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The Effect Of Breadfruit Flour Substitution On The Quality Of Marble Cake: Family Welfare Education

Kamila Raufa[1a]*, Yolanda Intan Sari[2b], Anni Faridah[3b], Ezi Anggraini [4c]
[1,2,3,4] Universitas Negeri Padang, Indonesia

[a]kamilaraufa02@gmail.com, [b]yolandaintansari@fpp.unp.ac.id, [c]faridah.anni@fpp.unp.ac.id, [d]ezia321214@fpp.unp.ac.id

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***Correspondence Address:**
kamilaraufa02@gmail.com

Abstract:
The use of local food resources as an alternative to wheat flour represents an effort to promote food diversification. Breadfruit (*Artocarpus altilis*) is a local food commodity that can be processed into flour and utilized as a partial substitute for wheat flour in pastry products, including marble cake. This study was conducted to determine the effect of breadfruit flour substitution at levels of 0%, 15%, 30%, and 45% on the sensory quality of marble cake, covering shape, color, aroma, texture, and taste. The research was carried out at the Culinary Workshop of Universitas Negeri Padang using a quantitative approach and a true experimental design with a Completely Randomized Design (CRD), comprising four treatments and three replications. Data were collected through organoleptic testing involving five trained panelists and analyzed using analysis of variance (ANOVA) at a 5% significance level. The findings indicated that breadfruit flour substitution at 0%, 15%, 30%, and 45% did not produce a significant effect on the shape, color, aroma, texture, or taste of the marble cake, as the calculated F-values for all observed attributes were below the critical F-value of 3.49. These findings indicate that breadfruit flour can be utilized as a partial substitute for wheat flour at levels of up to 45% in marble cake production without resulting in statistically significant changes in sensory quality.

Introduction (مقدمة)

Marble *cake* is a type of *cake* characterized by a distinctive combination of two different batter colors that form a marble-like pattern inside the product. This product is widely appreciated for its soft texture, sweet taste, distinctive aroma, and attractive appearance. The quality of marble *cake* is generally determined by several characteristics, including shape, color, aroma, texture, and taste. These characteristics can be influenced by the type and composition of raw materials used during the production process. Therefore, selecting appropriate raw materials is an important factor in producing high-quality marble *cake* that is acceptable to consumers (Bestari et al., 2024).

Marble *cake* is generally made using with wheat flour serving as the primary ingredient of wheat flour is based on its gluten content, which plays an important role in forming the batter structure, resulting in a soft *cake* texture and good volume expansion. Gluten is capable of forming an elastic network that functions to retain gas during the mixing and baking processes, resulting in a product with uniform pores and a stable structure. However, Indonesia's demand for wheat flour remains dependent on imported wheat because domestic wheat production is not yet able to meet national demand. Such dependence may lead to various problems, particularly in the event of rising prices or disruptions in the global wheat supply. Therefore, efforts are needed to utilize local food ingredients as alternative substitutes for wheat flour to support food diversification and national food security (Hendrawan, 2024).

One local food ingredient with has the potential to become developed as an alternative to wheat flour is breadfruit (*Artocarpus altilis*). Breadfruit is a tropical plant that can grow well in various regions of Indonesia and has relatively high productivity (Marta et al., 2026). The availability of breadfruit in local communities is also relatively abundant, and it can be easily found both in home gardens and traditional markets. Based on data from Statistics Indonesia (BPS), national breadfruit production reached 190,551 tons in 2020, indicating that this commodity has considerable potential as a local food source. Breadfruit production is distributed across almost all regions of Indonesia, with the largest contributions coming from Central Java, at 44,258 tons**;** West Java, at 24,251 tons; Special Region of Yogyakarta, at 23,357 tons; Banten, at 20,284 tons**;** East Java, at 19,070 tons; and South Sulawesi, at 11,593 tons. In addition, several other provinces, including Lampung (6,572 tons), Riau (4,891 tons), Southeast Sulawesi (3,920 tons), Riau Islands (2,919 tons), West Sumatra (2,681 tons), and East Nusa Tenggara (2,653 tons), also contribute to national production. Nevertheless, the utilization of breadfruit as a raw material for processed food products remains suboptimal. With the changing times, younger generations' knowledge and awareness of the existence and potential of breadfruit as a local food source tend to decline. In fact, breadfruit is relatively affordable and has fairly stable availability in the market, making it a potentially economical alternative food ingredient (Marta et al., 2026).

To date, the utilization of breadfruit has generally been limited to simple processing methods, such as frying, boiling, and steaming. Meanwhile, breadfruit is known to contain relatively high levels of carbohydrates as a source of energy, as well as dietary fiber, vitamins, and minerals that provide health benefits (Marta et al., 2026). Breadfruit also has low gluten content or is naturally gluten-free. Due to its low gluten content, the partial replacement of wheat flour with breadfruit flour in pastry and bakery products may be suitable for children and individuals with gluten sensitivity or those who are reducing their gluten intake as part of their daily diet (Aprilia et al., 2021; Chandra et al., 2021). When processed into flour, breadfruit has a longer shelf life, is easier to distribute, and can be utilized as a raw material in various processed food products (Marta et al., 2026).

