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Bilih Fish-Based Finger Food as a Local Complementary Feeding Innovation for Stunting Prevention in Children

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BILIH FISH-BASED FINGER FOOD AS A LOCAL COMPLEMENTARY FEEDING INNOVATION FOR STUNTING PREVENTION IN CHILDREN

Abstract: Bilih fish (*Mystacoleucus padangensis*), an endemic species of Lake Singkarak in West Sumatra, is a valuable source of animal protein. Its utilization in the development of a locally formulated finger food product offers potential as an alternative complementary food to support stunting prevention efforts. This study aimed to analyze the macronutrient, micronutrient, and energy composition of a bilih fish-based finger food using a descriptive laboratory analysis design. The formulation consisted of bilih fish, potatoes, carrots, eggs, and local spices. Nutritional analysis was conducted according to Indonesian National Standard (SNI) methods, assessing carbohydrate, protein, fat, calcium, zinc, iron, and sugar content. Energy values were calculated using the 4:4:9 kcal/g conversion for carbohydrates, proteins, and fats. The results showed that 100 grams of the product provided 188.19 kcal of energy, 15.61 g of carbohydrates, 16.52 g of protein, 6.63 g of fat, 132.23 mg/kg of calcium, 13.22 mg/kg of zinc, 2.02 mg/kg of iron, and 0.51 g of sugar. Compared with fresh bilih fish, the product demonstrated higher protein and energy content, although a reduction in some minerals was observed. Overall, this bilih fish-based finger food presents a favourable nutritional profile and demonstrates strong potential as a practical, nutrient-dense, and locally sourced complementary feeding innovation to support child growth and contribute to stunting prevention strategies.

Keywords: Bilih fish, finger food, complementary feeding, local food, stunting

Introduction

Stunting is a serious problem in nutrition and public health. It is characterized by delays in child growth and development due to poor nutritional intake, infections, and lack of psychosocial stimulation (Wake *et al.*, 2023). Inadequate quality and quantity of complementary feeding is also a contributing factor. Stunting is defined as a height ≤-2 SD of the WHO growth standard median. It is irreversible and can cause motor and cognitive development problems, decreased productivity, and an increased risk of nutrition-related chronic diseases such as hypertension, obesity, diabetes, and others later in life (De Sanctis *et al.*, 2021; Madinatuzzahrah *et al.*, 2023; Vaivada *et al.*, 2020).

Globally, stunting is a major public health problem, especially in developing countries. UNICEF (2023) reported that more than 148 million children under five are stunted worldwide (WHO, 2023a). In Indonesia, the 2023 National Health Survey found a stunting prevalence of 21.5%. West Sumatra has an even higher rate of 23.6%. Although there was a 1.6% decline from 2022, stunting remains a persistent issue (Ministry of Health RI, 2024). The 2022 Indonesian Nutrition Status Survey showed that children aged 6–11 months have 1.6 times higher risk of becoming stunted at 12–23 months (Munira, 2023). This is a critical period for child growth and nutrition through complementary feeding (Aboagye *et al.*, 2021; De Sanctis *et al.*, 2021). WHO recommends adequate, safe, and timely complementary feeding starting at 6 months up to 24 months (WHO, 2023b).

Complementary foods should contain various macronutrients and micronutrients with textures adjusted to age (Taufiqa, 2024; Taufiqa & Husna, 2023). Delays in introducing complementary foods or providing them in inadequate quality or quantity contribute to stunting. Studies show that insufficient dietary diversity and inappropriate complementary feeding increased stunting risk (WHO, 2023; Aboagye *et al.*, 2021; Masuke *et al.*, 2021). Finger food forms of complementary feeding not only meet daily nutritional needs but also stimulate sensory and oral-motor development and child independence in eating (Dike *et al.*, 2022; Yuan *et al.*, 2021).

Protein in complementary foods is proven effective for growth. Animal-based protein is an important intervention in stunting prevention (De Sanctis *et al.*, 2021; Parikh *et al.*, 2022). Protein intake positively

correlates with child height (Miyachi, 2020). WHO and FAO encourage interventions using sustainable and affordable local foods, adapted to sociocultural and economic contexts (WHO, 2023).

One potential local protein source in West Sumatra is bilih fish (*Mystacoleucus padangensis*), endemic to Lake Singkarak, Solok District. This flat, elongated fish measures 4.9–10.2 cm (Warsa *et al*., 2020). It is popular for its taste and health benefits. Research shows bilih fish is rich in protein, zinc, calcium, vitamin A, and vitamin E. Protein content is 13% per 100 g—adequate to meet protein requirements of children aged 6–23 months (Anissa & Dewi, 2021). Its zinc content is 17.33 mg/100 g, higher than beef (4.2 mg/100 g). Zinc is essential for growth and stunting prevention (Yuniritha *et al.*, 2020).

