

Fish Cake Odeng Formulation from Catfish (*Clarias batrachus*) Surimi with Addition of Rice Anchovy (*Stolephorus commersonii*) Flour as a Snack for Adolescents

¹Nursalastrie, ²Nur Afrinis, ³Widawati

¹Department of Nutrition, Faculty of Health Sciences, University Pahlawan Tuanku Tambusai, Riau, Indonesia, nursulastri1212@gmail.com

²Department of Nutrition, Faculty of Health Sciences, University Pahlawan Tuanku Tambusai, Riau, Indonesia, afrinis.eva@gmail.com

³Department of Nutrition, Faculty of Health Sciences, University Pahlawan Tuanku Tambusai, Riau, Indonesia, widawatigamal@gmail.com

Corresponding author: Nur Afrinis, e-mail: afrinis.eva@gmail.com

ABSTRACT

Adolescents are vulnerable to nutritional problems such as calcium deficiency, which may impair bone growth and height. This study aimed to evaluate the characteristics of fish cake *odeng* made from catfish (*Clarias batrachus*) surimi with the addition of rice anchovy (*Stolephorus commersonii*) flour in terms of nutritional content and organoleptic properties. A Completely Randomized Design (CRD) with one control (F0: 0%) and two treatments (F1: 9% and F2: 18%) was applied. Analyses included organoleptic tests, proximate composition, and calcium content. The results showed that F1 was the most preferred formulation according to panelists. The best formulation (F1) contained 20.2% moisture, 1.2% ash, 12.2 g protein, 8.7 g fat, 20.4 g carbohydrates, and 23.4 mg/100 g calcium, equivalent to 1.9% of the Recommended Dietary Allowance (RDA) for adolescents. Although the calcium content did not meet BPOM's threshold for a "source of calcium" claim ($\geq 15\%$ RDA per serving), the protein level met the criteria for a protein source, and the product provided approximately 10% of daily energy needs (215 kcal) from the fish cake alone (excluding the broth). In conclusion, the fish cake *odeng* developed in this study met the criteria for a protein-source snack and contributed to energy intake, but did not qualify as a calcium source. Further studies are recommended to improve processing methods and formulations to enhance its calcium content.

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Introduction

Adolescence (10–19 years) is a critical period of accelerated growth and physical development that requires optimal nutritional intake, particularly calcium (Rahayu et al., 2023). However, the results of SEANUTS II showed that 78% of Indonesian children have not achieved the recommended daily calcium intake (Syafriani, 2024). This condition contributes to an increased risk of impaired bone density. Data from 2020 reported a prevalence of 41.7% for osteopenia and 10.3% for osteoporosis, with cases of osteopenia already identified in individuals under 55 years of age (Dewi, 2023). This indicates that bone density problems may arise as early as the growth period, particularly during adolescence, as a result of low calcium intake during the peak bone mass formation period (Hereford et al., 2024).

Fish is one of the potential sources of calcium. Although national fish consumption reaches 57.61 kg/capita/year, its distribution remains uneven, with Riau Province consuming only 47.40 kg/capita/year (KKP, 2024). Therefore, innovation in processed fish products that are more appealing

to the community is needed. One such product is fish cake odeng, a surimi-based product with a soft and elastic texture, a savory yet slightly sweet taste, and a distinctive aroma derived from the spices used (Aji & Sahubawa, 2024). In one e-commerce platform, the sales of fish cake odeng reached 19,660 pieces per month, ranking third after fish balls and pempek.