Various studies have shown that breadfruit flour can be applied to a variety of pastry and bakery products, such as cookies, *nastar*, *cake*, and other processed food products. The use of breadfruit flour in these products has been reported to increase dietary fiber content without

significantly reducing consumer acceptance. In addition, research on breadfruit flour substitution in madeleine *cake* has demonstrated effects on the physical characteristics and sensory quality of the product, particularly in terms of color, aroma, texture, and volume expansion. The results indicate that breadfruit flour has considerable potential for further development in other *cake* products, including marble *cake* (Wardani et al., 2025; Firmansyach et al., 2024).

Despite its various advantages, the use of breadfruit flour in *cake* products also has several limitations. The absence of gluten in breadfruit flour results in a lower capacity for batter structure formation compared with wheat flour. This condition may affect the volume expansion, texture, and sensory characteristics of the resulting product. In addition, the relatively darker color of breadfruit flour and its distinctive aroma may potentially affect consumer acceptance of the final product. Therefore, an appropriate substitution level needs to be determined to ensure that the use of breadfruit flour can still produce a product with optimal quality and acceptable consumer characteristics (Wardani et al., 2025).

Previous studies on the utilization of local flour as an alternative to wheat flour in marble *cake* products have examined different flour sources, one of which is sorghum flour. The results showed that the use of local flour affected both the physical and sensory quality of marble *cake*. Therefore, an appropriate formulation is needed to produce a product with good quality that remains acceptable to consumers. However, research specifically The utilization of breadfruit flour as a substitute in marble *cake* production has received limited research attention. Therefore, further studies are needed to explore its effects on the quality of marble *cake*, including its shape, color, aroma, texture, and taste (Bestari et al., 2024).

The evaluation of marble *cake* formulated with breadfruit flour substitution in this study involved five organoleptic attributes, including shape, color, aroma, texture, and taste. Based on these considerations, the study investigated the effects of different levels of breadfruit flour substitution, namely 0%, 15%, 30%, and 45%**,** on the sensory quality of marble *cake*.

Method (منهج)

Research Method and Design

This study adopted a quantitative approach and employed a true experimental research method. A Completely Randomized Design (CRD) was applied, consisting of four treatment groups with three replications for each treatment. The treatments included 0% breadfruit flour substitution (X0) as the control, followed by 15% (X1), 30% (X2), and 45% (X3) breadfruit flour substitution. The breadfruit flour was prepared by processing fresh breadfruit through drying, milling, and sieving to produce flour with a consistent particle size before incorporation into the marble *cake* formulation. The substitution levels were established at 0%, 15%, 30%, and 45% to evaluate the changes in marble *cake* quality associated with progressively increasing amounts of breadfruit flour, from the control treatment without substitution to the highest substitution level of 45%. This experimental design enabled the assessment of the influence of increasing breadfruit flour proportions on the sensory characteristics of the resulting product.

Research Time and Location

This study was conducted at the Culinary Workshop, Department of Family Welfare, Faculty of Tourism and Hospitality, Padang State University

Materials and Equipment

The equipment used in this study included a digital scale, mixing bowl, hand towel, sieve, measuring spoons, mixer, spatula, baking pan, oven, and plastic container with a bottom diameter of 10 cm, a top diameter of 11 cm, and a height of 7 cm. The materials used in this study

are presented in Table 1 below:

Tabel 1. Ingredients for Marble Cake Substituted with Breadfruit Flour

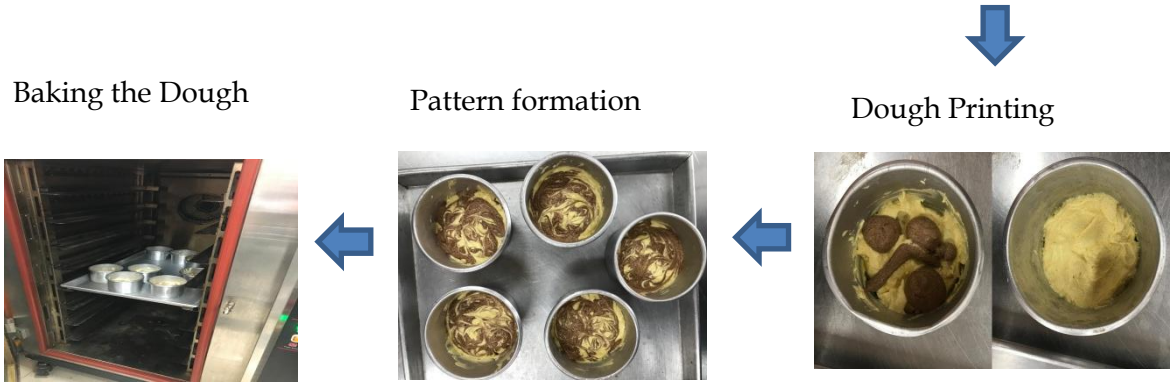
No	Ingredient Name	Research Ingredient Composition			
		0%	15%	30%	45%
1.	Wheat Flour	200 gr	170 gr	140 gr	110 gr
2.	Breadfruit Flour	0 gr	30 gr	60 gr	90 gr
3.	Powdered Sugar	250 gr	250 gr	250 gr	250 gr
4.	Margarine	250 gr	250 gr	250 gr	250 gr
5.	Egg	6 btr	6 btr	6 btr	6 btr
6.	Milk Powder	15 gr	15 gr	15 gr	15 gr
7.	Sweetened Condensed Milk	36 gr	36 gr	36 gr	36 gr
8.	Tbm	½ sdt	½ sdt	½ sdt	½ sdt
9.	Baking powder	½ sdt	½ sdt	½ sdt	½ sdt
10.	Chocolate Food Coloring	2 sdm	2 sdm	2 sdm	2 sdm

Research Procedure

The research procedure consisted of three main stages. The first stage was preparation, which involved preparing and weighing all ingredients according to the formulation specified for each treatment. The second stage was processing, beginning with the preparation of breadfruit flour. The breadfruit was peeled, cored, and thoroughly washed before being thinly sliced and soaked in clean water. The slices were then dried using a food dehydrator, followed by blending and sieving to produce fine breadfruit flour. The preparation of the marble *cake* was subsequently carried out by mixing margarine, TBM (cake emulsifier), and powdered sugar until the mixture became pale and fluffy. Eggs were gradually incorporated and mixed until evenly combined. Wheat flour, breadfruit flour, milk powder, and baking powder were then sifted and added to the mixture until a homogeneous batter was obtained. Sweetened condensed milk was added at the final mixing stage. Approximately one-third of the batter was separated and combined with chocolate food coloring. The plain and chocolate batters were then poured alternately into a baking pan previously greased with margarine. A marble pattern was formed by moving a toothpick in circular motions at several points on the batter. The batter was subsequently baked at 175°C for 25 minutes. The third stage involved sensory evaluation, in which all marble *cake* samples were assessed organoleptically by the panelists. The complete research procedure is illustrated in Figure 1 below.

Marble Cake Making Process

Praparation Mixing Ingredients Gradually Dough Distribution



Data Analysis Techniques

The data for this study were collected through an organoleptic evaluation involving five trained panelists from the Bachelor's and Diploma programs in Culinary Arts. Each sample was assigned a random code and presented to the panelists, who independently assessed the samples using the prepared evaluation instrument.

The results of the organoleptic assessment were subsequently tabulated and statistically analyzed using Analysis of Variance (ANOVA) to determine whether breadfruit flour substitution affected the quality of marble *cake*. When the analysis indicated that **Fcount > Ftable**, the statistical analysis was followed by Duncan's Multiple Range Test (DMRT) to determine which treatment groups differed significantly from one another.

Result (نتائج)

This study evaluated the sensory quality of marble cake with the addition of breadfruit flour through an organoleptic test, which included shape, color, aroma, texture, and taste.

Ranking Test

The following presents the results of the final data tabulation from the ranking test of marble cake with breadfruit flour substitution, covering the quality attributes of shape, color, aroma, texture, and taste.

1. **Quality of form**

   The shape quality of marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The shape quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on the degree of conformity of the resulting marble cake shape. The mean scores for shape quality for each treatment are presented in a line graph, as shown in the following figure.

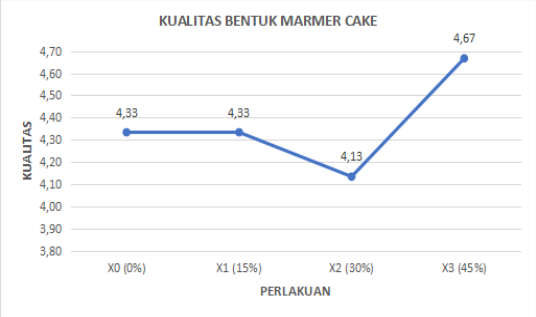


Figure 1. Line Graph of Shape Quality

Figure 1 presents the results of the organoleptic test on the shape quality of marble cake, showing that the mean scores for treatments X0 (0%) and X1 (15%) were both 4.33, while X2 (30%) obtained a mean score of 4.13 and X3 (45%) obtained a mean score of 4.67. The highest mean score was obtained by treatment X3 with 45% breadfruit flour substitution, while the lowest mean score was obtained by treatment X2 with 30% substitution. These data indicate that, descriptively, the shape of the marble cake in treatment X3 received the highest evaluation from the panelists. To determine whether the differences in the mean shape quality scores among treatments were statistically significant, an Analysis of Variance (ANOVA) was conducted. The results of the ANOVA calculation for the shape quality of marble cake are presented in the following table.

