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Nutritional content and acceptability of milkfish and purple sweet potato sambusa in an effort to prevent stunting

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ABSTRACT

Background: Stunting remains a major public health issue caused by chronic malnutrition and recurrent infections. In South Sulawesi, Indonesia, the prevalence of stunting in 2024 was 23.3%. One contributing factor is chronic energy deficiency (CED) among pregnant women. The government promotes supplementary feeding (PMT) to address this. Sambusa made from milkfish (Chanos chanos) and purple sweet potato has potential as a local PMT due to its nutritional value and local availability.

Methods: This experimental study used a randomized design to analyze the sensory characteristics and nutritional content of Sambusa with milkfish and purple sweet potato substitution. The organoleptic test was conducted at the Organoleptic Laboratory of Poltekkes Kemenkes Makassar, and nutrient analysis (protein, omega-3, anthocyanin) at the Integrated Biotechnology Laboratory, Hasanuddin University, during May–June 2025.

Results: Sensory evaluation showed significant differences in color and texture ($p<0.05$) but not in aroma or taste ($p>0.05$). The protein content in the control (F0) and best formula (F3) was 13.88% and 13.72%, respectively. The proportion of omega-3 to total fatty acids increased from 0.74% (F0) to 0.78% (F3), and anthocyanin levels rose from 2.57 CyE/g (F0) to 7.85 CyE/g (F3).

Conclusion: Substitution with milkfish and purple sweet potato influenced the sensory and nutritional qualities of Sambusa. The modification enhanced omega-3 and anthocyanin content without significantly affecting protein levels. This product shows promise as a nutritious local supplementary food for pregnant women to help prevent stunting.

Keywords: Milkfish, pregnant women, purple sweet potato, stunting, supplementary food.

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INTRODUCTION

Stunting is a nutritional disorder characterized by impaired growth and development in children due to chronic malnutrition and recurrent infections (Astuti, Suindyah Dwiningwarni and Atmojo, 2025). According to the World Health Organization (WHO), stunting is defined as a failure to achieve optimal height and development resulting from prolonged nutritional deficiencies, frequent infections, and inadequate psychosocial stimulation. The condition can begin as early as during pregnancy and continue after birth. The underlying causes are multifactorial and can be divided into prenatal and postnatal factors (Bhandari *et al.*, 2025). Prenatal causes are related to maternal health and nutritional status, such as chronic energy deficiency (CED), anemia, adolescent pregnancy, inadequate weight gain during pregnancy, and exposure to cigarette smoke (Carlqvist *et al.*, 2025). Postnatal factors include poor dietary intake, infectious diseases, and suboptimal parenting practices, which are influenced by socioeconomic and environmental determinants (Ashar *et al.*, 2025).

Based on the Indonesia Nutrition Status Survey (SSGI) 2024, the national prevalence of stunting is 19.8%, showing a decrease from 21.5% in 2023. However, the prevalence in South Sulawesi remains high at 23.3%, and in Makassar City at 22.9% . This figure remains far from the government's target stipulated in Presidential Regulation No. 72 of 2021, which aims to reduce stunting prevalence to 14% by 2024. Therefore, stronger and more sustainable interventions are urgently required to meet this target effectively (Kesehatan, 2025).

One major contributing factor to stunting is maternal chronic energy deficiency (CED) during pregnancy. Pregnant women with CED are 14.2 times more likely to give birth to stunted children than those with adequate nutritional status (Chowdhury *et al.*, 2025). CED is defined as a prolonged state of inadequate energy and protein intake, commonly assessed through mid-upper arm circumference (MUAC) measurements of less than 23.5 cm (Dominguez *et al.*, 2025). According to the Indonesian Health Survey 2023, 16.9% of pregnant women nationwide suffer from CED, and the prevalence in South Sulawesi is even higher at 19.7%. This issue requires immediate attention from both government and community health stakeholders (Eglovitch *et al.*, 2024). To address this, the National Strategy for Accelerating Stunting Prevention and Reduction (P3S) 2025–2029 emphasizes maternal and child nutrition interventions. The strategy targets pregnant women, breastfeeding mothers, infants, and children under five, focusing on preventing new cases of stunting. Among its six pillars, the fourth pillar highlights the importance of food and nutrition security, ensuring access to diverse, safe, and nutritious foods for vulnerable groups (Gómez *et al.*, 2025).