Catfish has great potential as a raw material for surimi due to its high protein content of approximately 17.7% (Primawestri et al., 2023), and its lower fat content (Kemenkes RI, 2020), affordable price, and abundant availability. However, the calcium content in one type of instant fish cake odeng remains low, at only about 48 mg/100 g or 4% of the Recommended Dietary Allowance (RDA). Inadequate calcium intake remains a widespread nutritional concern among adolescents globally. Evidence indicates that calcium intake is insufficient across many age groups, with adolescents being the most affected, which may contribute to suboptimal bone mineral density and increased risk of premature osteoporosis later in life (Askari et al., 2022). The

situation is also reflected in Indonesia. The South East Asian Nutrition Surveys II (SEANUTS II) reported that calcium deficiency remains a significant micronutrient problem among Indonesian children, with approximately 78% not achieving the recommended daily intake (Syafriani, 2024). This insufficient intake may negatively affect bone growth and development, particularly during critical growth periods such as childhood and adolescence.

Furthermore, a large-scale bone density assessment conducted in 2020 on 65,727 individuals found a prevalence of osteopenia of 41.7% and osteoporosis of 10.3%, with 41.2% of cases occurring in individuals younger than 55 years (Dewi, 2023). These findings indicate that impaired bone density no longer affects only older adults but is emerging earlier, potentially influenced by low calcium intake during growth, especially adolescence.

Given this context, one practical strategy to increase calcium intake through commonly consumed foods is fortification. One approach to increasing the calcium content of fish cake odeng is fortification using rice anchovy (*Stolephorus commersonii*), which contains a high calcium level of approximately 1,000 mg per 100 g (Kemenkes, 2021). Rice anchovy also has a mild fish aroma, a naturally light color, and is easy to process into fine flour, making it a suitable ingredient for product formulation.

Based on these considerations, this study aimed to develop catfish surimi based fish cake odeng with the addition of rice anchovy flour as a calcium-rich snack for adolescents.

Method

Research Tools and Materials

The equipment used for the preparation of catfish surimi, rice anchovy flour, and fish cake odeng included a 100-mesh sieve, basin, copper pan, baking paper, oven, tongs, knife, spoon, cutting board, and food scale. The equipment for chemical nutrient analysis included an oven, muffle furnace, porcelain crucibles, desiccator, analytical balance, complete Kjeldahl apparatus, complete Soxhlet apparatus, burette, pipette, Erlenmeyer flask, beaker, and permanganometric titration equipment for calcium analysis.

The main ingredients used in this study were fresh catfish, clean water, ice cubes, semi-dried rice anchovies, hot water, tapioca flour, egg white, salt, sugar, ground pepper, ground garlic, fresh garlic, onion, soy sauce, fish sauce, and mushroom broth powder. The materials for chemical analysis included H_2SO_4 , NaOH, HCl, H_3BO_3 , indicators, n-hexane solvent, $KMnO_4$, oxalic acid, and distilled water.

Research Stage

This study employed a Completely Randomized Design (CRD) with a single factor, namely the concentration of rice anchovy flour addition, consisting of three treatment levels: 0% anchovy flour (F0), 9% anchovy flour (F1), and 18%

anchovy flour (F2). The study included raw material preparation and the production of fish cake odeng.

Preparation of Fish Cake Odeng Ingredients

The main ingredients in this study were fresh catfish and semi-dried rice anchovies obtained from the Bangkinang City market. Additional ingredients included clean water, ice cubes, food-grade plastic, hot water, tapioca flour, egg white, salt, sugar, ground pepper, ground garlic, fresh garlic, onion, soy sauce, fish sauce, and mushroom broth powder.

Making Fish Cake Odeng

The preparation of fish cake odeng began by mixing catfish surimi with rice anchovy flour, tapioca flour, egg white, ice cubes, and seasonings consisting of salt, sugar, ground pepper, and ground garlic. All ingredients were processed using a food processor until a homogeneous dough was formed, then shaped into square sheets on baking paper. The dough was subsequently fried in hot oil until cooked. The odeng broth was prepared by boiling 500 ml of water, then adding 5 g of rice anchovy flour, garlic, onion, soy sauce, fish sauce, and mushroom broth powder. The mixture was boiled until it reached a uniform consistency and then served together with the fish cake odeng.

Data analysis

Data were processed using Microsoft Excel 2010 and SPSS 20. The sensory evaluation results were analyzed using one-way ANOVA, followed by Duncan's test at a 5% significance level.