Table 2. Analysis of Variance of Shape Quality

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	0,73	0,24	0,78	3,49
Panelis	4,00	8,59	2,15	6,84	3,26
Galat/sisa	12,00	3,77	0,31		
Total	19,00	13,09			

The results of the analysis of variance showed an Fvalue of 0.78 and an Ftable value of 3.49 at the 5% significance level. Since Fvalue ≤ Ftable value, No significant differences were observed among the treatments involving 0%, 15%, 30%, and 45% substitution of breadfruit flour with respect to the shape quality of the marble cake. Therefore, increasing the percentage of breadfruit flour substitution in this study did id not significantly affect the shape of the marble cake.

Based on the results of the study, substitution of breadfruit flour at levels of 0%, 15%, 30%, and 45% did not have a significant effect on the shape quality of the marble cake. The mean shape scores ranged from 4.13 to 4.67. Treatment X3, with 45% substitution, obtained the highest mean score, while X2 obtained the lowest mean score.

The lack of a significant effect suggests that breadfruit flour substitution at levels of up to 45% does not compromise the shape of the marble *cake*. The uniformity of the processing procedures, the use of an identical baking pan, and the controlled baking temperature and duration may have contributed to the consistency of product shape across the different treatments.

These findings suggest that breadfruit flour can serve as an alternative to wheat flour in marble *cake* production without substantially altering its shape. In terms of shape quality, breadfruit flour substitution of up to 45% was able to produce marble *cake* products that remained acceptable to the panelists.

2. Color Quality

a. Brown Color in the Middle Inner Part of the Marble Cake

The brown color quality of marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The brown color quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on the degree of conformity of the resulting brown color. The mean scores for color quality for each treatment are presented in a line graph, as shown in the following figure.

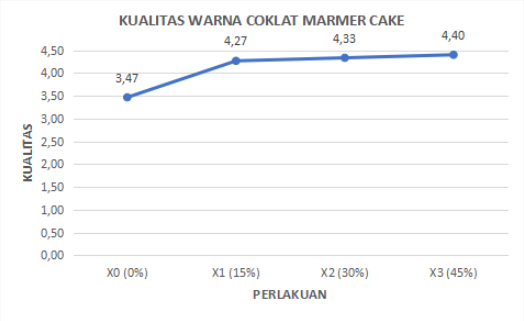


Figure 2. Line Graph of Brown Color Quality in the Inner Part

Figure 2 presents the results of the panelists' assessment of the brown color, showing that the mean scores for 0% (X0), 15% (X1), 30% (X2), and 45% (X3) were 3.47, 4.27, 4.33, and 4.40, respectively. The highest mean score was obtained by treatment X3 with 45% breadfruit flour substitution, while the lowest mean score was obtained by treatment X0 as the control. Based on these values, descriptively, the panelists' preference for the brown color tended to increase as the level of breadfruit flour substitution increased. To determine whether the differences in the mean color quality scores among treatments were statistically significant, an Analysis of Variance (ANOVA) was conducted. The results of the ANOVA calculation for the brown color quality of marble cake are presented in the following table.

Table 3. Analysis of Variance of Brown Color Quality in the Inner Part

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	2,86	0,95	2,10	3,49
Panelis	4,00	11,53	2,88	6,36	3,26
Galat/sisa	12,00	5,44	0,45		
Total	19,00	19,84			

The analysis of variance revealed an F-value of 2.10, which was below the F-table value of 3.49. Thus, breadfruit flour substitution did not significantly influence the brown color of the marble *cake* at the 5% significance level. Descriptively, the mean score for brown color showed an increasing trend from treatment X0 to X3; however, the observed differences were not large enough to reach statistical significance. These findings suggest that incorporating breadfruit flour at substitution levels of up to 45% could still produce a brown color that was considered acceptable by the panelists.

The descriptive increase in the mean brown color score can be associated with the color characteristics of the ingredients used and the browning reactions that occur during the baking process. The color of the cake is determined not only by the

substitution ingredient but is also influenced by baking temperature, baking time, sugar content, protein content, and other components that undergo reactions during heating.

b. Yellow Color Quality in the Inner Part of the Marble Cake

The quality of the yellow color of the marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The yellow color quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on the degree of conformity of the yellow color of the resulting marble cake. The mean scores for color quality for each treatment are presented in the form of a line graph, as shown in the following figure.

