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Localizing Western Desserts Through Mocaf Boterkoek and Red Rice Puff Pastry Fusion Products

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Abstract

This study aims to localize Western dessert products through the integration of Indonesian local flours and fusion gastronomy approaches. Using an experimental product development design, the study developed two localized pastry products: Mocaf Boterkoek and Red Rice Puff Pastry. The research was conducted in two stages: flour substitution trials and fusion product development. The research was conducted in two stages, namely flour substitution trials and fusion product development. The substitution stage identified 50% mocaf flour as the most suitable level for Boterkoek and 25% red rice flour for Puff Pastry in terms of structural and sensory performance. These formulations were then adapted using Indonesian dessert inspirations, resulting in a nastar-inspired Boterkoek and a molen-inspired Puff Pastry. Sensory evaluation involved 25 semi-trained panelists, 3 expert panelists, and 200 consumer panelists using a seven-point hedonic scale. Both products received consistently positive sensory scores, and paired sample t-test results showed no significant differences across all evaluated attributes. The novelty of this study lies in its integration of local flour substitution and fusion gastronomy within a single pastry innovation framework. The findings indicate that local flours can be successfully incorporated into Western dessert products without reducing consumer acceptance.

Keywords: fusion pastry, mocaf flour, red rice flour, boterkoek, puff pastry

A. Introduction

Western desserts have become an integral part of contemporary culinary culture in Indonesia, driven by the expansion of cafés, patisseries, lifestyle tourism and the growing influence of global gastronomy. However, wheat flour remains the primary ingredient in the production of the western dessert, leading to a continued dependency and relatively high level of wheat importation. At the same time, Indonesia possesses abundant local crops, such as cassava, banana, sago and sorghum which can be processed into alternative flours with promising functional and nutritional properties (Dewandari et al., 2023). Local food-based alternative flours have been widely studied and utilized as substitutes for wheat flour. These local flours offer several advantages, including higher fiber content, gluten-free properties and a lower glycemic index (Aulia Arifin et al., 2024). In addition, the growing global trend toward sustainable gastronomy has attracted increasing attention (Brono, 2024), and consumers are beginning to show stronger preference for functional and sustainable food products (Arif et al., 2025).

The localization of western dessert through fusion gastronomy offers a culturally responsive strategy to reinterpret global foods using local ingredients, techniques and flavor profiles. Fusion food is not merely the combination of culinary elements but a creative process that blends culture identities and generate novel gastronomic experiences that resonate with local audience (Kusnedi et al., 2025). Similarly, Suriani and Ariani assert that fusion cuisine contributes to destination identity and enhances culinary tourism by creating distinctive dishes that symbolize cultural hybridity (Suriani & Ariani, 2020).

In this context, the adaptation of western pastries through the incorporation of Indonesian local flours and traditional dessert concepts represents not only a technological innovation but also a form of cultural expression that strengthens Indonesia's culinary tourism portfolio. Previous studies on gluten-free pastry and bakery products, including those by Bukonja et al. and Putri, which utilized locally sourced flours, show that although fusion techniques play an important role, product quality and consumer preferences must also be carefully considered. Therefore, understanding consumer acceptance is essential when developing new culinary products (Bukonja et al., 2025; Putri et al., 2024).

Among the many western pastries, Boterkoek and Puff Pastry exhibit strong potential for localization due to their historical and cultural resonance in Indonesia. Boterkoek, a classic Dutch butter cake, has long standing ties to colonial culinary heritage, while puff pastry underlies numerous modern bakery products popular in Southeast Asia (Álvarez et al., 2024; Holten, 2014). Although numerous studies have explored the functional potential of local flours in gluten-free or wheat-reduced bakery products, most focus on single-product formulations or nutritional attributes rather than cultural adaptation. Existing literature rarely addresses the localization of western desserts through structured fusion techniques that combine ingredient substitution, hybrid processing and the incorporation of traditional Indonesian dessert concepts.

For instance, Septiani et al. examine sorghum flour in Madeleine while Ihromi et al. analyze mocaf-banana blends in cake formulations (Ihromi et al., 2018a; Septiani et al., 2024). However, these studies generally discuss local flour substitution and product innovation separately, without explicitly examining how Western dessert products can be systematically localized through the integration of local ingredients and fusion gastronomy approaches.

More specifically, previous studies tend to emphasize either the technical feasibility of flour substitution or the sensory performance of modified products, while limited attention has been given to the use of fusion gastronomy as a structured approach for localizing Western pastries. As a result, there is still a lack of understanding of how local flour substitution and culturally embedded fusion concepts can be combined within the development of Western dessert products that remain technically feasible and sensorially acceptable.