Measurement Methods

The measurement methods used in this study included sensory analysis, proximate analysis, and calcium analysis. The sensory analysis consisted of hedonic tests (color, aroma, texture, and taste) and hedonic quality tests. This evaluation involved 25 semi-trained panelists, who were undergraduate nutrition students from Universitas Pahlawan Tuanku Tambusai in the 6th and 8th semesters.

The proximate analysis of the selected formulation included the determination of ash content using the dry ashing method, moisture content using the oven method, fat content through the Soxhlet method, protein content using the Kjeldahl method, and carbohydrate content by difference. The permanganometric titration method was used to determine calcium levels. Although less common in food analysis compared to AAS or ICP-OES, this method was selected based on laboratory availability. Its feasibility is supported by previous studies applying permanganometric titration for calcium determination in food matrices (Sidabalok, 2025); (Pratama & Lestari, 2021); (Lawani et al., 2014).

Results

In this study, three formulations of fish cake odeng were produced: F0 (0% rice anchovy flour), F1 (9% rice anchovy flour), and F2 (18% rice anchovy

flour). The product formulations are presented in Figure 1.

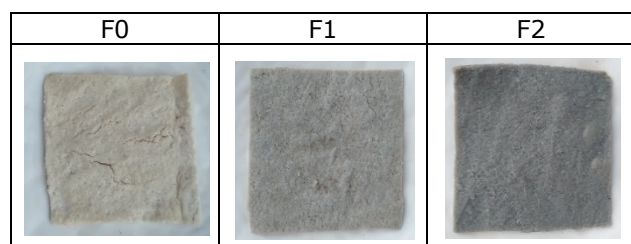


Figure 1 Catfish Surimi Based Fish Cake Odeng with the Addition of Rice Anchovy Flour

The results of the hedonic test of fish cake odeng are presented in Table 1. The scoring test results are shown in Figure 2. The scoring test was conducted to identify the selected product formulation.

Table 1 Hedonic Test Scores of Fish Cake Odeng

| Variabel | Formulation | | |
|----------|-------------|-------------|-------------|
| | F0 | F1 | F2 |
| Color | 4,28 ± 0,74 | 3,84 ± 0,90 | 3,28 ± 0,84 |
| Aroma | 4,12 ± 0,67 | 3,72 ± 0,94 | 3,12 ± 0,93 |
| Texture | 4,24 ± 0,71 | 3,84 ± 0,85 | 3,32 ± 0,85 |
| Taste | 4,52 ± 0,59 | 4,16 ± 0,98 | 3,16 ± 1,14 |

Data are presented as mean ± standard deviation. Values followed by different letters in the same column indicate a significant difference at $p < 0.05$.

Meanwhile, the results of the hedonic quality test of fish cake odeng are presented in Table 2 below.

Table 2 Hedonic Quality Test Scores of Fish Cake Odeng

| Formulation | Mean ± SD |
|-------------|-------------|
| F0 | 4,70 ± 0,75 |
| F1 | 4,15 ± 1,00 |
| F2 | 2,76 ± 1,04 |

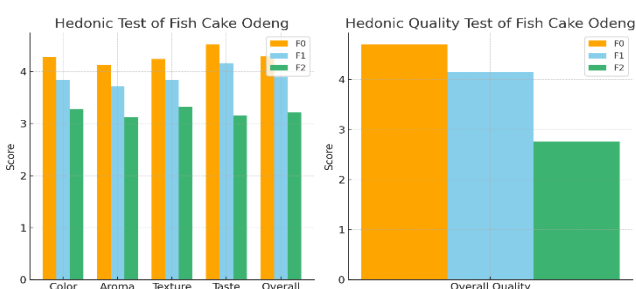


Figure 2 Total scoring of organoleptic characteristics of fish cake odeng

Based on the scoring evaluation, the fish cake odeng formulated with anchovy flour obtained the highest score in treatment F1, namely with the addition of 9% anchovy flour. Subsequently, proximate and calcium analyses were carried out on treatment F1. The results are presented in Table 3.

