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Pengaruh Substitusi Tepung Talas Kimpul (Xanthosoma Sagittifolium) Terhadap Mutu Fisik Dan Sensoris Onde-Onde

The Effect Of Kimpul Taro Flour (Xanthosoma Sagittifolium) Substitution On The Physical And Sensory Quality Of Onde-Onde

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Abstract

This study investigated the effect of substituting kimpul taro flour (Xanthosoma sagittifolium) for other flours on the physical and sensory quality of onde-onde, as a local food diversification strategy. An experimental method was applied using 10%, 20%, and 30% kimpul taro flour substitution for glutinous rice flour. A non-substituted formulation was used as the control in the physical quality tests. Physical quality was evaluated by measuring surface oil retention and changes in oil volume after frying, with three replications, and the data were analyzed using analysis of variance at the 5% significance level. Sensory quality was evaluated by 45 semi-trained panelists, with 15 panelists assigned to each treatment, covering color, kimpul taro aroma, sweetness, kimpul taro taste, texture, and overall appearance. Sensory data were analyzed using the Kruskal-Wallis test. The results showed that 10-30% substitution did not significantly affect surface oil retention or changes in oil volume. None of the sensory attributes differed significantly because all calculated chi-square values were lower than the critical value. Descriptively, the 10% treatment produced mean scores of 4.7 for color, 4.5 for sweetness, and 4.4 for texture, and most closely resembled the standard product. Substitution up to 30% remained acceptable in sensory terms, although higher substitution levels tended to reduce color brightness and chewiness. Kimpul taro flour can therefore be used as a partial substitute in onde-onde, with the 10% level recommended as the most stable formulation based on the combined physical and sensory results.
***Keywords**: food diversification; kimpul taro; local flour; onde-onde; sensory quality*

Abstrak

Penelitian ini mengkaji pengaruh substitusi tepung talas kimpul (*Xanthosoma sagittifolium*) terhadap kualitas fisik dan sensori *onde-onde* sebagai strategi diversifikasi pangan lokal. Metode eksperimental diterapkan dengan menggunakan tingkat substitusi tepung talas kimpul sebesar 10%, 20%, dan 30% terhadap tepung ketan. Formulasi tanpa substitusi digunakan sebagai kontrol dalam uji kualitas fisik. Kualitas fisik dievaluasi dengan mengukur retensi minyak pada permukaan dan perubahan volume minyak setelah penggorengan (dilakukan dalam tiga ulangan), dan data dianalisis menggunakan analisis varians pada tingkat signifikansi 5%. Kualitas sensori dinilai oleh 45 panelis semi-terlatih—dengan 15 panelis untuk setiap perlakuan—yang mencakup aspek warna, aroma talas kimpul, tingkat kemanisan, rasa talas kimpul, tekstur, dan kenampakan keseluruhan. Data sensori dianalisis menggunakan uji Kruskal-Wallis. Hasil penelitian menunjukkan bahwa substitusi sebesar 10–30% tidak memberikan pengaruh yang signifikan terhadap retensi minyak permukaan maupun perubahan volume minyak. Tidak ada perbedaan signifikan pada atribut sensori mana pun karena seluruh nilai *chi-square* hasil perhitungan lebih rendah daripada nilai kritisnya. Secara deskriptif, perlakuan 10% menghasilkan skor rata-rata 4,7 untuk warna, 4,5 untuk tingkat kemanisan, dan 4,4 untuk tekstur, serta memiliki karakteristik yang paling mendekati produk standar. Substitusi hingga tingkat 30% tetap dapat diterima secara sensori, meskipun tingkat substitusi yang lebih tinggi cenderung mengurangi kecerahan warna dan kekenyalan. Oleh karena itu, tepung talas kimpul dapat digunakan sebagai bahan substitusi parsial dalam pembuatan *onde-onde*, dengan tingkat substitusi 10% direkomendasikan sebagai formulasi paling stabil berdasarkan gabungan hasil uji fisik dan sensori.
Kata kunci: diversifikasi pangan; talas kimpul; tepung lokal; *onde-onde*; kualitas sensori

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1. Introduction

Food diversification is an important strategy for reducing dependence on a single carbohydrate source while increasing the added value of local commodities. Indonesia has a wide variety of tuber crops that can be developed as food ingredients, yet their utilization remains lower than that of rice and maize. Tubers are important sources of starch and can be processed into semi-finished food ingredients, particularly flour, making them easier to store, distribute, and incorporate into various products (Hoky et al., 2022; Moulia et al., 2025). Diversification based on local raw materials can also broaden product variety and increase the economic value of commodities previously marketed only in simple forms (Sulistyani et al., 2025).