Therefore, the novelty of this study lies in its integrated approach to localizing Western desserts through the combination of local flour substitution and fusion gastronomy. Unlike previous studies that mainly focus on formulation or acceptability testing alone, this research develops Western pastry products by simultaneously incorporating Indonesian local flours and traditional dessert inspirations, thereby offering a more culturally grounded model of pastry innovation.

Given this gap, this study aims to investigate how western dessert can be localized through the development of Mocaf Boterkoek and Red Rice Puff Pastry fusion products. This study explores (1) how the fusion techniques be applied to Boterkoek and Puff Pastry using local flours as an alternative substitute for wheat flour and (2) the consumer acceptance of the formulated products.

B. Literature Review

Utilization of Local Flour in Bakery and Pastry

The use of local flours as substitutes for wheat flour has increased significantly in recent years due to their nutritional value, functional properties, and potential to reduce dependence on imported commodities. Previous studies showed that mocaf flour, red rice flour, sorghum flour and banana flour are commonly used in research. These flours provide several advantages, including gluten-free characteristic, higher dietary fiber and lower glycemic index value (Aulia Arifin et al., 2024). In bakery and pastry products, flour substitution is not only a matter of replacing ingredients but also of maintaining functional performance, particularly in relation to dough structure, moisture retention, texture, and flavor development.

A number of studies have demonstrated that local flours can be successfully incorporated into baked products when applied at appropriate substitution levels. Mocaf flour, for instance, has been used in cookies, cakes, brownies, and pastries with acceptable sensory and structural results, particularly at moderate substitution levels, which is about 50% (Ihromi et al.,

2018b; Widanti et al., 2021). Similarly, red rice flour has been reported to contribute positively to the color and aroma of laminated pastry products, although its use must be carefully controlled to avoid undesirable changes in texture and dough extensibility (Fadilah et al., 2022). Studies by Putri et al. and Bukonja et al. further confirm that local flour-based pastries products remain acceptable to consumers when appropriately formulated. These findings suggest that local flour substitution can be technically feasible, provided that formulation adjustments are made to accommodate the functional differences between wheat and non-wheat flours.

These findings suggest strong technical feasibility for applying local flour substitution in western dessert products. However, most previous studies have primarily focused on the technical feasibility, nutritional enhancement, or gluten-free potential of local flour substitution. Limited attention has been given to how these substitutions may support the localization of Western dessert products through broader product innovation strategies. As a result, while the functional role of local flour has been widely explored, its application within culturally adapted Western pastry development remains underexamined.

Fusion Gastronomy in Dessert Innovation

Fusion gastronomy involves the intentional blending of culinary techniques, ingredients and cultural traditions to create novel food experiences, serving not merely as a combination of disparate elements but as a medium for cultural expression, identity negotiation and creative adaptation within contemporary food systems (Kusnedi et al., 2025). From a conceptual perspective, fusion gastronomy may also be understood through the notion of cultural hybridity, in which culinary products are formed through the blending of different cultural references while maintaining elements of recognizability and identity. In this context, successful fusion products often depend on their ability to balance novelty with familiarity, allowing consumers to experience innovation without losing a sense of cultural or sensory connection.

In the field of dessert and pastry innovation, several studies have shown that fusion approaches can revitalize traditional products and generate new forms of culinary appeal. Suriani and Ariani, for example, demonstrate how Balinese fusion food reinterprets local culinary heritage by indigenous ingredients and modified processing techniques in ways that remain accessible to contemporary consumers (Suriani & Ariani, 2020). Similar patterns are observed in dessert-oriented fusion innovations, such as the modification of *kue talam ebi* as traditional dessert combined with puff pastry. The hybridizing traditional steamed cakes with western laminated dough significantly increases consumer acceptance and enhances the visual appeal of traditional products (Bridha et al., 2023). In addition, Aulia et al. highlight that fusion techniques applied in vocational pastry training by combining local crops like pumpkin and purple sweet potato with modern dough making and shaping methods, can introduce new sensory attributes while maintaining familiarity, thereby encouraging broader consumer engagement (Mafatikhul Aulia et al., 2022).

These studies indicate that fusion gastronomy can function as a creative strategy for adapting food products to new cultural and sensory contexts.

Nevertheless, previous studies on fusion food innovation tend to emphasize creative modification or educational practice, rather than systematically examining fusion as a structured approach to localizing Western pastry products. In many cases, fusion is treated as a stylistic or aesthetic modification, with limited attention to its role in product localization through the integration of local ingredients and traditional dessert references. Therefore, further investigation is needed to understand how fusion gastronomy can be applied more systematically in the development of Western desserts with stronger local cultural relevance.

