., E. N., G. R.; methodology; M; validation; T. R formal analysis.; E. N. investigation.; G. R. resources; M.data curation: writing—original; T. R., draft preparation; E. N., writing—review and editing; G. R.

Visualization; M. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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