Currently, bilih fish available in the market is sold fresh, smoked, fried, or crispy. Innovations in bilih fish processing may increase its economic value. Processed bilih fish has a longer shelf life and improved quality (Desmiati *et al.*, 2024; Yuniritha *et al.*, 2020). Furthermore, the nutritional components—especially protein and zinc—found in bilih fish can help meet children's daily needs and benefit their growth and development. However, no finger food–based complementary feeding products made from bilih fish with evaluated nutritional values after processing have been developed.

Given this gap, it is hypothesized that a bilih fish–based finger food formulated from locally available ingredients contains adequate macronutrient and micronutrient levels to support complementary feeding strategies. Therefore, this study aimed to develop a bilih fish–based finger food product and analyze its nutritional composition through descriptive laboratory analysis as a potential local innovation to support stunting prevention efforts.

Methods

This study employed a laboratory-based descriptive nutritional analysis design to determine the macronutrient, micronutrient, and energy composition of a bilih fish–based finger food product. The formulation was prepared using the following ingredients: 15 g bilih fish, one chicken egg, 100 g potato, 10 g carrot, one shallot, one clove of garlic, 5 g scallion, 3 g celery leaves, 20 g cornstarch, ¼ teaspoon salt, and cooking oil. The production process was shown in Figure 1.

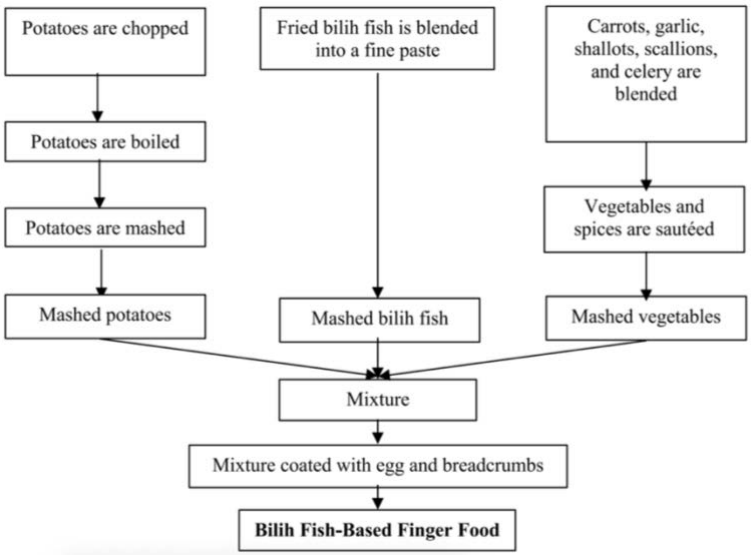

Figure 1. Production process

To ensure consistency, three independent batches of the final product (each approximately 120 g) were prepared using identical ingredients, preparation steps, and cooking conditions. From each batch, a homogenized subsample was collected, and triplicate laboratory analyses were conducted for every nutritional parameter to enhance reliability and minimize random measurement error.

Samples were submitted to the Center for Standardization and Industrial Services (BSPJI), Padang, West Sumatra, for laboratory analysis. Carbohydrate, protein, and fat contents were analyzed according to the Indonesian National Standards (SNI) 01-2891-1992 sections 9, 7.1, and 8.1, respectively. Micronutrients (calcium, zinc, and iron) were determined using SNI 01-2896-1998 section 5. Total sugar content was analyzed following SNI 01-2891-1992 section 3.1.

To maintain analytical accuracy, quality control procedures were implemented, including calibration of laboratory instruments prior to analysis, use of reagent blanks, and verification against certified reference materials where applicable. All measurements were reported as mean ± standard deviation.

The total calories of product were determined using conversion factors for carbohydrates, proteins, and fats. These conversion factors represent the number of calories per gram of each macronutrient. The conversion factor used was 4:4:9 kcal/g, meaning that carbohydrates and proteins contribute 4 calories per gram, while fats contribute 9 calories per gram.

Results and Discussion

The bilih fish-based finger food is a type of frozen finger food with a crispy outer texture and a soft interior, accompanied by the distinctive aroma of bilih fish. The frying process enhances the aroma and makes the outer layer even crispier (Figure 2). The mixing process with other ingredients during preparation produces a smooth texture in the bilih fish. This modification facilitates consumption by young children, especially since bilih fish is traditionally served fried and contains fine bones that may pose challenges for infants.



