

Anchovy Rice Nuggets and Straw Mushroom with Porang Flour Substitution to Prevent Stunting

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Abstract

Stunting is one of the chronic nutritional problems in toddlers that remains highly prevalent in Indonesia. Prevention efforts can be carried out through the innovation of functional foods based on nutrient-rich local ingredients. This study aimed to determine the effect of *porang* flour substitution on the hedonic quality, toddler panelists' acceptance, and nutritional composition of anchovy rice and straw mushroom nuggets. The study used an experimental design with three formulas: P1 (60% anchovy rice, 25% straw mushroom, 20% *porang* flour), P2 (60% anchovy rice, 20% straw mushroom, 25% *porang* flour), and P3 (60% anchovy rice, 15% straw mushroom, 30% *porang* flour). Hedonic and hedonic quality tests were conducted on 25 toddler panelists, while proximate analysis included moisture, ash, fat, protein, crude fiber, and carbohydrate content. The results showed that P1 obtained the highest scores and was most preferred in terms of color, aroma, taste, and texture. Proximate analysis also showed that P1 had the highest protein content (6.81%) with 65.82% moisture, 1.56% fat, 2.33% ash, 0.95% crude fiber, and 23.47% carbohydrates. Meanwhile, the increased substitution of *porang* flour in P3 reduced sensory quality and protein levels, although it increased fiber and carbohydrates. Therefore, P1 can be considered the best formula because it achieved the highest acceptance and provided more suitable nutrients to support the improvement of toddlers' nutritional status. This study highlights that the utilization of local food ingredients such as anchovy rice, straw mushrooms, and *porang* flour has the potential to serve as an innovative strategy for stunting prevention.

Keywords: Animal Protein; Complementary Feeding; Local Food; Nutritional Value; Stunting.

INTRODUCTION

Stunting is a condition of growth failure in children caused by chronic malnutrition, marked by height being lower than the average for their age (Isasih et al., 2025). Stunted children are at high risk of cognitive development disorders, low immunity, and reduced productivity in adulthood (Dessie et al., 2024). According to WHO in 2023, the global prevalence of stunting was 22% (Schneider, 2025). In Indonesia, the rate was 21.5%, in West Nusa Tenggara (NTB) 24.6%, and in North Lombok Regency 19.3%. One of the main causes is the lack of energy and protein intake among toddlers (Isasih, Inayati, et al., 2024). A preliminary survey in Tanjung village, North Lombok Regency, showed that 60% of mothers of stunted toddlers provided snacks such as crackers/chips, 22% gave wafers, and 35% gave candy. These snack types reduce appetite and have low or incomplete nutritional value (Astuti et al., 2025). Therefore, stunting can be addressed through interventions and the development of nutritious, affordable, and child-friendly foods such as nuggets (Indah et al., 2024). Nuggets are popular among children

and have strong potential to be modified into functional foods (Atmojo et al., 2025).

Developing nuggets using local nutrient-rich ingredients provides an opportunity in North Lombok Regency. Anchovies, abundant due to the wide seas, are rich in protein. Straw mushrooms, which contain plant-based protein, grow well because of the availability of rice straw from frequent rice harvests. In addition, *porang*, now widely cultivated in North Lombok Regency, produces tubers that can be processed into flour rich in glucomannan. Thus, developing nuggets from straw mushrooms with *porang* flour substitution represents an innovative step to prevent stunting, improve nutrition, and strengthen food security using local resources (Solehah et al., 2024).

Previous studies have shown that anchovies support growth and tissue repair (Afgani, 2024), straw mushrooms are high in protein, fiber, vitamins, and minerals that aid muscle development (Halimhah et al., 2023), and *porang* contains glucomannan, a natural prebiotic that improves digestion and nutrient absorption (Fakhira et al., 2025). Substituting part of the nugget ingredients with *porang* flour can increase functional

value without reducing taste and texture preferred by children (Sukoso et al., 2025). The urgency of this study lies in the high stunting rate in North Lombok Regency (19.3%), combined with toddlers' frequent consumption of low-nutrient snacks. However, there is no evidence yet that anchovy straw mushroom nuggets with porang flour substitution can serve as functional food to prevent stunting.

This study evaluates three nugget formulations combining anchovies and straw mushrooms with *porang* flour substitution, using locally abundant and widely consumed ingredients. The strength of this research is in its assessment through hedonic and hedonic quality tests on 75 toddlers using facial scales, along with proximate analysis of moisture, ash, fat, crude fiber, protein, and carbohydrates using UV-Vis spectrophotometry. The goal is to identify the best formulation of anchovy–straw mushroom nuggets as nutritious, affordable, and acceptable functional food for children. The novelty of this research lies in being the first to investigate nuggets made with anchovies, straw mushrooms, and *porang* flour substitution for stunting prevention. The research problem is framed as: What is the potential of anchovy–straw mushroom nuggets with *porang* flour substitution as functional food to prevent stunting.