Providing adequate nutrition for pregnant women, especially those with CED, through Supplementary Feeding Programs (PMT) has proven effective in improving maternal weight gain. Studies show that supplementary food provided for three weeks can increase maternal body weight by an average of 1.62 kg (Gough *et al.*, 2024). Furthermore, adequate dietary intake during pregnancy correlates with optimal weight gain and improved maternal and fetal health outcomes (Haque *et al.*, 2024). PMT should therefore consist of balanced meals high in energy and protein to meet nutritional requirements.

Sambusa, a traditional snack from Polewali Mandar, shaped like a triangle and similar to Middle Eastern samosa, has potential as a local supplementary food. Traditionally made with fish such as barracuda or tuna and wrapped in wheat-based

dough, it is rich in protein and culturally acceptable (Isdiany *et al.*, 2024). This study developed sambusa made from milkfish (Chanos chanos) and purple sweet potato (Ipomoea batatas L.), utilizing locally available ingredients in South Sulawesi, where milkfish production reached 173,249 tons in 2023 (Sulsel, 2023), and sweet potato production was 71.68 thousand tons. Milkfish is a nutritious fish containing 20–24% protein, essential amino acids, omega-3 fatty acids, and minerals such as calcium, magnesium, and iron (Jalloh *et al.*, 2025). Meanwhile, purple sweet potato provides carbohydrates, dietary fiber, anthocyanins, vitamins, and antioxidants that promote health (Kamruzzaman *et al.*, 2025). Combining these two ingredients is expected to produce a nutritious and acceptable product that can be used as supplementary food for pregnant women with CED, contributing to sustainable stunting prevention.

This research aimed to analyze the nutritional composition and sensory acceptability of milkfish and purple sweet potato sambusa. Specifically, it evaluated protein content, omega-3 fatty acids, and anthocyanin levels, as well as color, aroma, taste, and texture preferences among trained panelists. The findings are expected to provide scientific evidence supporting the development of local food-based interventions that are both nutritious and culturally acceptable for improving maternal nutrition and preventing stunting in Indonesia.

RESEARCH METHODOLOGY

Research Design, Location, and Period

This study employed an experimental design with a completely randomized design (CRD). The research was conducted at the Organoleptic Test Laboratory of Poltekkes Kemenkes Makassar and the Integrated Biotechnology Laboratory, Faculty of Animal Science, Hasanuddin University, during May–June 2025.

Formulation of Treatments

Four formulations of milkfish and purple sweet potato sambusa were prepared:

F0 (Control): Barracuda fish and wheat flour without substitution.

F1: 25% milkfish and 75% barracuda fish; 75% purple sweet potato and 25% wheat flour.

F2: 50% milkfish and 50% barracuda fish; 50% purple sweet potato and 50% wheat flour.

F3: 75% milkfish and 25% barracuda fish; 25% purple sweet potato and 75% wheat flour.

Organoleptic Test

The acceptability (organoleptic) test was conducted to evaluate color, aroma, taste, and texture using a hedonic scale ranging from 1 (dislike very much) to 5 (like very much). The test involved 30 semi-trained panelists who had previously taken culinary nutrition courses. Data from the sensory evaluation were analyzed statistically using SPSS software. The most preferred formulation was determined based on the highest mean score from the panelists' responses. The selected formula and control (F0) were subsequently analyzed for nutritional content.

Nutritional Analysis

Nutritional analysis was performed on the control (F0) and the most preferred formula (F3), focusing on protein content, omega-3 fatty acids, and anthocyanin levels.

Protein content was analyzed using the Kjeldahl method.

Omega-3 fatty acids were analyzed using Gas Chromatography–Mass Spectrometry (GC-MS).

Anthocyanin content was determined using the pH differential method with spectrophotometry.

All analyses were carried out at the Integrated Biotechnology Laboratory, Faculty of Animal Science, Hasanuddin University.