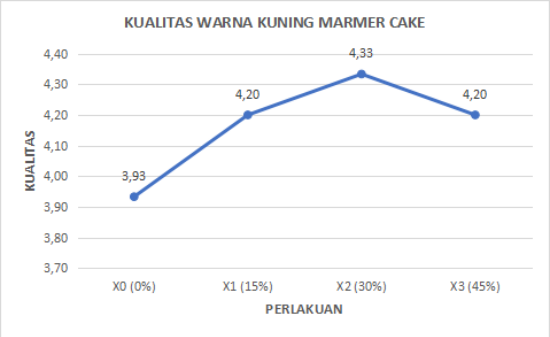


Figure 3. Line Graph of Yellow Color Quality in the Inner Part

Figure 3 shows the results of the yellow color assessment, with mean scores of 3.93 for 0% (X0), 4.20 for 15% (X1), 4.33 for 30% (X2), and 4.20 for 45% (X3). The highest mean score was obtained by treatment X2 at 30%, while the lowest mean score was obtained by treatment X0 at 0%. To determine whether the differences in the mean color quality scores among treatments were statistically significant, an analysis of variance (ANOVA) was conducted. The results of the ANOVA calculation for the color quality of the marble cake are presented in the following table.

Table 4. Analysis of Variance of Yellow Color Quality in the Inner Part

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	0,42	0,14	0,28	3,49
Panelis	4,00	9,78	2,44	4,78	3,26
Galat/sisa	12,00	6,13	0,51		
Total	19,00	16,33			

Based on the results of the analysis of variance, an Fvalue of 0.28 and an Ftable value of 3.49 were obtained. Since the Fvalue ≤ Ftable value, breadfruit flour substitution did not have a significant effect on the yellow color of the marble cake. Descriptively, increasing the level of breadfruit flour substitution from 0% to 30% tended to increase the mean yellow color score. However, at 45% substitution, there was a slight decrease in the mean score. This condition indicates that changes in the percentage of breadfruit flour may cause changes in color characteristics, but these changes remained within an acceptable level and did not result in a significant difference according to the statistical analysis. The yellow color of the marble cake was also influenced by other ingredients used in the formulation, particularly eggs, margarine, and the baking process. Since all treatments used the same basic ingredients and processing procedures, the differences in color resulting from breadfruit flour substitution were relatively small.

3. Aroma Quality

a. Fragrant Aroma

The fragrant aroma quality of the marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The fragrant aroma quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on the degree of conformity of the fragrant aroma of the resulting marble cake. The mean scores for aroma quality for each treatment are presented in the form of a line graph, as shown in the following figure.

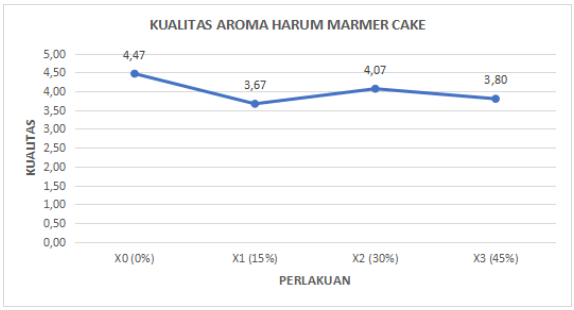


Figure 4. Line Graph of Fragrant Aroma Quality

Figure 4 shows the results of the panelists' assessment of the fragrant aroma, with mean scores of 4.47 for 0% (X0), 3.67 for 15% (X1), 4.07 for 30% (X2), and 3.80 for 45% (X3). The highest mean score was obtained by the control treatment X0, while the lowest mean score was obtained by X1 with 15% substitution. To determine whether the differences in the mean aroma quality scores among treatments were statistically significant, an analysis of variance (ANOVA) was conducted. The results of the ANOVA calculation for the fragrant aroma quality of the marble cake are presented in the following table.

Table 5. Analysis of Variance of Fragrant Aroma Quality

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	1,87	0,62	1,42	3,49
Panelis	4,00	19,56	4,89	11,19	3,26
Galat/sisa	12,00	5,24	0,44		
Total	19,00	26,67			

The results of the analysis of variance showed an F-value of 1.42 and an F-table value of 3.49. Since the F-value ≤ F-table value, breadfruit flour substitution did not have a significant effect on the fragrant aroma of the marble cake.The decrease in the mean fragrant aroma scores in treatments using breadfruit flour was presumed to be associated with the emergence of the characteristic aroma of breadfruit flour, which may have influenced the overall aroma of the product. However, the aroma of the marble cake was also derived from other ingredients, such as margarine, eggs, milk, and the flavoring agents used in the formulation. Therefore, the resulting aroma was a combination of the aromas of all ingredients used.