Table 3 Proximate and Calcium Content of Fish Cake Odeng

| Component | Content |
|--------------|---------|
| Moisture (%) | 20,2 |
| Ash (%) | 1,2 |
| Protein (%) | 12,2 |

| Component | Content |
|--------------------|---------|
| Fat (%) | 8,7 |
| Carbohydrate (%) | 20,4 |
| Calcium (mg/100 g) | 23,4 |

Data are expressed on a wet weight basis. Calcium content is presented as milligrams per 100 grams of sample.

Discussion

Hedonic Test Scores of Fish Cake Odeng

1. Organoleptic Color

The results of the organoleptic test on the color parameter presented in Table 3 show that treatment F0 had the highest mean score (4.28 ± 0.74), followed by F1 (3.84 ± 0.90), while F2 obtained the lowest score (3.28 ± 0.84). Statistical analysis revealed a significant difference among treatments ($p < 0.05$). Duncan's test indicated that F0 was significantly different from F2, whereas F1 was not significantly different from either treatment. Increasing the proportion of anchovy flour tended to intensify the color change of the product, which may reduce its visual appeal. This is important because color is the first sensory factor that influences consumers' perception of food quality. These findings are consistent with previous research reporting that higher levels of rice anchovy flour addition result in darker product color (Haq et al., 2021). This was also evident in formulations F1 and F2, which obtained lower color scores compared to F0.

2. Organoleptic Aroma

The results of the organoleptic test for aroma presented in Table 3 showed that treatment F0 had the highest mean score of 4.12 ± 0.67 , followed by F1 with 3.72 ± 0.94 . Treatment F2 had the lowest score of 3.12 ± 0.93 . Statistical analysis indicated significant differences among treatments ($p < 0.05$). Duncan's test revealed that F0 was significantly different from F2, while F1 did not differ significantly from either treatment. The decrease in aroma score in F2 was presumably due to the higher proportion of anchovy flour, which has a stronger characteristic odor, thereby reducing panelist acceptance. The higher the concentration of anchovy flour, the more pronounced the fishy aroma produced. These results differ from a previous study which reported that anchovy flour fortification had no significant effect on the aroma of canned tuna porridge (Tangke et al., 2022). This was presumably due to the low percentage of anchovy flour addition and the presence of spices such as clove and nutmeg, which masked the characteristic fishy odor.

3. Organoleptic Texture

The results of the organoleptic test for texture presented in Table 3 showed that treatment F0 had the highest mean score of 4.24 ± 0.71 , followed by F1 with 3.84 ± 0.85 . Treatment F2 had the lowest score of 3.32 ± 0.85 . Statistical analysis indicated significant differences among treatments ($p < 0.05$). Duncan's test revealed that F0 was significantly different from F2, while F1 did not differ

significantly from either treatment. The decrease in texture score in F2 was presumably due to the high proportion of anchovy flour, which made the dough firmer and less elastic. High levels of anchovy flour addition can affect water availability and interaction with starch, resulting in a denser fish cake structure. These findings are consistent with previous research reporting that an increased percentage of anchovy flour led to a firmer texture in canned tuna porridge. (Tangke et al., 2022).

4. Organoleptic Taste

The results of the sensory test for taste presented in Table 4 showed that treatment F0 had the highest mean score of 4.52 ± 0.59 , followed by F1 with 4.16 ± 0.98 . Treatment F2 had the lowest score of 3.16 ± 1.14 . Statistical analysis indicated significant differences among treatments ($p < 0.05$). Duncan's test revealed that F0 was significantly different from F2, whereas F1 did not differ significantly from either treatment. The decrease in taste score in F2 was presumably related to the high proportion of anchovy flour, which imparted a stronger fish flavor and could reduce the overall taste balance of the product. Increasing the amount of anchovy flour enhances the characteristic fishy taste, which may not be preferred by some panelists. These results are consistent with previous research reporting that the most preferred fish cookie taste was F1, while F3 was the least preferred. Substitution with anchovy flour produced a bitter taste and strong fish aroma, making F3 less favored by panelists (Ramadhan et al., 2019).