One tuber with considerable development potential is kimpul taro (Xanthosoma sagittifolium). Kimpul taro is a carbohydrate source with a high starch content and is well adapted to tropical regions. Processing the tuber into flour extends its shelf life, simplifies formulation, and creates opportunities for its use as a partial replacement for conventional flour. Processing modifications, including fermentation and controlled drying, have been reported to improve the characteristics of kimpul taro flour and reduce compounds that may cause an itching sensation (Hudi et al., 2023; Rahmawati & Sandrasari, 2023; Moulia et al., 2025).

Kimpul taro flour has been incorporated into various food products. Its substitution in broiler chicken nuggets affected several chemical characteristics, color, and texture, while its application in wet noodles showed that structure-forming components also determine the product's physical and sensory quality (Windyasmara et al., 2022; Indraputri et al., 2024). Other studies have demonstrated that kimpul taro can be used in glutinous-rice-based sagon cookies, whereas taro flour in bakery and noodle products tends to alter color and texture as its proportion increases (Dewi & Marsiti, 2018; Prameswary et al., 2022; Suhartatik & Mustofa, 2023). These findings indicate that the effects of taro flour strongly depend on starch characteristics, product type, and processing conditions.

Onde-onde is a traditional snack made primarily from glutinous rice flour, filled with mung bean paste, and coated with sesame seeds. Its principal characteristics are a round shape, a sweet-savory flavor, and a chewy texture, which are mainly due to the high amylopectin content of glutinous rice flour. The similarity between the adhesive properties of kimpul taro starch and glutinous rice flour creates an opportunity for partial substitution. However, excessive replacement may alter dough gelatinization, crust formation during frying, color, aroma, and chewiness. In onde-onde formulated with modified cassava flour and beneng taro flour, the flour composition was reported to determine the organoleptic and physicochemical quality of the product (Widyanto et al., 2025).

Experimental food studies published in CEEJ commonly present three treatment levels, evaluate physical properties using analysis of variance, and assess sensory quality using semi-trained panelists and the Kruskal-Wallis test. This approach was used, for example, in a study of peanut aquafaba in lidah kucing cookies, which showed that several attributes could remain stable despite modification of a principal ingredient (Keishya et al., 2026). A similar approach is relevant for determining whether kimpul taro flour can partially replace glutinous rice flour without reducing the defining characteristics of onde-onde.

Research on substituting kimpul taro flour for glutinous rice in glutinous-rice-based products, particularly onde-onde, remains limited. This study, therefore, aimed

to analyze the effects of substituting 10%, 20%, and 30% of kimpul taro flour on the physical and sensory quality of onde-onde. Its contribution lies in identifying a substitution level that maintains product characteristics while supporting the utilization of locally produced flour.

2. Methods

The study was conducted at the Food Processing Laboratory of the Culinary Education Study Program, Faculty of Engineering, Universitas Negeri Jakarta, from August 2025 to July 2026. A quantitative experimental design was employed. The treatment factor was the percentage of kimpul taro flour used to replace white glutinous rice flour, namely 10%, 20%, and 30%. A formulation without substitution was used as the control in the physical quality tests.

Kimpul taro flour was prepared from fresh tubers that were sorted, peeled, washed, thinly sliced, soaked in salt water for 1-2 hours, washed again, dried, milled, and sieved through a 60-mesh sieve. Soaking and repeated washing were performed to reduce sap and oxalate compounds that may cause itching. The flour was stored in a sealed container until use.

The skin formulation used a total of 500 g of a combined mixture of glutinous rice flour and kimpul taro flour. The quantities of the other ingredients were kept constant: 30 g rice flour, 100 g sugar, 4 g salt, and 380 mL water. The filling was prepared from peeled mung beans, sugar, salt, coconut milk, water, and pandan leaves. Each portion of skin dough and filling weighed 5 g. The products were shaped into balls, moistened, coated with sesame seeds, and fried in stages from approximately 100°C to 170°C. Formulation and processing conditions were controlled so that product differences would primarily reflect the level of kimpul taro flour substitution.