Sensory Evaluation and Consumer Acceptance of Local Flours Pastries

Consumer acceptance is a crucial aspect of product innovation, particularly in bakery and pastry products that involve ingredient modification. From the perspective of sensory perception and consumer behavior, food acceptance is shaped not only by objective product quality but also by consumers' responses to sensory attributes such as appearance, aroma, texture, flavor, and aftertaste. In modified food products, acceptance may also be influenced by the extent to which the product remains familiar while offering a sense of novelty. For this reason, sensory evaluation plays an essential role in determining whether a reformulated product is likely to be accepted in the market.

A number of studies have shown that local flour substitution can affect consumer acceptance in different ways depending on the type of flour and the level of substitution used. The research conducted by Septiani et al. on sorghum-based madeleine found that sorghum increased density and graininess but remained acceptable to consumers at moderate substitution levels (Septiani et al., 2024). Similarly, Ihromi et al. reported that combining mocaf and banana flour in sponge-based products improved moisture retention while influencing aroma (Ihromi et al., 2018a). Sensory studies generally employ hedonic scales and ANOVA to determine product acceptability and identify statistically significant differences among formulations (Chae et al., 2025). The literature also highlights that consumers increasingly value products with sustainable, local ingredients, contributing to greater acceptance of alternative-flour pastries (Arif et al., 2025). These findings suggest that local flour substitution may alter sensory performance, which in turn affects overall product acceptance.

At the same time, sensory acceptance in pastry innovation is not determined solely by technical formulation. In products that incorporate fusion concepts, consumer responses may also be shaped by the familiarity of the flavor profile, cultural associations, and perceived uniqueness of the product. In this sense, local flour substitution may influence consumer acceptance through changes in texture, aroma, and appearance, while fusion gastronomy may enhance acceptance by introducing culturally recognizable elements into the product. However, previous studies have rarely examined consumer acceptance

in products that combine both local flour substitution and culturally embedded fusion elements within Western dessert formats. This indicates the need for a more integrated understanding of how sensory performance and cultural adaptation interact in shaping consumer responses.

Localization of Western Dessert Through Ingredients and Techniques

The localization of Western desserts involves more than the substitution of ingredients; it also requires adaptation at the level of flavor, texture, presentation, and cultural meaning. In this process, product localization may be understood as the reinterpretation of globally recognized food forms through local ingredients, local taste preferences, and culturally familiar culinary references. In pastry development, this means that Western dessert products can be modified not only to suit technical or nutritional needs but also to reflect local identity and eating culture.

Past research on substitution in pastries and bakery products using local flour often focuses on single product with gluten-free reformulation rather than cross cultural fusion. Madeleine, cookies, pancakes, brownies and sponge cakes have been widely explored using mocaf, sorghum, suweg and composite flour blends (Marta et al., 2023; Putri et al., 2024). These studies provide useful evidence regarding the feasibility of local ingredient use in bakery products. However, they tend to emphasize formulation outcomes and sensory results rather than the broader process of localizing Western desserts through both ingredient substitution and culturally meaningful product transformation.

In the context of this study, localization is understood as a process that links three interconnected dimensions: local flour substitution, fusion gastronomy, and consumer acceptance. Local flour substitution provides the material basis for reformulating Western pastry products, fusion gastronomy offers a framework for embedding Indonesian dessert identity into those products, and consumer acceptance reflects the extent to which the localized products remain desirable and feasible. Despite the relevance of these three dimensions, previous studies have rarely brought them together in a structured manner, particularly in relation to Western pastries such as Boterkoek and Puff Pastry. Boterkoek, a dense Dutch butter cake introduce during the colonial period, carries historical culinary relevance in Indonesia (Holten, 2014). Puff pastry is commonly used in Southeast Asian bakery applications. It's structurally suitable for partial substitution due to its reliance on lamination techniques than gluten development (Álvarez et al., 2024). This highlights the need for a more integrated approach to understanding how Western desserts can be localized through both technical and cultural adaptation.