Hedonic Quality Test Scores of Fish Cake Odeng

The results of the hedonic quality test presented in Table 5 showed that treatment F0 had the highest mean score of 4.70 ± 0.75 , followed by F1 with 4.15 ± 1.00 . Treatment F2 had the lowest score of 2.76 ± 1.04 . Statistical analysis indicated significant differences among treatments ($p < 0.05$). Duncan's test revealed that all three treatments (F0, F1, and F2) were significantly different from each other. These results indicate that the addition of a high amount of anchovy flour negatively affected the product quality, likely due to the more dominant taste and aroma of anchovy. The decrease in hedonic quality in F2 may be attributed to various factors, such as the overly strong or dominant fishy taste, which might be unfamiliar to the panelists, or the firmer texture of the product, which was less preferred.

One limitation of this study is that the sensory panel consisted of semi trained panelists with a similar academic background in nutrition. This may influence their perception and evaluation, potentially making them more critical or sensitive to specific attributes compared to regular consumers. Future research should involve a more diverse group of panelists to obtain more generalizable results.

Scoring

The scoring test was conducted to determine the selected product for subsequent nutrient analysis. The results of the scoring test are presented in Figure 2. The highest overall mean score was obtained in treatment F0 with 4.29, followed by F1 with 3.89. The lowest score was observed in F2 with a mean of 3.22. In the hedonic quality test, F0 also received the highest score of 4.70, followed by F1 with 4.15, and F2 with 2.76. Therefore, the fish cake odeng product most preferred by the panelists was treatment F1 (9% rice anchovy flour addition).

Proximate and Calcium Analysis of Fish Cake Odeng

The moisture content of the selected fish cake odeng was 20.2%, which is still in accordance with the Indonesian National Standard (SNI) for fish otak-otak (SNI 7758:2013), which sets a maximum limit of 70%. This low moisture content was influenced by the high-protein anchovy flour, which has strong water binding capacity (Litaay et al., 2023), resulting in a denser product with potentially better shelf life.

The ash content of the selected fish cake odeng was 1.2%, which is still in accordance with the Indonesian National Standard (SNI) for fish otak-otak (SNI 7758:2013), which sets a maximum limit of 2%. This value indicates a safe mineral content and reflects the use of good raw materials and proper processing methods. These results are in line with Litaay (2023), who reported that increasing the concentration of fish flour could raise the ash content in dried noodles.

The protein content of the selected fish cake odeng was 12.2 g/100 g, which meets the Indonesian National Standard (SNI) for fish otak-otak (SNI 7758:2013), requiring a minimum of 5%. This protein content originated from catfish surimi, anchovy flour, and the addition of egg whites. These findings are consistent with Litaay (2023), who reported an increase in protein content in sago noodles with the addition of anchovy flour.

The fat content of the selected fish cake odeng was 8.7 g/100 g, which still complies with the quality standard for fish otak-otak according to SNI 7758:2013, setting a maximum limit of 16%. This value was influenced by the frying method, where oil absorption occurred due to water evaporation at high temperatures (Zahra et al., 2013). In addition, the frying duration and temperature also influenced the amount of oil absorbed (Pudja, 2015).

The carbohydrate content of the selected fish cake odeng was 20.4 g/100 g. This value was lower than the findings of Zuraida et al., (2025) on fried black tilapia fish cakes (27–59%), but comparable to the carbohydrate content of commercial fish cake odeng, which ranges from 22 to 26 g. The carbohydrate content mainly originated from tapioca flour as the primary contributor, while fish meat provided only a minor contribution due to its low carbohydrate levels (0.34–0.77%) (Junianto & Rostini, 2024).