MATERIALS AND METHODS

This study employed a quantitative experimental approach with a Completely Randomized Design (CRD), using three levels of treatment formulas for anchovy–straw mushroom nuggets with *porang* flour substitution. The treatment levels were determined based on fulfilling 10% of the daily nutritional needs for toddler snacks, as recommended by the 2019 Dietary Reference Intake (Kumala & Sianipar, 2019).

A previous study evaluated tuna nugget supplementation (PMT) for stunted toddlers. This research focuses on anchovy–straw mushroom nuggets with *porang* flour substitution, assessed through hedonic tests, hedonic quality tests, carbohydrate tests, glucomannan analysis, and proximate analysis to identify the best formula. A preliminary survey on snack consumption patterns has been conducted. Using a quantitative experimental method with a Completely Randomized Design (CRD), three treatment levels were tested to develop a nutritious, affordable, and child-acceptable functional food. The treatment levels were set based on the 2019 Dietary Reference Intake for toddlers' snack needs (10% of daily requirement) (Suhartini et al., 2022). The proportions (%) of anchovy, straw

mushroom, and *porang* flour used in each treatment are presented in the following table.

Table 1. Proportion levels (%) of anchovy-based nuggets and straw mushrooms with *porang* flour substitution as a functional food intervention for stunting prevention.

Treatment Formula	Anchovy (%)	Straw Mushroom (%)	Porang Flour (%)
P1	60	25	20
P2	58	20	17
P3	58	17	25

Based on Table 1, three treatment formulas of anchovy–straw mushroom nuggets with *porang* flour substitution were tested. The formulation followed previous studies using flour, fish, and vegetables as main ingredients. Nugget preparation involved anchovies, straw mushrooms, *porang* flour, cornstarch, eggs, breadcrumbs, salt, garlic, and scallions, processed with standard cooking tools. Anchovies were cleaned, soaked, and deodorized with lime juice, while straw mushrooms were sorted and rinsed. Ingredients were chopped, weighed, mixed, molded, steamed, cooled, portioned, coated with egg and breadcrumbs, and fried until golden. Hedonic and hedonic quality tests (color, aroma, taste, texture, appearance) were conducted on 75 stunted toddlers using a 1–7 facial scale. Proximate analyses measured moisture, ash, protein, fat, and carbohydrates, with all tests performed in triplicate. One-Way ANOVA determined significance, and the best formula was identified as a nutrient-rich, affordable, and acceptable functional food based on local ingredients for stunting prevention.

RESULTS AND DISCUSSION

Result

Fish nuggets are fishery products processed from at least 30% minced fish meat, combined with flour and other ingredients, then cooked (Aisyah et al., 2022). In this study, nuggets were prepared with three treatment levels: P1 consisted of 60% anchovies, 25% straw mushrooms, and 20% *porang* flour; P2 consisted of 58% anchovies, 20% straw mushrooms, and 17% *porang* flour; P3 consisted of 58% anchovies, 17% straw mushrooms, and 25% *porang* flour. Organoleptic testing is a sensory evaluation of taste, color, aroma, texture, and overall quality using human senses. There are two types of organoleptic tests: the hedonic test and the hedonic quality test. The results of the hedonic test can be seen in the following table:

Table 2. Hedonic test of anchovy–straw mushroom nuggets with *porang* flour substitution.

Formulation Treatments	Parameters of Hedonic Evaluation Attributes				Total
	Color	Aroma	Flavor	Texture	
P1	7,00 ^a	7,00 ^a	6,00 ^a	6,00 ^a	26,00 ^a
P2	6,00 ^b	6,00 ^b	5,00 ^b	4,00 ^b	21,00 ^b
P3	5,00 ^c	4,00 ^c	4,00 ^c	5,00 ^c	18,00 ^c
P-Value	0,039	0,023	0,028	0,001	0,029

Based on table 2, the hedonic test results for anchovy–straw mushroom nuggets with *porang* flour substitution showed significant differences across all sensory parameters, including color, aroma, taste, texture, and overall evaluation. Formula P1 achieved the highest total score of 26.00, followed by P2 (21.00) and P3 (18.00). The p-values for all attributes were <0.05 (color 0.039; aroma 0.023; taste 0.028; texture 0.001;

total 0.029), indicating significant differences among the formulas.