Table 1. Flour formulation for the onde-onde skin

Treatment	Glutinous rice flour (g)	Kimpul taro flour (g)	Substitution proportion
Control	500	0	0%
P1	450	50	10%
P2	400	100	20%
P3	350	150	30%

Physical quality testing included surface oil retention and changes in oil volume. Surface oil was assessed by weighing kitchen tissue before and after absorbing oil from the drained product. The change in oil volume was determined by the difference between the oil volume before and after frying. Each treatment was tested in three replications. Physical data were analyzed using analysis of variance at $\alpha = 0.05$. A post hoc test was planned if a significant difference was detected.

Sensory testing was conducted after the products had been declared suitable by five expert panelists. A total of 45 semi-trained panelists from the Culinary Education Study Program who had completed courses in sensory evaluation or traditional cakes participated in the test. Each treatment was evaluated by 15 panelists using randomized codes. The evaluated attributes were color, kimpul taro aroma, sweetness, kimpul taro taste, texture, and overall appearance, using a five-point hedonic quality scale. Ordinal data were analyzed using the Kruskal-Wallis test at $\alpha =$

0.05. The calculated chi-square values were compared with the critical value of 5.99 at two degrees of freedom.

3. Results and Discussion

Preliminary trials showed that formulations containing up to 30% kimpul taro flour could still be shaped and fried properly. At 40% substitution, the skin became harder and less chewy; therefore, this level was not included in the main experiment. The appearance of the products containing 10%, 20%, and 30% substitution is presented in Figure 1.

Figure 1. Onde-onde containing 10%, 20%, and 30% kimpul taro flour substitution (research documentation)

3.1. Physical Quality

Table 2. Mean physical test results for onde-onde

Treatment	Surface oil retention (%)	Change in oil volume (%)	ANOVA interpretation
Control	6.9	1.36	Not significantly different
10%	6.3	2.61	Not significantly different
20%	8.6	2.10	Not significantly different
30%	10.3	1.74	Not significantly different

Surface oil retention tended to increase at the 20% and 30% substitution levels, although the 10% treatment was slightly lower than the control. The ANOVA results showed that these differences were not significant at the 5% level. Thus, changes in flour proportion within the tested range did not produce sufficiently large or consistent changes in surface oil retention.

Oil uptake in fried foods is associated with mass transfer during frying. Water evaporates from the surface and interior of the product, creating pores that can be filled with oil, particularly when the product is removed from the frying medium and begins to cool. Starch composition, dough moisture, crust formation, frying temperature, frying duration, and pore structure influence the amount of retained oil (Xie et al., 2022). In this study, all ingredients except the flour proportion were held constant, and the frying process was standardized. This uniformity in the process may explain why differences in flour composition were not strong enough to produce statistically significant effects.

The change in oil volume was greatest at 10% substitution and decreased at 20% and 30%; however, none of the treatments differed significantly. This non-linear

pattern indicates that oil measurements in fried products are affected by process variability, including oil remaining on equipment, sesame seeds, tissue, and product surfaces. The findings should therefore be interpreted as evidence of stable physical quality across the 10-30% substitution range, rather than as indicating that increasing taro flour consistently raises or lowers oil uptake.

These results are consistent with the principle that modifying an ingredient does not necessarily affect all physical parameters simultaneously. In a CEEJ study of peanut aquafaba, the treatment did not affect several sensory attributes. However, it did affect specific physical parameters because each parameter was governed by a different formation mechanism (Keishya et al., 2026). In the present onde-onde formulations, glutinous rice flour remained the dominant component at all treatment levels and may have continued to maintain dough cohesion and skin formation during frying.

3.2. Sensory Quality

Table 3. Mean sensory quality scores and Kruskal-Wallis results

Attribute	10%	20%	30%	Calculated χ^2	Critical χ^2	Decision
Color	4.7	4.6	4.1	5.22	5.99	Not significantly different
Kimpul taro aroma	3.6	3.0	3.5	1.74	5.99	Not significantly different
Sweetness	4.5	4.5	4.1	2.32	5.99	Not significantly different
Kimpul taro taste	3.7	3.0	3.9	3.84	5.99	Not significantly different
Texture	4.4	4.3	4.2	0.59	5.99	Not significantly different
Overall appearance	4.7	4.9	4.9	0.21	5.99	Not significantly different

All sensory attributes had calculated chi-square values below 5.99. Accordingly, kimpul taro flour substitutions at 10%, 20%, and 30% did not produce significant differences in sensory quality. The absence of a statistical difference does not mean that the three products were identical; rather, it indicates that variation among panelist ratings was greater than the differences among treatment levels. In practical terms, these results show that kimpul taro flour can be used at levels up to 30% without eliminating the principal characteristics of onde-onde.