The calcium content of the selected fish cake odeng was 23.4 mg/100 g, equivalent to 1.9% of the

recommended dietary allowance (RDA) for adolescents. This value is relatively low compared to other fortified fish-based products. For instance, fish bars formulated with *bilih* (*Mystacoleuseus padangensis*) flour contained 922.23 mg calcium per 100 g (Trisnawati et al., 2024), indicating that the calcium level in this study was considerably lower. The difference may be due to the lower inclusion rate of rice anchovy flour (9%) and potential mineral loss during soaking and frying. These findings suggest that optimizing the fortification level or incorporating calcium-binding ingredients may enhance mineral retention in future formulations. This value was substantially lower than that reported by Haq (2023) in semprong cookies substituted with 5% rice anchovy flour (820.6 mg), as well as the findings of Simaremare et al., (2024) in crackers fortified with anchovy flour (360.4 mg). The relatively low calcium content in this study was presumably influenced by the soaking process of semi-dried anchovies in hot salted water prior to processing. This treatment may have led to mineral leaching into the soaking medium, as also described by Wardani & Handrianto, (2019) Soaking in a high-temperature saline solution has been reported to reduce calcium oxalate levels due to cell wall disruption and the interaction of Na⁺ and Cl⁻ ions with Ca²⁺. Jiang et al., (2023) reported that the salting process of fish fillets can trigger the migration of water-soluble compounds through mass transfer mechanisms, involving the diffusion of solutes from the tissue into the brine, thereby potentially accelerating the loss of minerals, including calcium. In addition, the frying method also influences calcium levels. Although calcium is relatively stable under heat, Alugwu et al., (2023) found that deep-fat frying could reduce calcium content by up to 45.06% due to leaching into the oil.

Calcium content might be higher if fish bone flour were used as a fortification ingredient, as shown by Afrinis et al., (2018) who reported a markedly high calcium level in vermicelli fortified with catfish bone flour (1002 mg/100 g). In contrast, the present study utilized anchovy flour, resulting in relatively lower calcium content.

In this study, fish cake odeng was consumed along with broth, which also contributed to calcium intake. Based on the Indonesian Food Composition Table, one serving of broth contained 254.26 mg of calcium, mainly derived from 5 g of anchovy flour and fish sauce. Pontoh et al., (2023) highlighted that anchovies are an excellent source of animal based calcium, suggesting that the broth could provide an additional calcium intake despite the relatively low calcium content of the fish cake itself.

Conclusion

The findings of this study indicate that the addition of anchovy flour influenced the sensory quality and nutritional composition of fish cake odeng. The F1 formulation (9% anchovy flour) achieved the highest scores in color, aroma, texture, and taste, whereas F2 (18%) was less preferred by the

panelists. Hedonic quality testing also confirmed that products with anchovy flour addition were still acceptable. Proximate analysis of F1 revealed a moisture content of 20.2%, ash 1.2%, protein 12.2 g/100 g, fat 8.7 g/100 g, and carbohydrates 20.4 g/100 g, all of which complied with the Indonesian National Standard for fish otak-otak (SNI 7758:2013). The calcium content of the product was 23.4 mg/100 g, equivalent to 1.9% of the adolescent recommended dietary allowance, which is relatively lower than expected and compared to previous studies. Limitations of this study include calcium analysis performed on only one formulation, less homogeneous dough mixing due to the absence of a food processor, and the lack of calcium bioavailability testing. Overall, fish cake odeng with anchovy flour shows potential as a nutritious snack to increase protein and mineral intake among adolescents, although Further efforts are needed to enhance its calcium content, such as incorporating calcium rich ingredients like fish bone flour or calcium salts. Future research should focus on optimizing anchovy flour processing to minimize mineral loss, applying more homogeneous mixing methods, and including calcium bioavailability tests. In addition, shelf life evaluation and consumer acceptance studies are required to further develop anchovy flour based fish cake odeng as a functional and healthy snack that is well accepted by consumers.

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