The hedonic quality test is an evaluation used to assess the specific quality attributes of a product such as color, aroma, taste, and texture based on sensory perception, to determine how well these characteristics meet acceptable standards. The results of the hedonic quality test can be seen in the following table:

Table 3. Hedonic quality test of anchovy straw mushroom nuggets with *porang* flour substitution.

Treatment Formula	Attributes of Hedonic Quality Evaluation				Total
	Golden yellow appearance	Characteristic fish aroma	Umami flavor	Chewable texture	
P1	5,00 ^a	7,00 ^a	7,00 ^a	6,00 ^a	25 ^a
P2	4,00 ^b	6,00 ^b	6,00 ^b	5,00 ^b	21 ^b
P3	6,00 ^c	4,00 ^c	5,00 ^c	4,00 ^c	19 ^c
P-Value	0,001	0,017	0,033	0,043	0,037

The hedonic quality evaluation presented in table 3 revealed statistically significant differences across all parameters, including golden-yellow appearance, characteristic fish aroma, umami flavor, and bite texture. All attributes exhibited p-values below 0.05, confirming that the sensory quality of anchovy–straw mushroom nuggets with *porang* flour substitution was markedly affected by formulation differences. Formula P1 obtained the highest overall score of 24, followed by P2 and P3 with 22 each. The superior score of P1 indicates that

panelists expressed greater preference for its color, aroma, flavor, and texture. In terms of golden-yellow appearance, Formula P3 surpassed both P1 and P2, a result attributable to its higher *porang* flour content, which enhanced product coloration. Nonetheless, despite its more appealing color, P3 received lower ratings for both flavor and aroma. The results of the proximate analysis of anchovy–straw mushroom nuggets with *porang* flour substitution are presented in the following table:

Table 4. Proximate analysis results of anchovy–straw mushroom nuggets with *porang* flour substitution.

Formulation Treatments	Proximate Analysis Parameters					
	Moisture (%)	Ash (%)	Lipid (%)	Crude fiber (%)	Protein (%)	Carbohydrate (%)
P1	65,8272	2,3274	1,5606	0,9458	6,8120	23,4728
P2	64,0141	1,2770	1,6031	1,3789	6,5766	26,5293
P3	63,1313	1,1906	1,8168	1,4027	4,2428	29,6185

The proximate analysis results in Table 4 show that the chemical composition of anchovy–straw mushroom nuggets with *porang* flour substitution varied across formulas. The highest moisture content was found in P1 (65.82%), followed by P2 (64.01%) and P3 (63.13%).

Discussion

The findings revealed that P1 was the most preferred by the panelists compared to P2 and P3. This preference is likely due to the optimal proportion of *porang* flour in P1, which preserved the original sensory qualities of the nuggets. *Porang* flour contains glucomannan, which binds water and forms a gel, thereby improving texture (Fakhira et al., 2025). However, excessive use, as in P3,

reduced flavor and created an unpleasant mouthfeel due to glucomannan's viscous and slightly slimy properties (Anggela et al., 2023).

In terms of color, P1 and P2 received higher scores than P3. This aligns with previous research noting that excessive *porang* flour can affect product brightness through non-enzymatic browning during cooking (Dharma et al., 2025). For aroma and taste, P1 also ranked highest. This supports Nareswari's findings that *porang* flour must be limited in food formulations, as higher concentrations may mask the original flavor and produce an undesirable aroma (Nareswari et al., 2024). Texture showed the most significant difference ($p=0.001$). P1 had the most favorable texture, as moderate glucomannan content enhanced chewiness. Conversely, P3 had poorer texture, becoming denser and harder due to excessive *porang* flour substitution. This is consistent with Satrya's study, which noted that high levels of *porang* flour reduce tenderness in protein-based foods (Satrya et al., 2025). These results also agree with Windi Habsari and Dita Ayu Lestari (2025), who reported that glucomannan improves water retention and texture in processed meat products, though its use must be carefully controlled to avoid flavor deterioration (Windi Habsari, Dita Ayu Lestari, 2025). Overall, P1 was the best formula, producing anchovy–straw mushroom nuggets with the most desirable color, aroma, taste, and texture among all treatments.

The fishy aroma was rated lower in formulas P2 and P3 compared to P1. This indicates that excessive *porang* use may produce a distinctive aroma less favored by panelists, consistent with previous research stating that a strong *porang* aroma can reduce product acceptance (Rahman et al., 2025). Regarding savory taste, formula P1 obtained the highest score. This suggests that a moderate amount of *porang* flour can preserve the flavor of anchovy–straw mushroom nuggets without masking the natural taste of the main ingredients. In contrast, formula P3, which contained more *porang*, showed a decline in savory taste due to a slightly bitter sensation and a slimy texture caused by glucomannan (Dharma et al., 2025).

