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THE EFFECT OF RAJA BULU BANANA FLOUR *(MUSA PARADISIACA L. VAR SAPIENTUM)* SUBSTITUTION ON BAKING LOSS AND SENSORY QUALITY OF DRY CHOUX PASTRY

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Abstract

This study aims to examine the effect of raja bulu banana flour (Musa paradisiaca L. var. sapientum) substitution on baking loss and sensory quality characteristics of dry choux pastry (sus kering). The research employed an experimental approach with a Completely Randomized Design (CRD), encompassing three substitution levels 10% (P1), 15% (P2), and 20% (P3) each replicated three times. Baking loss was analyzed using one-way ANOVA, while sensory quality assessment involved 45 semi-trained panelists using a 5-point hedonic scale instrument, subsequently analyzed using the Kruskal-Wallis test and Tukey's HSD post-hoc test at a significance level of $\alpha = 0.05$. Results indicated that variations in substitution level did not produce significant differences in baking loss values (F calculated 3.36 < F table 5.14), with mean values of 2.10%, 1.96%, and 1.61% for P1, P2, and P3, respectively. From a sensory quality perspective, substitution significantly affected color (H=20.82), cavity/hollow structure (H=19.26), and crispness texture (H=6.39), while aroma (H=3.48), banana flavor (H=4.87), and savory taste (H=0.39) showed no statistically significant differences. The 15% substitution level was identified as the optimal treatment, achieving the best balance between baking loss, textural crispness, cavity formation, and overall sensory acceptance by panelists.

Keywords: Raja Bulu Banana Flour, Dry Choux Pastry, Baking Loss, Sensory Quality, Flour Substitution

INTRODUCTION

Banana is one of the horticultural commodities that plays an important role in supporting national food security. According to the Food and Agriculture Organization (FAO, 2022), global banana production reaches approximately 114 million tons per year, with Indonesia contributing 7.5 million tons, placing the country among the world's leading banana producers. Despite the high production volume, Indonesia's dependence on imported wheat-based flour remains considerable. Data from the Central Bureau of Statistics (BPS, 2022) reveals a significant opportunity to transform locally produced bananas into value-added products, one of which is banana flour as a partial substitute for wheat flour in the food industry.

Dry choux pastry (sus kering) is one of the popular pastry products in Indonesia's modern bakery industry. Originating from the French pâte à choux technique, it produces a hollow-

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structured product with a crispy outer texture. A Nielsen (2022) survey showed that approximately 25% of Indonesia's urban consumers have interest in French-style pastry products, including dry choux pastry. Wheat flour plays a crucial role in its production through gluten content that forms an elastic protein network to support product volume and structure (Wilderjans et al., 2013). However, the dominant use of wheat flour has limitations in terms of dietary fiber content and functional nutritional value.

Raja bulu banana flour (Musa paradisiaca L. var. sapientum) has physicochemical characteristics that are potentially useful as a wheat flour substitute, including high starch content (70–80%), dietary fiber (5–10%), vitamin C (10–20 mg/100 g), and potassium (400–500 mg/100 g) (Wulandari et al., 2021). Research by Kumar et al. (2019) reported that substituting 20–30% banana flour in bread products can increase fiber content by up to 15% while maintaining acceptable sensory quality. The present study aims to analyze the effect of raja bulu banana flour substitution at levels of 10%, 15%, and 20% on baking loss and sensory quality of dry choux pastry, as well as to determine the most optimal substitution level.

IMPLEMENTATION METHOD

The research was conducted at the Pastry and Bakery Laboratory of the Food and Culinary Education Study Program, Faculty of Engineering, Universitas Negeri Jakarta, beginning in May 2026. The research method employed was experimental, using a Completely Randomized Design (CRD) with three substitution level treatments: P1 (10%), P2 (15%), and P3 (20%), each replicated three times.

The basic materials for dry choux pastry included wheat flour (partially substituted with raja bulu banana flour), chicken eggs, butter, water, salt, and baking powder. Raja bulu banana flour was produced through a series of stages: selection of mature-green fruits, peeling, washing, slicing (±2 mm thickness), blanching (80–90°C, 5 minutes), soaking in 0.2% w/v $Na_2S_2O_5$ solution for 5 minutes, final washing, drying, grinding using a food grinder, and sieving through a 100-mesh sieve.

The production of dry choux pastry followed these steps: weighing of ingredients, boiling water and butter, incorporating flour and salt into the boiling liquid until a smooth dough formed, cooling the dough to ±40–50°C, beating eggs and baking powder, mixing all components, piping the dough using a star-shaped nozzle, and baking in two stages (200°C for 15 minutes, followed by 150°C for 10 minutes, rested for 15 minutes at room temperature, then re-baked at 100°C for 5 minutes).

Baking loss testing was performed by measuring the weight difference of the dough before and after baking, expressed as a percentage, and analyzed using one-way ANOVA. Sensory quality evaluation involved 45 semi-trained panelists (students of UNJ's Food and Culinary Education Study Program enrolled in or having completed the Organoleptic Evaluation course), using a 5-point hedonic scale covering color, aroma, banana flavor, savory taste, crispness texture, and hollow cavity structure. Sensory data were analyzed using the Kruskal-Wallis test and Tukey's HSD post-hoc test at $\alpha = 0.05$. Prior to sensory data collection, a validation test was conducted by 5 expert panelists (faculty members of the Food and Culinary Education Study Program).