C. Research Methodology

Research Design

This study employed an experimental product development design to formulate and evaluate localized Western dessert products using local flour substitution and fusion gastronomy approaches. The research was carried out in

two main stages: (1) substitution trials, aimed at identifying the most technically feasible level of local flour incorporation while maintaining product quality, and (2) fusion development, in which the selected substituted products were adapted using Indonesian traditional pastry references. This two-stage approach was consistent with the original research framework, which was designed to develop fusion pastry products based on local flour innovation

Tools, Materials and Procedures

This study uses standard pastry and bakery production equipment including digital scales, mixers, spatulas, stainless steel mixing bowls, lamination rollers, silicon mats, convection ovens and temperature-controlled cooling racks. Sensory evaluation was conducted using controlled tasting booths and uniform presentation trays to ensure sample consistency. The main ingredients consisted of ingredients used in the formulation of the two fusion products, including wheat flour, mocaf flour, red rice flour, eggs, butter, sugar, salt, roll-in fat, cooking oil, pineapple jam, banana and chocolate.

The production process using the basic procedures in making Boterkoek and Puff Pastry with some modification according to the fusion projection. All procedures were designed to ensure consistency in texture, structure and sensory characteristics across batches, enabling reliable evaluation of the fusion dessert formulations. Before the substitution stage, the original versions of the selected products were first produced as a baseline for comparison during formulation trials.

Product Formulation and Substitution Trials

The substitution stage focused on integrating local Indonesian flours into western dessert formulation as the foundational step prior to fusion with the acceptable sensory analysis: (1) Boterkoek formulation is conducted with mocaf flour as a partial substitute for wheat flour based on its demonstrated suitability in previous studies on cookies and cakes, which reported acceptable sensory outcomes at specific substitution levels (Gusti et al., 2021; Ihromi et al., 2018b; Widanti et al., 2021); (2) Puff Pastry formulation using red rice flour as a local flour substitution, guided by early findings from Fadilah et al. who successfully applied red rice flour in laminated pastry systems such as lotus pastry. The share reliance on layered structure formation in both products provided a rationale for its use, allowing the pastry to retain lamination integrity (Fadilah et al., 2022)

The substitution stage was conducted to determine the optimal level of local flour incorporation for each product before the fusion process was applied. Based on preliminary formulation trials and product performance evaluation, Boterkoek was tested using mocaf flour at three substitution levels: 100%, 75%, and 50% of total flour composition, while Puff Pastry was tested using red rice flour at two substitution levels: 50% and 25% substitution. These substitution levels were selected to explore the upper and moderate tolerance of non-wheat flour application in pastry products based on the past research.

Table 1. Initial Substitution Treatments

Product	Local Flour	Wheat Flour	Local Flour	Substitution Level
Boterkoek	Mocaf	0%	Mocaf flour	100%
Boterkoek	Mocaf	25%	Mocaf flour	75%
Boterkoek	Mocaf	50%	Mocaf flour	50%
Puff Pastry	Red Rice	50%	Red rice flour	50%
Puff Pastry	Red Rice	25%	Red rice flour	25%

Source: Analysis Result (2025)

The substitution trial for Boterkoek was conducted using mocaf flour as a partial substitute for wheat flour. The substitution was tested progressively in three formulations: 100%, 75%, and 50% mocaf flour. This stepwise trial was conducted to determine the maximum substitution level that could still maintain the physical and sensory quality of the product. The initial trial using 100% mocaf flour produced a dough with excessive crumbliness, low elasticity, and difficulty in shaping. The baked product also showed a slight bitter aftertaste. The second formulation using 75% mocaf flour showed some improvement in dough handling, but the texture remained fragile and still differed substantially from the control. The final formulation using 50% mocaf flour and 50% low-protein wheat flour showed the best balance in terms of structure, colour, flavour, and overall resemblance to the control product. Therefore, this formulation was selected for the fusion stage.

The substitution trial for Puff Pastry used red rice flour as a partial substitute for wheat flour. Two substitution levels were tested: 50% and 25% red rice flour. The initial 50% substitution was selected to explore the tolerance limit of a non-gluten flour in a laminated pastry product. The first trial with 50% red rice flour resulted in a product with a darker surface colour and a texture that was significantly different from the control. The dough showed reduced lamination quality, with layers becoming more chewy and less flaky. This indicated that the higher proportion of red rice flour reduced gluten network formation, which is essential for the development of puff pastry layers. The formulation was then adjusted to 25% red rice flour and 75% high-protein wheat flour, which produced a more workable dough and more stable layer formation. Although the final colour remained slightly darker than conventional puff pastry, the texture, flavour, and aroma were much closer to the control. Therefore, the 25% red rice flour substitution was selected as the final formulation.

Fusion Products Development

After the substitution stage, the selected formulations were further developed using a fusion gastronomy approach, in which Western pastry products were adapted using local culinary references.