Materials and Equipment

The main ingredients used in this study included wheat flour, purple sweet potato, milkfish, barracuda fish, spring onion, eggs, margarine, garlic, shallots, pepper, water, salt, and cooking oil. Analytical-grade reagents were used for the determination of protein, omega-3, and anthocyanin contents. The equipment used included gas chromatograph, spectrophotometer, Kjeldahl apparatus, stove, frying pan, rolling pin, mixing bowl, and other standard laboratory tools.

Preparation Procedure

Dough preparation: Wheat flour, margarine, and water were mixed until smooth and non-sticky, then rolled to a 1 mm thickness.

Filling preparation: Barracuda and milkfish were steamed at 100°C, shredded, and sautéed with garlic, shallots, pepper, spring onion, egg, and salt until cooked. Forming sambusa: The dough was cut into triangular shapes, filled with the prepared mixture, sealed, and deep-fried at 150°C for 2–3 minutes until golden brown. Sample analysis: The products were cooled to room temperature before being subjected to organoleptic and nutritional analyses.

Data Analysis

All sensory data were analyzed using Kruskal–Wallis non-parametric tests to determine significant differences between treatments at a 5% significance level ($p < 0.05$). Nutrient analysis results were presented as mean ± standard deviation and interpreted descriptively to compare the effects of substitution levels on protein, omega-3, and anthocyanin contents.

RESULT

Table 1. Composition of Ingredients in Each Treatment (Formula)

Ingredients (g)	**F0**	**F1**	**F2**	**F3**
Barracuda fish	40	30	20	10
Milkfish	0	10	20	30
Wheat flour	50	12.5	25	37.5
Purple sweet potato	0	37.5	25	12.5
Egg	4	4	4	4
Shallot	4	4	4	4
Garlic	4	4	4	4
Leek	20	20	20	20
Salt	0.5	0.5	0.5	0.5
Pepper	0.1	0.1	0.1	0.1
Water	15	15	15	15
Cooking oil	20	20	20	20

Notes:
F0 = Control formula (no substitution)
F1 = Substitution of purple sweet potato : wheat flour = 75 : 25 and milkfish : barracuda = 25 : 75
F2 = Substitution of purple sweet potato : wheat flour = 50 : 50 and milkfish : barracuda = 50 : 50
F3 = Substitution of purple sweet potato : wheat flour = 25 : 75 and milkfish : barracuda = 75 : 25

Table 2. Sensory Characteristics and Nutritional Content of Milkfish and Purple Sweet Potato Sambusa

Parameter	Formula F0	Formula F1	Formula F2	Formula F3	*p*-value	Interpretation
Color	-	3.47	3.87	4.10	0.016	Significant difference ($p<0.05$); F3 most preferred due to bright color and appealing appearance.
Aroma	-	3.93	4.17	4.17	0.440	No significant difference ($p>0.05$); similar aroma profile across formulas.
Taste	-	4.00	3.93	4.10	0.624	No significant difference ($p>0.05$); consistent flavor among samples.
Texture	-	3.50	3.70	3.97	0.033	Significant difference ($p<0.05$); F3 most preferred due to crispy texture.
Protein (%)	13.88	-	-	13.72	-	Slight reduction (0.16%) in F3; substitution did not significantly affect protein content.
Omega-3 (%TFA)	0.74	-	-	0.78	-	Slight increase (0.05%); milkfish substitution improved omega-3 proportion.
Anthocyanin (CyE/g)	2.57	-	-	7.85	-	Substantial increase (~3× higher); purple sweet potato increased antioxidant content.

The combined analysis of sensory and nutritional parameters of Sambusa made from milkfish (Chanos chanos) and purple sweet potato (Ipomoea batatas L.) shows notable improvements in product quality due to the ingredient substitutions.

Sensory Characteristics. Significant differences were found in color and texture ($p<0.05$), while aroma and taste remained statistically similar ($p>0.05$). Panelists preferred formula F3, which had the highest mean scores for color (4.10) and texture (3.97). This was attributed to a better balance between the milkfish and wheat flour ratio, producing a crisp texture and visually appealing appearance.