The bite texture in the three formulas was relatively similar, although P1 performed slightly better. This is consistent with previous research indicating that the gelling properties of glucomannan in *porang* can enhance water-binding capacity, making the product texture more elastic (Indrayani & Khasana, 2025). However, excessive use may result in an overly dense and less tender texture (Aisyah et al., 2022). Therefore, P1, which used *porang* flour in a balanced amount, was considered the best in terms of texture.

This study supports previous findings that *porang* can be used as a substitute ingredient in food products, particularly to improve texture and extend shelf life. Nevertheless, its use should be limited to avoid reducing other sensory qualities such as aroma and flavor.

Accordingly, P1 was once again identified as the best formulation in the hedonic quality test, as it produced anchovy–straw mushroom nuggets with a sufficiently appealing color, a more desirable aroma, a dominant savory taste, and a superior bite texture compared with the other formulas.

The decrease in moisture content along with higher *porang* substitution is likely due to the strong water-binding capacity of glucomannan, which reduces the amount of free water measurable. This aligns with previous research stating that glucomannan in *porang* functions as a hydrocolloid, binding water and forming gels, thus lowering measurable water content (Ayu Joyana Sri Hartatik et al., 2024).

Ash content was highest in P1 (2.32%), while P2 and P3 contained only 1.27% and 1.19%, respectively. Ash reflects mineral content, so the decrease in P2 and P3 is likely due to a lower proportion of mineral-rich raw materials, replaced by *porang* flour. This finding is consistent with previous studies showing that *porang* flour has relatively low mineral levels compared to animal or mushroom-based ingredients (Pradina Arifah Nurcahyani, 2025). Fat levels were generally low across all formulas, ranging from 1.56% to 1.81%. Formula P3 showed the highest fat level (1.82%), possibly due to differences in additional ingredients. However, fat levels across formulas still align with mushroom-based nuggets, which are typically low in fat (Rahman et al., 2025).

Crude fiber content increased with higher *porang* substitution: P1 (0.94%), P2 (1.37%), and P3 (1.40%). This corresponds to *porang* flour's high dietary fiber content, particularly glucomannan, which is a soluble fiber (Fakhira et al., 2025). Protein levels were highest in P1 (6.81%), slightly decreased in P2 (6.57%), and dropped significantly in P3 (4.24%). The reduction in P3 indicates that a high proportion of *porang* flour lowers protein content since *porang* is not protein-rich compared to mushrooms or other animal-based ingredients. This supports prior findings showing that substituting non-protein ingredients in food formulations significantly reduces protein levels (Isasih, Fajriani, et al., 2024).

Conversely, carbohydrate content increased with greater *porang* substitution: P1 (23.47%), P2 (26.53%), and P3 (29.62%). This increase is due to *porang* flour's high glucomannan content, contributing to higher total carbohydrates. These results confirm previous reports that *porang* flour can enhance carbohydrate and dietary fiber content in processed foods (Suhartini et al., 2022).

Overall, the proximate analysis shows that P1 had the highest protein and moisture content, along with lower carbohydrate levels compared to other formulas, making it nutritionally more balanced. P2 and especially P3 had higher carbohydrate and fiber content but at the expense of reduced protein and mineral levels. This highlights that excessive *porang* flour not only affects sensory characteristics but also reduces nutritional quality. Thus,

P1 remains the best formula in terms of both sensory quality and nutritional composition.

CONCLUSIONS

This study demonstrates that anchovy straw mushroom nuggets with *porang* flour substitution have strong potential as functional food for stunting prevention. Hedonic and quality tests showed significant differences, with formula P1 (60% anchovy, 25% straw mushroom, 20% *porang* flour) receiving the highest preference for color, aroma, taste, and texture. Proximate analysis confirmed P1's balanced nutrition, with the highest protein (6.81%), optimal moisture, and moderate carbohydrates. Meanwhile, higher *porang* flour in P3 reduced sensory quality and protein but increased fiber. Thus, P1 is the best formula, offering nutritious, acceptable, and locally based innovation to strengthen food security and prevent stunting.

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Authors' Contributions: Junendri Ardian. Possesses expertise in the field of nutrition, served as the initiator of the research topic, and participated in the development of anchovy rice and straw mushroom nuggets with *porang* flour substitution. Contributed to data collection for hedonic and hedonic quality tests, data management and analysis, as well as the preparation of the research proposal, report, and outputs

Anisah and Widani darma isasih. Possesses expertise in public health, participated in the development of anchovy rice and straw mushroom nuggets with *porang* flour substitution, and was involved in carbohydrate, glucomannan, and proximate analyses. Also contributed to the preparation of the research report and outputs.

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