The absence of a significant effect indicates that the differences in fragrant aroma perceived by the panelists were not sufficiently large to statistically distinguish the four treatments. Thus, breadfruit flour substitution of up to 45% was still able to produce a marble cake aroma that was acceptable to the panelists.

b. Breadfruit Aroma

The breadfruit aroma quality of the marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The breadfruit aroma quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on the degree of conformity of the breadfruit aroma of the resulting marble cake. The mean scores for breadfruit aroma quality for each treatment are presented in the form of a line graph, as shown in the following figure.

Figure 5. Line Graph of Breadfruit Aroma Quality

Figure 5 shows the results of the breadfruit aroma assessment, indicating an increase in the mean scores as the percentage of breadfruit flour substitution increased. The mean scores were 2.20 for 0% (X0), 2.47 for 15% (X1), 3.33 for 30% (X2), and 3.87 for 45% (X3). The highest mean score was obtained by treatment X3 at 45%, while the lowest mean score was obtained by the control treatment X0. To determine whether the differences in the mean breadfruit aroma quality scores among treatments were statistically significant, an analysis of variance (ANOVA) was conducted. The results of the ANOVA calculation for the breadfruit aroma quality of the marble cake are presented in the following table.

Table 6. Analysis of Variance of Breadfruit Aroma Quality

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	8,91	2,97	1,39	3,49
Panelis	4,00	32,03	8,01	3,74	3,26
Galat/sisa	12,00	25,70	2,14		
Total	19,00	66,64			

The results of the analysis of variance showed an Fvalue of 1.39, while the Ftable value was 3.49. Since the Fvalue ≤ Ftable value, breadfruit flour substitution did not have a significant effect on the breadfruit aroma of the marble cake. Although the difference was not statistically significant, descriptively, there was a tendency for the panelists' assessment of breadfruit aroma to increase as the percentage of breadfruit flour increased. This is a logical condition because increasing the amount of breadfruit flour in the formulation resulted in a greater proportion of the ingredient with the characteristic aroma of breadfruit.

Treatment X3, with 45% substitution, had the highest mean score for breadfruit aroma. This indicates that at higher substitution levels, the characteristic aroma of breadfruit was more easily recognized by the panelists. Thus, the use of breadfruit flour

not only served as a substitute ingredient but also contributed a distinctive characteristic to the marble cake product.

4. Texture Quality

a. Soft Texture in the Inner Part

The texture quality of the marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The texture quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on the degree of conformity of the texture of the resulting marble cake. The mean scores for texture quality for each treatment are presented in the form of a line graph, as shown in the following figure.

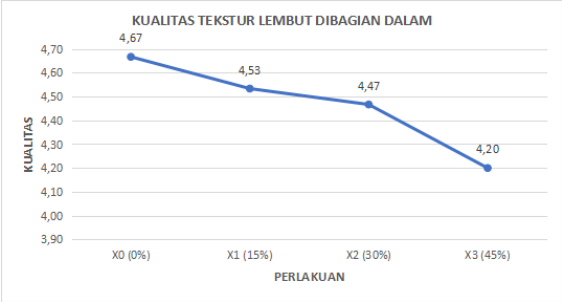


Figure 6. Line Graph of Soft Texture Quality

Figure 6 shows that the mean scores for the inner soft texture of the marble cake were 4.67 at 0% (X0), 4.53 at 15% (X1), 4.47 at 30% (X2), and 4.20 at 45% (X3). The highest mean score was obtained by treatment X0, while the lowest mean score was obtained by treatment X3. To determine whether the differences in the mean texture quality scores among treatments were statistically significant, an analysis of variance (ANOVA) was conducted. The results of the ANOVA calculation for the texture quality of the marble cake are presented in the following table.

Table 7. Analysis of Variance of Soft Texture Quality

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	0,58	0,19	2,85	3,49
Panelis	4,00	10,70	2,68	39,58	3,26
Galat/sisa	12,00	0,81	0,07		
Total	19,00	12,09			

The results of the analysis of variance showed an F-value of 2.85 and an F-table value of 3.49. Since the F-value ≤ F-table value, breadfruit flour substitution did not have a significant effect on the softness of the inner part of the marble cake. Descriptively, there was a tendency for the softness score to decrease as the percentage of breadfruit flour substitution increased. This condition may be associated with differences in the characteristics of breadfruit flour and wheat flour. Wheat flour contains gluten-forming proteins that play a role in the formation of the dough structure, whereas breadfruit flour has different characteristics, so increasing its use may affect the structure and texture of the product.

However, this decrease did not result in a statistically significant difference. This indicates that, at the substitution percentages used in this study, the changes in texture

were relatively small, so the panelists did not provide significantly different assessments.

b. Texture Quality: Pores of the Marble Cake

The texture quality of the marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The texture quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on the degree of conformity of the texture of the resulting marble cake. The mean scores for texture quality for each treatment are presented in the form of a line graph, as shown in the following figure.