For Boterkoek, the fusion concept was inspired by nastar, a traditional Indonesian butter-based pastry with pineapple jam filling. Boterkoek was selected for this fusion because it shares a similar short-dough character with nastar, despite being baked in a tray and served as a sliced pastry. The selected Boterkoek formulation maintained its butter-rich structure but was modified by adding a pineapple jam layer between two layers of dough. The production process retained the creaming method to preserve the soft and buttery texture of Boterkoek while introducing a filling concept similar to nastar.

For Puff Pastry, the fusion concept was inspired by molen, a popular fried pastry snack in Indonesia typically filled with banana. The selected Puff Pastry formulation was adapted by incorporating banana filling and modifying the cooking method from baking to frying. This adaptation was intended to combine the flaky layered structure of puff pastry with the familiar shape and flavor profile of molen. Preliminary trials showed that direct frying of standard puff pastry caused excessive oil absorption. Therefore, the formulation was adjusted by reducing the amount of roll-in fat and modifying the folding process to maintain lamination while minimizing oil uptake.

Sensory Evaluation

The sensory evaluation was conducted using a multi-stage evaluation approach, involving semi-trained panelists, expert panelists, and consumer panelists. This structure was designed to assess the products progressively, from formulation screening to technical validation and final consumer acceptance. The first stage involved 25 semi-trained panelists, consisting of individuals with prior basic knowledge of bakery and pastry sensory evaluation. This stage served as a screening phase to assess the early acceptability of the substituted and fusion products.

The second stage consisted of descriptive evaluation by three expert pastry chefs from four-star hotel in Makassar, who assessed technical characteristics such as sweetness, buttery notes, flakiness, tenderness, moistness, and the presence of off-flavors. Their role was to validate the technical quality and sensory suitability of the selected products. Products were classified as "pass" or "fail" based on expert validation. Only products that passed this stage were advanced to consumer testing.

The final stage involved 200 consumer panellists, recruited using convenience sampling. The participants represented the intended target market and included students, young adults, and general consumers aged 18–45 years with non-professional culinary backgrounds. This stage aimed to measure broader consumer acceptance of the final selected products.

All sensory evaluations used a 7-point hedonic scale, ranging from 1 = strongly dislike to 7 = strongly like. The sensory attributes evaluated included appearance, aroma, texture, taste, aftertaste, and overall liking. Hedonic testing is widely used in food product development to assess consumer preference and acceptance, particularly in studies involving modified or substituted bakery products (Lisa Putri Simanungkalit et al., 2018; Meldasari Lubis & Agustina, 2021)

Table 2. Sensory Evaluation Stage

Stage	Panelists	Number	Purpose
Preliminary screening	Semi-trained panelist	25	Initial screening of product formulation
Technical validation	Expert panelist	3	Validation of technical and sensory quality
Consumer acceptance	Consumer panelits	200	Measurement of broader consumer preference

Source: Analysis Result (2025)

Sensory Evaluation

The sensory data were analysed descriptively and statistically. Descriptive statistics were used to summarize the mean hedonic scores for each sensory attribute. To determine whether significant differences existed between Boterkoek and Puff Pastry, the sensory scores were analyzed using a paired sample t-test for each evaluated attribute. This test was considered appropriate because both products were assessed by the same group of panelists, resulting in dependent observations. Statistical significance was determined at $p < 0.05$. This analytical approach was selected because it is appropriate for comparing consumer sensory responses across multiple product formulations and has also been applied in previous bakery and pastry acceptability studies. (Chae et al., 2025; Septiani et al., 2024)

D. Result

Product Selection from Substitution Trials

For the Boterkoek formulation, the most stable and acceptable formulation was achieved at 50% mocaf substitution, which produced a dense yet tender crumb consistent with the traditional characteristics of Boterkoek, while maintaining a clean buttery aroma without undesirable notes. In the Boterkoek trials, higher levels of mocaf flour (75% and 100%) resulted in a more fragile dough structure and less desirable sensory quality. This formulation was therefore selected as the base for the fusion stage.

Similarly, in Puff Pastry, the 50% red rice flour substitution produced a darker color and reduced lamination quality, whereas the 25% substitution yielded a more workable dough and more stable layered structure This 25% formulation provided the optimal balance between structural performance and sensory distinctiveness, and was selected for the subsequent fusion innovation.

Table 3. Selected Substitution Formulations

Product	Local Flour	Final Substitution Level	Final Selected Formula
Boterkoek	Mocaf	50%	50% Mocaf flour + 50% Wheat flour
Puff Pastry	Red Rice	25%	25% Red rice flour + 75% Wheat flour

Source: Analysis Result (2025)

Fusion Product Development Results

After the substitution stage, the selected formulations were developed into fusion pastry products. The final Boterkoek product used 50% mocaf flour and was combined with a pineapple jam layer, while the final Puff Pastry product used 25% red rice flour and was adapted into a banana-filled fried pastry format. At this stage, both products successfully maintained their basic pastry structures and were considered suitable for sensory evaluation.