RESULTS AND DISCUSSION

Baking Loss Test Results

The baking loss test was conducted to determine the percentage of weight loss in dry choux pastry during the baking process. The calculation results are presented in Table 1 below.

Table 1. Baking Loss Test Results of Dry Choux Pastry with Raja Bulu Banana Flour Substitution

Treatment	Replication 1 (%)	Replication 2 (%)	Mean (%)
P1 (10%)	2.05	2.10	2.10
P2 (15%)	1.92	1.95	1.96
P3 (20%)	1.89	1.80	1.61

Source: Research Data, 2026

Based on Table 1, the highest mean baking loss was recorded in P1 (10%) at 2.10%, followed by P2 (15%) at 1.96%, and the lowest in P3 (20%) at 1.61%. These figures indicate a descending trend in baking loss values with increasing substitution levels of raja bulu banana flour. However, statistical analysis using one-way ANOVA showed that the calculated F value (3.36) was smaller than the F table value (5.14) at $\alpha = 0.05$, indicating that raja bulu banana flour substitution did not have a significant effect on baking loss.

The decrease in baking loss values at higher substitution levels is associated with the physicochemical characteristics of raja bulu banana flour, which has relatively high dietary fiber and resistant starch content, enabling better water binding during baking. Furthermore, the reduced proportion of wheat gluten which releases water through protein denaturation during baking results in lower product weight loss at higher substitution rates (Kristianti et al., 2020).

Sensory Quality Test Results

The sensory quality evaluation results of dry choux pastry across all assessed attributes are summarized in Table 2 below.

Table 2. Summary of Sensory Quality Test Results of Dry Choux Pastry

Sensory Attribute	Mean P1 (10%)	Mean P2 (15%)	Mean P3 (20%)	H Value	Result
Color	4.27	3.80	3.13	20.82	Significant Effect
Aroma	4.27	4.00	4.53	3.48	No Significant Effect
Banana Flavor	4.20	4.00	4.60	4.87	No Significant Effect
Savory Taste	4.87	4.80	4.93	0.39	No Significant Effect
Crispness	5.00	5.00	4.60	6.39	Significant Effect
Cavity Structure	4.80	4.93	3.60	19.26	Significant Effect

Source: Research Data, 2026 | χ^2 table (df=2; α=0.05) = 5.99

The color attribute showed significant differences among treatments (H=20.82 > χ^2=5.99). Tukey's HSD test confirmed that all three treatments differed significantly from one another. The increase in raja bulu banana flour substitution percentage was directly proportional to the intensity of the product's browning, with P3 (20%) producing the darkest brown color. This phenomenon is attributed to the natural sugar content of raja bulu banana flour, which participates in Maillard reactions and caramelization during baking (Winarno, 2004). The P1 (10%) treatment produced the best color outcome, falling in the light brown category that most closely matches ideal dry choux pastry characteristics.

The aroma and banana flavor attributes showed no significant differences among treatments. Notably, P3 (20%) produced the strongest banana aroma and flavor intensity, as the higher concentration of volatile compounds particularly esters such as isoamyl acetate naturally present in banana flour more consistently surpassed the sensory detection threshold (Boudhrioua et al., 2003). The savory taste attribute also showed no significant differences across all three treatments, as the savory profile of dry choux pastry is predominantly influenced by unchanged components such as eggs, butter, and salt.

The crispness texture attribute showed significant differences (H=6.39 > χ^2=5.99). Treatments P1 (10%) and P2 (15%) produced optimal crispness with a mean score of 5.00, while P3 (20%) showed a decline with a mean of 4.60. Tukey's HSD test confirmed that P1 and P2 did not differ significantly from each other, but both differed significantly from P3. The reduction in crispness at P3 is related to gluten dilution caused by the increased proportion of gluten-free banana flour, as well as the dietary fiber content that binds more water, resulting in a less crispy texture at higher concentrations (Agama-Acevedo et al., 2018).

The cavity structure attribute also showed significant differences (H=19.26 > χ^2=5.99). P2 (15%) produced the best cavity structure with the highest mean score of 4.93, followed by P1 (4.80), while P3 showed a dramatic decline to 3.60. Cavity formation in dry choux pastry operates through a steam leavening mechanism; a strong gluten network is essential for retaining steam pressure so that the product expands and forms a large internal cavity. In P3, the significant weakening of the gluten network reduced the dough's ability to retain steam pressure, resulting in suboptimal cavity formation (Widya & Nindyarani, 2019).

CONCLUSION

Based on the results of this study, the following conclusions can be drawn. First, substitution of raja bulu banana flour at levels of 10%, 15%, and 20% did not produce a significant effect on baking loss of dry choux pastry based on ANOVA analysis (F calculated 3.36 < F table 5.14), although a descriptive downward trend in baking loss values was observed with increasing substitution levels. Second, raja bulu banana flour substitution had a significant effect on color, crispness texture, and cavity structure attributes, but did not significantly affect aroma, banana flavor, and savory taste. Third, the 15% substitution treatment was identified as the best treatment, as it achieved the optimal balance between baking loss value, textural crispness, cavity quality, and overall sensory acceptance. For future research, it is recommended to include more comprehensive physical testing parameters such as texture profile analysis (TPA), as well as to adjust the formulation to compensate for changes in dough viscosity caused

by raja bulu banana flour substitution.

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