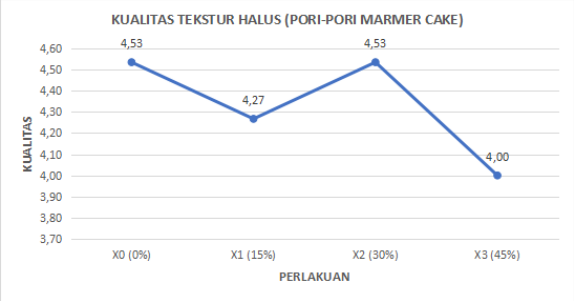


Figure 7. Line Graph of Pore Quality

Figure 7 shows the results of the fine texture assessment, with mean scores of 4.53 for 0% (X0), 4.27 for 15% (X1), 4.53 for 30% (X2), and 4.00 for 45% (X3). The highest mean scores were obtained by X0 and X2, while the lowest mean score was obtained by X3. To determine whether the differences in the mean texture quality scores among treatments were statistically significant, an analysis of variance (ANOVA) was conducted. The results of the ANOVA calculation for the texture quality of the marble cake are presented in the following table.

Table 8. Analysis of Variance of Pore Quality

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	0,98	0,33	2,39	3,49
Panelis	4,00	4,06	1,01	7,45	3,26
Galat/sisa	12,00	1,63	0,14		
Total	19,00	6,67			

The results of the analysis of variance showed an Fvalue of 2.39 and an Ftable value of 3.49. Since the Fvalue ≤ Ftable value, breadfruit flour substitution did not have a significant effect on the fine texture or pores of the marble cake. Descriptively, the mean score for X3 decreased compared with the other treatments. This was presumed to be due to the increased use of breadfruit flour, which may affect the characteristics of the batter and pore formation during baking. Breadfruit flour has a different composition and physical properties from wheat flour; therefore, increasing the proportion of breadfruit flour may cause changes in the crumb structure and pores of the product.

Nevertheless, the ANOVA results showed that these changes were not statistically significant. This means that the differences in the levels of breadfruit flour substitution used in this study did not result in sufficiently large changes in the fineness of the pores of the marble cake.

c. Crumb Texture of the Marble Cake

The crumb texture quality of the marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The crumb texture quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on the degree of conformity of the crumb texture of the resulting marble cake. The mean scores for the texture quality of each treatment are presented in the form of a line graph, as shown in the following figure.

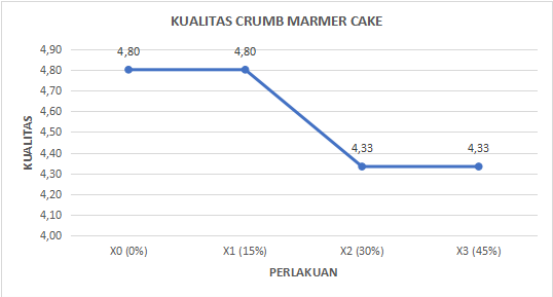


Figure 8. Line Graph of Crumb Texture Quality

Figure 8 shows the results of the assessment of crumb texture, with mean scores of 4.80 for X0, 4.80 for X1, 4.33 for X2, and 4.33 for X3. The highest mean scores were obtained by X0 and X1, while the lowest mean scores were obtained by X2 and X3. To determine whether the differences in the mean texture quality scores among the treatments were statistically significant, an analysis of variance (ANOVA) was conducted. The results of the ANOVA calculation for the crumb texture quality of the marble cake are presented in the following table.

Table 9. Analysis of Variance of Crumb Texture Quality

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	1,09	0,36	1,47	3,49
Panelis	4,00	8,63	2,16	8,73	3,26
Galat/sisa	12,00	2,97	0,25		
Total	19,00	12,69			

The results of the analysis of variance showed an F-value of 1.47 and an F-table value of 3.49. Therefore, since the F-value ≤ F-table value, breadfruit flour substitution did not have a significant effect on the crumb texture of the marble cake. The decrease in the mean scores for X2 and X3 indicates that the use of higher levels of breadfruit flour tended to affect the characteristics of the crumb. This may be attributed to differences in the properties of breadfruit flour and wheat flour, particularly in terms of structural formation and the ability to retain moisture in the product.

However, these differences did not show a statistically significant effect. Thus, breadfruit flour substitution of up to 45% still produced crumb texture that was acceptable to the panelists.

5. Taste Quality

a. Sweetness

The sweetness quality of the marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The sweetness quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on

the degree of conformity of the sweetness of the resulting marble cake. The mean scores for the sweetness quality of each treatment are presented in the form of a line graph, as shown in the following figure.