Figure 1. Boterkoek Fusion and Red Rice Puff Pastry Fusion
Source: Analysis Results (2025)

Sensory Analysis

The sensory evaluation demonstrated that both fusion dessert prototypes, Mocaf Boterkoek and Red Rice Puff Pastry were well accepted across all testing stages. In the preliminary screening with semi-trained panellists, both products achieved scores in the "liked" category. These results indicate that both formulations had acceptable early sensory performance and were suitable for expert validation.

Table 4. Mean Hedonic Scores from semi-trained panelist

Sensory Attribute	Boterkoek	Puff Pastry
Appearance	5.64	5.88
Aroma	5.88	6.04
Texture	6.08	6.00
Flavor	5.92	6.24
Aftertaste	5.76	5.92
Overall Liking	6.12	6.20

Source: Analysis Results (2025)

Expert evaluation by three pastry chefs of Four-Star Hotel in Makassar confirmed the technical feasibility of both products. Boterkoek showed a balanced buttery–sweet flavor with a cohesive crumb structure, while the puff pastry displayed satisfactory lamination and a pleasant nutty aroma derived from red rice flour. Both products received "PASS" status on expert check forms, demonstrating acceptable performance in appearance, aroma, texture, taste, aftertaste, and overall impression using five scales values. This result indicating that they were eligible for consumer testing.

Table 5. Technical Validation Result from Expert

Sensory Attribute	Boterkoek	Puff Pastry
Appearance	4.33	3.33
Aroma	3.67	3.67
Texture	4.33	3.33
Flavor	4.00	4.00
Aftertaste	4.00	3.67
Overall Liking	4.33	4.00

Source: Analysis Results (2025)

Consumer testing involving 200 panellists further validated product acceptability. Puff Pastry recorded high liking scores for appearance, texture, and overall impression, reflecting strong consumer appeal for its layered crispness and familiar molen-inspired flavour. Boterkoek received consistently positive ratings for flavour and aftertaste, with panellists noting the appealing combination of buttery richness and pineapple jam characteristic of Nastar. Overall, both products obtained mean scores above 5.8 across all sensory attributes, indicating a generally positive level of consumer acceptance.

Table 6. Mean Hedonic Scores from consumer panelist

Sensory Attribute	Boterkoek	Puff Pastry
Appearance	5.83	6.09
Aroma	5.83	6.07
Texture	5.86	5.95
Flavor	5.86	5.97
Aftertaste	5.83	5.84
Overall Liking	6.01	6,05

Source: Analysis Results (2025)

Overall, the sensory evaluation confirmed that the optimized substitution levels (50% mocaf for Boterkoek and 25% red rice flour for Puff Pastry) successfully supported the fusion formulations. Both products demonstrated strong consumer acceptance and maintained the structural and sensory qualities expected of localized Western desserts.

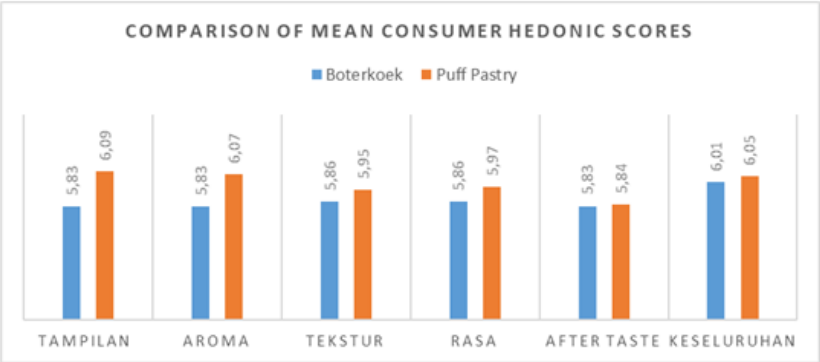


Figure 2. Comparison of mean consumer hedonic scores
Source: Analysis Results (2025)

Both fusion pastry products demonstrate equally strong consumer acceptance, with no significant differences across all sensory attributes, confirming that local flour substitution can be successfully applied without compromising sensory quality.

Statistical Comparison of Consumer Acceptance

Overall, the sensory evaluation confirmed that the optimized substitution levels (50% mocaf for Boterkoek and 25% red rice flour for Puff Pastry) successfully supported the fusion formulations. Both products demonstrated strong consumer acceptance and maintained the structural and sensory qualities expected of localized Western desserts.