Protein Content. The protein concentration in the control sample (F0 = 13.88%) and the experimental formula (F3 = 13.72%) differed minimally (−0.16%), suggesting that substituting barracuda with milkfish and adding purple sweet potato did not significantly reduce protein levels. The resulting protein content still met the recommended nutrient level for supplementary foods for pregnant women.

Omega-3 Fatty Acids. There was a slight increase in omega-3 content from 0.74% (F0) to 0.78% (F3), indicating that milkfish contributed beneficial polyunsaturated fatty acids, especially EPA and DHA. This suggests potential health benefits for pregnant women, particularly in fetal development and prevention of premature birth.

Anthocyanin Content. Anthocyanin levels showed a threefold increase, from 2.57 to 7.85 CyE/g in F3. The inclusion of purple sweet potato was the key factor in enhancing

the antioxidant capacity of the Sambusa, offering additional functional benefits that could support maternal health and stunting prevention programs.

The substitution of milkfish and purple sweet potato in Sambusa significantly improved its color, texture, and antioxidant profile without compromising taste or protein quality. Thus, the F3 formulation presents a promising local food innovation suitable as a supplementary food for pregnant women to support stunting prevention efforts.

DISCUSSION

This study aimed to analyze the sensory characteristics and nutritional composition of milkfish and purple sweet potato sambusa as a potential local supplementary food to prevent stunting, particularly among pregnant women with chronic energy deficiency (CED). The results indicated that substitution with milkfish and purple sweet potato affected the color and texture of sambusa significantly ($p < 0.05$) but had no significant effect on aroma and taste ($p > 0.05$). Moreover, the substitution increased the omega-3 and anthocyanin content, while protein levels remained relatively stable. These findings suggest that the product has potential functional and nutritional benefits to support maternal nutrition in stunting prevention programs.

Sensory Characteristics

The sensory evaluation revealed that the color and texture of sambusa were the most affected parameters by the substitution. The use of purple sweet potato contributed to a darker color tone, enhancing the visual appeal of the product. According to (Kamudoni *et al.*, 2024), food color strongly influences consumer acceptance and appetite stimulation, as it is associated with perceived freshness and taste quality. Similarly, (Kinshella, Moore and Elango, 2025) emphasized that color perception plays a key role in determining consumer satisfaction and product preference. The darker shade produced in treatment F3 (75% milkfish substitution) may result from anthocyanin pigments in purple sweet potatoes, which are sensitive to heat and pH changes during frying (Kumar *et al.*, 2024).

Texture analysis also revealed significant differences among treatments. The F3 formulation received the highest texture score (3.97), indicating a crisp yet tender consistency preferred by panelists. Increased use of purple sweet potato tends to soften the texture because of its higher water and fiber content. As moisture retention rises, the fried surface becomes less crunchy, consistent with observations by (Landin Basterra *et al.*, 2025) that heat exposure and carbohydrate composition directly affect the crispness of fried products.

In contrast, aroma and taste were not significantly influenced by substitution ratios. The similar flavor profile across all formulations may be attributed to the uniform seasoning and fish composition used. Aroma in food products typically arises from volatile compounds released during cooking, while flavor is determined by the interaction of taste and aroma (Latif, Adam and Kamaruddin, 2025). The results indicate that the substitution did not alter these sensory attributes in a perceptible manner, suggesting that milkfish and purple sweet potato are compatible ingredients for developing acceptable local foods.

Protein Content

Protein analysis showed minimal variation between control (F0) and the substituted formula (F3), with values of 13.88% and 13.72%, respectively. The slight decrease in

protein levels may result from heat denaturation during frying. High-temperature cooking can damage protein structures and reduce solubility (Liu and Qiu, 2024). Nevertheless, the protein content in milkfish sambusa remains within the recommended level for supplementary foods for pregnant women, which is around 7–9 grams per serving (Miller *et al.*, 2025).