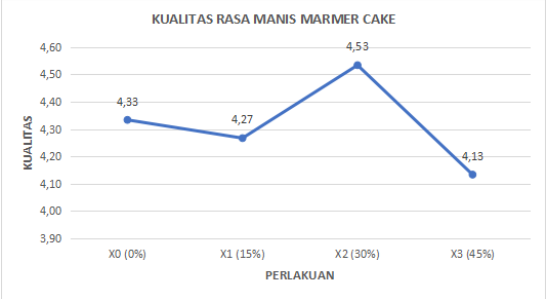


Figure 9. Line Graph of Sweetness Quality

Figure 9 shows the results of the sweetness assessment, with mean scores of 4.33 for X0, 4.27 for X1, 4.53 for X2, and 4.13 for X3. The highest mean score was obtained by treatment X2 at 30%, while the lowest mean score was obtained by treatment X3 at 45%. To determine whether the differences in the mean sweetness quality scores among the treatments were statistically significant, an analysis of variance (ANOVA) was conducted. The results of the ANOVA calculation for the sweetness quality of the marble cake are presented in the following table.

Table 10. Analysis of Variance of Sweetness Quality

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	0,42	0,14	3,33	3,49
Panelis	4,00	12,52	3,13	75,13	3,26
Galat/sisa	12,00	0,50	0,04		
Total	19,00	13,44			

The results of the analysis of variance showed an Fvalue of 3.33 and an Ftable value of 3.49. Since the Fvalue ≤ Ftable value, breadfruit flour substitution did not have a significant effect on the sweetness of the marble cake at the 5% significance level. The F-value for the sweetness indicator was the closest to the F-table value compared with several other indicators. This indicates that, statistically, there was a tendency for differences in sweetness assessments among the treatments; however, these differences did not reach the established level of significance.

Differences in the mean sweetness scores may have been influenced by the composition of the ingredients used in the marble cake, particularly sugar and other ingredients. Breadfruit flour substitution may alter the proportion of wheat flour in the formulation, but it does not directly change the amount of sugar used. Therefore, the changes in sweetness were relatively small.

b. Breadfruit Taste

The breadfruit taste quality of the marble cake was evaluated at four treatment levels, namely X0 (0%), X1 (15%), X2 (30%), and X3 (45%). The breadfruit taste quality of the marble cake was assessed through an organoleptic test (ranking test) by the panelists based on the degree of conformity of the breadfruit taste of the resulting marble cake. The mean scores for the breadfruit taste quality of each treatment are presented in the form of a line graph, as shown in the following figure.

Figure 10. Line Graph of Breadfruit Taste Quality

Figure 10 shows the results of the breadfruit taste assessment, with mean scores of 2.47 for X0, 2.47 for X1, 3.47 for X2, and 4.33 for X3. The highest mean score was obtained by treatment X3 with 45% breadfruit flour substitution, while the lowest mean scores were obtained by X0 and X1. To determine whether the differences in the mean breadfruit taste quality scores among the treatments were statistically significant, an analysis of variance (ANOVA) was conducted. The results of the ANOVA calculation for the breadfruit taste quality of the marble cake are presented in the following table.

Table 11. Analysis of Variance of Breadfruit Taste Quality

SK	DB	JK	KT	Fhitung	Ftabel
					0,05
Sampel	3,00	12,15	4,05	1,71	3,49
Panelis	4,00	28,02	7,01	2,96	3,26
Galat/sisa	12,00	28,38	2,36		
Total	19,00	68,55			

The analysis of variance produced an F-value of 1.71, compared with an F-table value of 3.49. As the calculated F-value was lower than the F-table value, the substitution of breadfruit flour did not result in a significant effect on the breadfruit taste of the marble *cake*. Nevertheless, the descriptive results showed an increasing trend in the intensity of breadfruit taste as the proportion of breadfruit flour increased. This tendency may be attributed to the greater amount of breadfruit-derived components present in the formulation, which consequently enhanced the characteristic taste of breadfruit in the resulting product.

Treatment X3 obtained the highest mean score, namely 4.33, indicating that the breadfruit taste was more recognizable when 45% breadfruit flour was used. This finding indicates that breadfruit flour substitution can contribute a characteristic breadfruit taste to the marble cake, although based on the statistical analysis, the difference was not significant.

Conclusion And Advice (خاتمة)

Based on the results of the study on the effect of breadfruit flour substitution on the quality of marble cake, it can be concluded that the use of breadfruit flour at substitution levels of 0%, 15%, 30%, and 45% did not show a significant effect on the shape, color, aroma, texture, and taste of marble cake at the 5% significance level. This was evidenced by the calculated F-values for all evaluated attributes being lower than the critical F-value of 3.49. Although no statistically significant differences were observed, several product characteristics showed descriptive changes, particularly an increase in the characteristic breadfruit aroma as the substitution level increased, as well as changes in some texture characteristics. Therefore, the use of breadfruit flour

at a substitution level of up to 45% can still be applied in the production of marble cake as an alternative for partially replacing wheat flour without causing significant differences in product quality.

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