Figure 2. The bilih fish-based finger food, finger food made from bilih fish

Processing product contain 15 g of bilih per 100 g produced 188.19 kcal of energy. This is higher than fresh bilih fish, which contains 132 kcal per 100 g, representing an increase of 42.5%, as shown in Table 1. Per 100 g of product, the bilih fish-based finger food contained carbohydrates (15.61 g), protein (16.52 g), total fat (6.63 g), calcium (132.39 mg/kg), zinc (13.22 mg/kg), and iron (2.02 mg/kg). Compared to fresh bilih fish, there was the addition of carbohydrates, which were absent in bilih fish but present in bilih fish-based finger food. Additionally, protein increased by 27.1% and fat by 44.1%. However, calcium decreased by 40%, zinc by 23.6%, and iron by 94.2%, likely due to thermal processes, dilution with non-animal ingredients, or leaching during cooking

Table 1: Comparison of bilih fish-based finger food and raw bilih fish composition

Nutrient (per 100 g)	Bilih Fish-Based Finger Food	Raw Bilih Fish
Calories (kcal)	188.19	132.0
Carbohydrates (g)	15.61	–
Protein (g)	16.52	13.0
Fat (g)	6.63	4.6
Calcium (mg)	13.23	22.0
Zinc (mg)	1.32	17.3
Iron (mg)	0.20	34.7
Sugar (g)	0.52	–

We conducted a comparative analysis of bilih fish-based finger food's nutrient composition with other local animal-based protein sources, such as dadiah and eggs (Figure 3). Dadiah is a naturally fermented buffalo milk product from West Sumatra. Our previous study has shown that supplementation with dadiah during pregnancy demonstrated positive trends in maternal immunological status and beneficial microbiota proportions in infants, potentially influencing child growth in the future (Taufiqa, 2025). Dadiah contains 216.04 kcal energy, 2.09 g carbohydrates, 7.91 g protein, 19.56 g fat, 347.98 mg/kg calcium, 4.87 mg/kg zinc, and 6.53 mg/kg iron (Taufiqa *et al.*, 2024). Meanwhile, eggs have been proven effective in addressing stunting. Daily egg consumption increased the height of stunted toddlers from an average of 74.81 cm to 79.00 cm. Providing one egg per day reduced stunting cases by 47%, due to its essential amino acids needed to build bone matrix and influence bone growth (Sartikah, 2023).

Compared to these two animal protein sources, bilih fish-based finger food had the highest zinc content (13.22 mg/kg), far exceeding that of eggs (1.05 mg) and dadiah (4.87 mg/kg). Iron content was highest in dadiah (6.53 mg/kg), followed by bilih fish-based finger food (2.02 mg/kg), and eggs (1.19 mg, about 6% of the daily requirement). For calcium, dadiah had the highest level (347.98 mg/kg), followed by bilih fish-based finger food (132.39 mg/kg), and eggs (50 mg, or about 5% of daily requirement) (Figure 3).

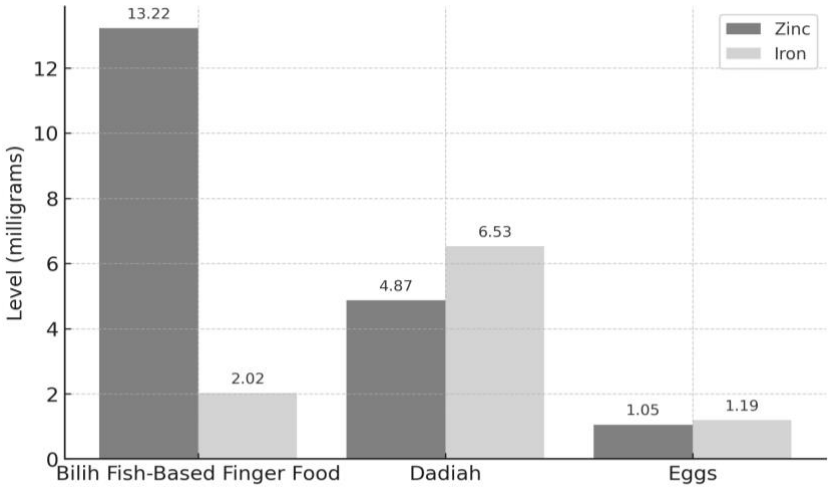

Figure 3. Comparison of zinc and iron levels

The processing of bilih fish-based finger food involves various components and multiple stages, resulting in changes in form, texture, color, aroma, and taste. The addition of potatoes and cornstarch increases carbohydrate, sugar, and fat content. The addition of eggs increases the protein content of bilih fish-based finger food compared to fresh bilih fish alone. However, the processing of bilih fish-based finger food reduces calcium, iron, and zinc content.