Fish protein is of high biological value, containing essential amino acids that support maternal and fetal growth (Orimadegun *et al.*, 2025). Thus, even without a significant increase, maintaining adequate protein concentration in the product contributes to addressing the protein-energy malnutrition commonly found among CED mothers. Furthermore, consuming such locally based protein sources is a sustainable strategy to enhance maternal nutrition without relying heavily on imported supplements (Putri, Bachtiar and Suprapto, 2025).

Omega-3 Fatty Acids

The omega-3 content showed an increase from 0.74% in F0 to 0.78% in F3 of total fatty acids. Although the increase appears modest, this finding demonstrates that incorporating milkfish effectively enriches the product with omega-3 fatty acids such as DHA and EPA. Budi (2023) reported that milkfish contains omega-3 levels significantly higher than salmon, making it a valuable local source of essential fatty acids.

Omega-3 fatty acids play a crucial role in fetal neurodevelopment, cognitive function, and reducing inflammation (Sentika *et al.*, 2024). Adequate omega-3 intake during pregnancy particularly DHA supplementation starting in the second trimester can reduce the risk of preterm birth and support optimal brain growth (Sharma *et al.*, 2025). Therefore, incorporating milkfish into supplementary food formulations represents a culturally appropriate and nutritionally sound approach to improve omega-3 intake among pregnant women (Southard and Randell, 2024).

Anthocyanin Content

The most striking change was the tripling of anthocyanin levels from 2.57 CyE/g in F0 to 7.85 CyE/g in F3. Anthocyanins are bioactive compounds responsible for the purple color of sweet potatoes and are known for their strong antioxidant capacity (Estiasih et al., 2016). Purple sweet potato varieties, particularly Antin 3, exhibit higher anthocyanin concentrations than other local cultivars (Suprapto *et al.*, 2025). These compounds not only contribute to food color but also promote health benefits, including anti-inflammatory and cardioprotective effects (Tareke *et al.*, 2025).

The increased anthocyanin level in F3 supports the product's functional food potential. For pregnant women, antioxidant intake helps reduce oxidative stress, which is often elevated due to increased metabolic demands during pregnancy. Previous studies demonstrated that purple sweet potato consumption positively affected maternal nutritional status by increasing arm circumference (LILA) and body weight among pregnant women with CED (Udom *et al.*, 2025).

Implications for Stunting Prevention

The combination of milkfish and purple sweet potato in sambusa not only enhances its nutritional profile but also aligns with national stunting prevention strategies focusing on local food-based interventions. The product provides essential nutrients protein, omega-3 fatty acids, and antioxidants that collectively support maternal health and fetal development. Considering that stunting often originates from maternal undernutrition,

incorporating such foods into supplementary feeding programs can effectively improve dietary quality among vulnerable groups.

Milkfish and purple sweet potato sambusa demonstrated acceptable sensory qualities and improved nutritional content. The substitution enhanced omega-3 and anthocyanin levels without compromising protein concentration or taste acceptability. Therefore, this product has strong potential as a culturally acceptable, nutrient-rich supplementary food for pregnant women in Indonesia's stunting reduction initiatives. Future studies should explore alternative cooking methods such as steaming or baking to minimize nutrient loss and improve product stability over time.

CONCLUSION

The substitution of milkfish (Chanos chanos) and purple sweet potato (Ipomoea batatas L.) in sambusa significantly affected the product's sensory and nutritional characteristics. There were notable differences in color and texture, while aroma and taste remained unaffected. The combination enhanced omega-3 fatty acid and anthocyanin contents, contributing to improved nutritional quality, though the protein level showed no significant change. These findings indicate that milkfish and purple sweet potato sambusa can serve as a potential locally based supplementary food to support nutritional interventions for pregnant women, especially in preventing chronic energy deficiency (CED) and stunting.

Further studies are recommended to develop milkfish and purple sweet potato sambusa using different processing methods such as steaming or baking, which may better preserve nutrient content, particularly proteins and essential fatty acids. Product diversification using other local nutrient-dense ingredients could also enhance its functional value and acceptability. Collaboration between researchers, local food industries, and public health programs is essential to promote sustainable utilization of this product as an alternative supplementary food for maternal and child nutrition improvement in stunting prevention efforts.

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Conflict of Interest

There are no potential conflicts of interest relevant to this article.

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