The color score decreased from 4.7 at 10% substitution to 4.1 at 30%. This tendency indicates that increasing the proportion of kimpul taro flour produced a more yellowish-brown color. The color of fried products is influenced by raw-material pigments, sugar content, temperature, and browning reactions during heating. A higher proportion of tuber flour may also impart the flour's natural color to the final product. Studies of taro-based products have reported similar color changes as the

proportion of taro flour increased (Windyasmara et al., 2022; Prameswary et al., 2022). Nevertheless, all scores remained within color categories considered appropriate for cooked onde-onde.

Kimpul taro aroma did not show a linear pattern. The score at the 20% level was lower than those at 10% and 30%, but the differences were not significant. Tuber aroma can be influenced by flour quality, drying, soaking, and its interaction with the aromas of sesame seeds, frying oil, and mung bean filling. Adequate soaking and washing can reduce the characteristic aroma and lower the compounds responsible for itching. Rahmawati and Sandrasari (2023) emphasized the importance of processing methods in improving the quality of kimpul taro flour. The dominant aromas of sesame seeds and frying may also have masked the flour aroma in the final product.

Sweetness scores remained relatively high across all treatments: 4.5 at the 10% and 20% levels and 4.1 at the 30% level. All formulations contained the same amount of sugar and filling; therefore, flour substitution did not directly alter the concentration of sweetening ingredients. The slight decrease at 30% may have occurred because the characteristic tuber taste became more noticeable, thereby altering the perception of sweetness. However, kimpul taro taste scores also did not differ significantly, indicating that the tuber taste did not dominate the product at substitution levels up to 30%.

Texture scores decreased gradually from 4.4 to 4.2. Although the decline was small and not statistically significant, the tendency was consistent with the reduced proportion of glutinous rice flour. Glutinous rice flour contains very high levels of amylopectin, which produces adhesive and chewy properties after gelatinization. Kimpul taro flour also has a high starch content, but its gelatinization behavior, granule size, fiber content, and water-binding capacity differ from those of glutinous rice flour. Increasing the substitution level may therefore reduce the dough matrix's elasticity and produce a denser texture. Similar findings have been reported for other taro-flour-substituted products, in which a greater tuber proportion tended to modify hardness or chewiness (Indraputri et al., 2024; Suhartatik & Mustofa, 2023).

Overall appearance received very high scores, particularly at the 20% and 30% substitution levels, which both scored 4.9. The round shape and adherence of sesame seeds were maintained in all treatments. This finding indicates that the dough retained sufficient cohesion and surface moisture for shaping and sesame coating. This is important because consumers' initial acceptance of traditional snacks is strongly influenced by shape and visual appearance before they evaluate flavor and texture.

Based on the combined parameters, the 10% substitution level was selected as the most stable formulation. This treatment had the lowest surface oil value among the substituted formulations, the highest color score, a joint-highest sweetness score, and the highest texture score. The 20% and 30% formulations remained acceptable in sensory terms and may be considered when product development prioritizes increased use of local flour. Selection of the final formulation should therefore balance substitution intensity, product characteristics, ingredient costs, and diversification objectives.

This study had several limitations. The sensory evaluation involved semi-trained panelists, and each panelist evaluated only one treatment; therefore, the design did not directly reflect the preferences of general consumers. Oil was measured using a simple method sensitive to variations in drainage and at the surface. In addition, the

chemical composition of the flour, oxalate content, moisture content, and instrumental texture profile were not analyzed. Future studies should use a balanced design in which panelists evaluate all samples, perform instrumental texture analysis, measure oil content using an extraction method, and characterize the flour chemically.

4. Conclusion

Substitution of glutinous rice flour with 10%, 20%, and 30% kimpul taro flour did not significantly affect the physical quality of onde-onde, as measured by surface oil retention and changes in oil volume. The substitution also had no significant effect on color, kimpul taro aroma, sweetness, kimpul taro taste, texture, or overall appearance. Kimpul taro flour can therefore be used at levels up to 30% as a partial substitute for glutinous rice flour without statistically reducing product quality. Based on the descriptive results, the 10% formulation is recommended because it most closely maintained the characteristics of the standard product, particularly color, sweetness, texture, and surface oil retention. Further development should optimize flour processing to reduce oxalate, broaden consumer acceptance testing, and include chemical and instrumental texture analyses.

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