To examine whether there were significant differences between the two products, a paired sample t-test was conducted across all sensory attributes. The results showed that no statistically significant differences were found between Boterkoek and Puff Pastry for any of the evaluated attributes. The p-values for appearance ($p = 0.357$), aroma ($p = 0.521$), texture ($p = 0.633$), flavour ($p = 0.118$), aftertaste ($p = 0.550$), and overall liking ($p = 0.633$) were all above the significance threshold of 0.05. These findings indicate that although Puff Pastry showed slightly higher mean scores across several attributes, the differences were not statistically significant. Therefore, both products can be considered to have comparable levels of consumer acceptance.

E. Discussion

The findings of this study demonstrate that local flour substitution can be successfully integrated into Western dessert products without reducing consumer acceptance, provided that the substitution level is carefully adjusted according to the technical requirements of each product. In the present study, the most feasible formulations were obtained at 50% mocaf flour substitution for Boterkoek and 25% red rice flour substitution for Puff Pastry. These findings indicate that the tolerance of local flour incorporation varies depending on product structure and dough functionality. Products with a denser and less laminated structure, such as Boterkoek, appear to allow a higher level of

substitution, whereas laminated products such as Puff Pastry require a lower substitution level due to their stronger dependence on gluten development and dough extensibility.

This finding supports previous studies showing that the success of local flour substitution in bakery and pastry products depends strongly on the functional role of wheat flour in each product type (Fadilah et al., 2022; Ihromi et al., 2018b; Widanti et al., 2021). However, the present study extends those findings by showing that local flour substitution can be applied not only in conventional bakery products such as cakes or cookies, but also in Western dessert products that undergo fusion adaptation. In this sense, the contribution of this study is not merely technical but also conceptual, as it demonstrates that flour substitution can function as part of a broader process of culinary localization rather than only as a nutritional or gluten-reduction strategy.

Another important finding is that both products obtained consistently positive sensory scores across semi-trained, expert, and consumer evaluations. In the consumer test, both Boterkoek and Puff Pastry achieved mean scores above 5.8 for all evaluated sensory attributes, with no statistically significant differences found between the two products. This suggests that although the products differed in formulation, structure, and cooking method, both were similarly well accepted by consumers. These findings reinforce the idea that local flour substitution does not necessarily reduce consumer acceptance when the product is reformulated appropriately and aligned with recognizable sensory expectations.

Compared with previous studies, this result is particularly important because many earlier studies on substituted bakery products focus primarily on whether local flour can technically replace wheat flour, with less attention to how the final product is perceived once it is transformed into a more culturally familiar or commercially appealing form (Fadilah et al., 2022; Septiani et al., 2024). In the present study, the sensory acceptability of both products suggests that consumer acceptance is shaped not only by technical formulation but also by the successful adaptation of the product into a familiar and coherent pastry concept. This indicates that product development using local ingredients should not be evaluated solely in terms of substitution percentage, but also in relation to the extent to which the final product remains desirable in taste, texture, and overall eating experience.

The choice of fusion references in this study also appears to have contributed to the positive sensory acceptance of the final products. Boterkoek was paired with nastar because both products share a butter-rich, short-textured pastry character, making the incorporation of pineapple jam technically and sensorially coherent. Likewise, Puff Pastry was adapted into a molen-inspired format because both products rely on pastry-based shell structures and are compatible with banana filling as a familiar flavor component. These findings suggest that the success of fusion pastry innovation may depend not only on novelty, but also on the degree of structural and sensory compatibility between the original Western product and the selected local reference. In this study, the

fusion process did not merely involve symbolic cultural blending, but rather a practical adaptation based on texture, flavor profile, preparation method, and consumer familiarity.

From the perspective of fusion gastronomy, the findings suggest that fusion-based pastry innovation can be understood as a process that combines technical adaptation and cultural reinterpretation. Previous studies on fusion gastronomy often emphasize creativity, novelty, or aesthetic experimentation (Bridha et al., 2023; Mafatikhul Aulia et al., 2022; Suriani & Ariani, 2020). However, the present study shows that fusion in pastry development also requires technical compatibility between ingredients, structure, and sensory outcome. In other words, fusion is not only about combining food identities but also about ensuring that the resulting product remains functionally feasible and sensorially acceptable.