Based on the Indonesian daily nutritional adequacy for children aged 6–11 months, consuming 100 grams of bilih fish-based finger food per day fulfills approximately 23.52% of daily energy needs (Ministry of Health, 2019). For children aged 12–23 months, the contribution is 13.94%. Adequate daily energy intake is crucial for supporting child growth and development. In terms of energy derived from carbohydrates, 100 grams of bilih fish-based finger food per day can meet about 14.86% of the needs of children aged 6–11 months and 7.2% for children aged 12–23 months.

Protein is one of the most important macronutrients in supporting child growth and development. It plays a role in the formation and repair of body tissues and in maintaining the body's acid-base balance (Anissa & Dewi, 2021). High-quality protein in complementary feeding has been proven to support child growth effectively. Amino acids such as lysine and arginine are known to be involved in growth hormone release through the somatotropic axis (De Sanctis *et al.*, 2021). Amino acids in protein also contribute to building the bone matrix, which can modulate genetic potential so that child growth is optimized (Sartikah, 2023). During growth, protein also plays a significant role in brain development, which later influences cognitive ability and productivity in adulthood. Most brain development occurs in the first 1000 days of life, with about 80% of total development completed by the age of two (Yin *et al.*, 2025). The bilih fish-based finger food provides a substantial amount of protein, even meeting about 110% of daily protein requirements for children aged 6–11 months and 82.6% for children aged 12–23 months.

In addition to protein, bilih fish-based finger food also helps meet children's daily fat needs. Fat is an important energy source and facilitates the absorption of fat-soluble vitamins such as A, D, E, and K (Anissa & Dewi, 2021). Consuming 100 grams of bilih fish-based finger food per day can provide approximately 18.94% of daily fat needs for children aged 6–11 months and 14.73% for those aged 12–23 months. Therefore, bilih fish-based finger food has the potential to provide a balanced intake of macronutrients—carbohydrates, protein, and fat—which are important for supporting optimal child growth and development.

Adequate micronutrient intake is also an important factor in child growth and development. A daily intake of 100 grams of bilih fish-based finger food can fulfill about 44% of zinc, 4.8% of calcium, and 1.8% of iron

requirements for children aged 6–11 months, as well as 44%, 2%, and 2.8% for children aged 12–23 months. These micronutrients play roles in neurological processes such as nerve signaling, myelination, and synapse formation (Vigil *et al.*, 2025; Pikor *et al.*, 2024; Yusuf & Helmi, 2022).

Table 2. Contribution of Bilih Fish-Based Finger Food (100 g) to Daily Nutrient Requirements

Nutrient	% RDA (6–11 months)	% RDA (12–23 months)
Energy	23.52%	13.94%
Carbohydrates (energy contribution)	14.86%	7.20%
Protein	110.00%	82.60%
Fat	18.94%	14.73%
Zinc	44.00%	44.00%
Calcium	4.80%	2.00%
Iron	1.80%	2.80%

Besides its nutritional profile, the finger food format supports developmental milestones. Self-feeding promotes fine motor skills, sensory exploration, and oral–motor coordination. The product's elongated shape and varied textures facilitate grasping and biting, making it suitable as a developmentally supportive complementary food option (Białek-Dratwa *et al.*, 2025).

Based on the description above, bilih fish-based finger food has potential as a complementary feeding product made from local foods rich in protein and zinc, which are important for child growth and development, with the nutritional complexity it contains.

Although the bilih fish-based finger food demonstrated promising nutritional composition, this study did not assess product acceptability, nutrient bioavailability, safety parameters, or direct growth outcomes in children. Therefore, conclusions regarding its effectiveness in preventing stunting should be interpreted cautiously. Further intervention studies are needed to evaluate its clinical and population-level impact.

Conclusion

The development of bilih fish-based finger food as a local animal-based complementary feeding product demonstrated promising nutritional composition results relevant to child nutrition. The product contains essential macronutrients and micronutrients required for growth and development, particularly protein and zinc, which play important roles in linear growth and physiological development. The bilih fish-based finger food contributes substantially to daily nutrient adequacy, providing approximately 110% of protein requirements and 44% of zinc requirements for children aged 6–11 months per 100 g serving. In addition, its finger food presentation may support sensory stimulation and oral-motor skill development during complementary feeding.

However, this study was limited to laboratory-based nutritional composition analysis and did not assess acceptability, bioavailability, safety parameters, or direct growth outcomes. Therefore, its implications for stunting prevention should be interpreted cautiously.

Future research should include acceptability trials among caregivers and children, shelf-life and microbiological safety analyses, and intervention studies evaluating nutrient absorption and growth outcomes. Such studies are necessary to determine the clinical and population-level effectiveness of bilih fish-based finger food as a complementary feeding innovation in stunting prevention efforts, particularly during the first 1,000 days of life.

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