This is where the present study offers a more specific contribution to the development of fusion gastronomy concepts. What is new in this study is the integration of local flour substitution and fusion gastronomy within the same product development process. While previous studies tend to treat flour substitution as a technical issue and fusion as a creative or stylistic approach, this study demonstrates that both can be combined as complementary strategies in pastry innovation. This finding suggests that fusion gastronomy may be understood not only as cross-cultural food combination, but also as a structured product development approach in which ingredient functionality, cultural familiarity, and sensory acceptance are negotiated simultaneously.

The practical implications of this study are also relevant for the culinary and hospitality industry, particularly for pastry producers, café businesses, hotel bakeries, and culinary entrepreneurs seeking to diversify their product offerings. The findings suggest that local flours such as mocaf and red rice flour can be incorporated into pastry products at appropriate levels without compromising consumer acceptance. This creates opportunities for food businesses to develop more distinctive and locally grounded pastry products while reducing dependence on imported wheat flour. In addition, the fusion approach demonstrated in this study may be useful for culinary businesses seeking to create products that are both innovative and culturally relatable to Indonesian consumers.

At the same time, this study also shows that the success of fusion pastry innovation depends on careful formulation decisions, not merely on the idea of combining local and Western elements. The different substitution tolerance observed between Boterkoek and Puff Pastry confirms that not all products can accommodate local flour at the same level. Therefore, product development involving local ingredients should consider the structural demands of each pastry type, particularly in products that depend heavily on gluten formation, flakiness, or lamination performance.

Despite these contributions, this study has several limitations. First, the study focused only on two selected pastry products, which limits the generalizability of the findings to other types of bakery and dessert products.

Second, the consumer evaluation was based on hedonic sensory assessment only, without exploring deeper perceptual variables such as purchase intention, familiarity, or perceived authenticity. Third, while the study employed a structured multi-stage evaluation process, the sensory assessment was conducted within a limited consumer context and did not include broader market segmentation. Future studies may therefore expand the scope of products, include additional consumer behavior variables, and test localized pastry products in wider commercial or hospitality settings.

Overall, this study demonstrates that the localization of Western desserts through local flour substitution and fusion gastronomy is both technically feasible and sensorially acceptable. More importantly, it suggests that pastry innovation using local ingredients should be viewed not only as a matter of formulation, but also as a process of culinary reinterpretation that bridges product functionality, cultural familiarity, and consumer acceptance.

F. Conclusion

This study demonstrates that the localization of Western dessert products through local flour substitution and fusion gastronomy is both technically feasible and sensorially acceptable. The findings show that 50% mocaf flour substitution in Boterkoek and 25% red rice flour substitution in Puff Pastry produced the most acceptable formulations in terms of structure, sensory quality, and overall consumer preference. Consumer testing further showed that both products received consistently positive hedonic scores across all evaluated sensory attributes, and no statistically significant differences were found between the two products.

The contribution of this study lies in its demonstration that local flour substitution and fusion gastronomy can be integrated within a single product development framework, rather than being treated as separate approaches. In this regard, the study extends previous research by showing that local ingredient substitution can function not only as a technical or nutritional strategy, but also as part of a broader process of culinary localization and pastry innovation. This finding also contributes to the development of fusion gastronomy theory, particularly by suggesting that successful fusion products depend not only on novelty, but also on the technical and sensory compatibility between the original product and the selected local reference.

From a practical perspective, the findings of this study provide useful insights for the culinary and hospitality industry, including pastry businesses, hotel bakeries, cafés, and small food enterprises, by showing that local flours such as mocaf and red rice flour can be incorporated into pastry products at appropriate levels without reducing consumer acceptance. This opens opportunities for more locally grounded, distinctive, and potentially more sustainable pastry product development.

Nevertheless, this study was limited to two pastry products and focused primarily on hedonic sensory acceptance. Future research is therefore recommended to examine a wider range of bakery and pastry products,

incorporate additional consumer behavior variables such as purchase intention or perceived authenticity, and explore the commercial feasibility of localized fusion pastry products in broader hospitality and culinary contexts.

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H. Conflict of Interest

The authors declare no competing financial or non-financial interests associated with the development and evaluation of the pastry products examined in this study. Research funding and institutional support are disclosed in the Acknowledgement section.

I. Declaration of AI Use

ChatGPT by OpenAI supported the authors in exploring preliminary research ideas, considering conceptual frameworks, and organizing the manuscript's structure. The authors assessed the conceptual suggestions against original scholarly sources and reviewed the proposed organization for consistency with the experimental procedures and findings. They refined the relevant suggestions and made all final conceptual and editorial decisions. The authors accept full responsibility for the accuracy, originality, references, and integrity of the manuscript.

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