Jurnal Gizi dan Dietetik Indonesia
(Indonesian Journal of Nutrition and Dietetics)
Vol 14, Issue 2, 2026:153-168

Available online at: https://ejournal.almaata.ac.id/index.php/IJND
p-ISSN 2303-3045 e-ISSN 2503-183X
DOI : https://dx.doi.org/10.21927/ijnd.2026.14(2).153-168

Formulation of mixed food ingredients with mackerel fish flour (*rastrelliger neglectus*) and tempe flour substitution for complementary foods incidence stunting under five years old

Oktavina Permatasari[1*], Andrea Putri Sekar Tunjung[1], Zuhria Ismawanti[2]

[1]Department of Nutrition, Elisabeth College of Health Science Semarang, Jalan Kawi No. 11, Wonotingal, Candisari, Semarang, Jawa Tengah, 50232, Indonesia.
[2]Department of Nutrition, Politeknik Kesehatan Kemenkes Semarang, Jalan Tirto Agung, Pedalangan, Banyumanik, Kota Semarang, Jawa Tengah, 50268, Indonesia.

*Correspondence : tataoktavinaa@gmail.com

ABSTRAK

Latar Belakang: *Permasalahan gizi Indonesia yang belum teratasi pada kelompok balita yaitu stunting. Riskesdas Tahun 2018 stunting di Jawa Tengah pada baduta 33,3%, Tahun 2021 Kota Semarang 3,10%. Stunting balita dapat terjadi karena kurang asupan zat gizi. Upaya penanganan stunting Kota Semarang diperlukan peningkatan kandungan gizi MP-ASI dengan substitusi bahan pangan tinggi protein dan zat gizi mikro.*
Tujuan: *Memperoleh formulasi BMC bubur instan substitusi ikan kembung dan tepung tempe yang diterima balita dengan menentukan nilai gizi dan anjuran takaran saji konsumsi.*
Metode: *Penelitian kuantitatif dengan metode eksperimen, Rancangan Acak Lengkap. Objek yang diteliti BMC bubur instan dengan 3 kelompok perlakuan substitusi tepung tempe dan tepung ikan kembung sebagai pengganti beras merah, BMC F2 masing-masing 4%, F3 10%, F4 16%, serta F1 sebagai kontrol.*
Hasil: *BMC bubur instan F3 (substitusi tepung ikan kembung 5% dan tepung tempe 5%) paling diterima panelis dengan energi 439,95 kkal, protein 14,67 g/100g, karbohidrat 60,69 g/100g, lemak 15,39 g/100g, serat 25,66 g/100g, vitamin A 14,56 µ/100g, vitamin C 226,5 mg/100g, zat besi 0,29 mg/100g, zink 19,27 mg/100g, kelarutan sesuai standar, densitas kamba lebih baik dari bubur instan komersial, lolos uji cemaran mikrobiologi berdasarkan standar SNI*
Kesimpulan: *BMC bubur instan substitusi tepung ikan kembung dan tepung tempe layak dikonsumsi dan digunakan sebagai MP-ASI makanan utama balita stunting dengan takaran saji 20 gram berat kering atau 60 gram rehidrasi memenuhi 395,93 kkal energi, serta 100% protein, karbohidrat, lemak, serat, vitamin C, dan zink.*

KATA KUNCI : *BMC; ikan kembung; MP-ASI; stunting; tepung tempe*

ABSTRACT

Background : *Stunting is a persistent nutritional problem in Indonesia affecting toddlers. The 2018 Basic Health Research showed stunting cases in Central Java among toddlers at 33.3%, while in Semarang City in 2021 reached 3.10%. Stunting in toddlers can occur due to inadequate nutritional intake, particularly during complementary foods. In an effort to reduce stunting, it is necessary to increase the nutritional content of complementary foods substituting ingredients high protein and micronutrients.*

Objectives: *Formulating instant porridge with substitutions of mackerel and tempeh flour that accepted by toddlers while ensuring appropriate nutritional content and recommended serving sizes.*

Methods: *This research using a quantitative experimental approach with a Completely Randomized Design (CRD). The study focused on BMC instant porridge, including three treatment groups with substitutions of tempeh and mackerel flour, BMC F2 4%, F3 10%, F4 16%, F1 as a control.*

Results: *BMC instant porridge formula 3 was the preferred by panelists. This formulation provides 439.95 kcal of energy, 14.67 g/100g protein, 60.69 g/100g carbohydrates, 15.39 g/100g fat, 25.66 g/100g fiber, 14.56 µg/100g vitamin A, 226.5 mg/100g vitamin C, 0.29 mg/100g iron, and 19.27 mg/100g zinc. Meets solubility standards, has a density superior to commercial instant porridge, and passes microbiological contamination tests.*

Conclusions: *BMC instant porridge substituted with mackerel and tempeh flour, is suitable as complementary food for stunted toddlers. Each serving, consisting of 20 grams of dry porridge or 60 grams when rehydrated, provides 395.93 kcal of energy,100% of the recommended intake for protein, carbohydrates, fat, fiber, vitamin C, and zinc.*

KEYWORDS: *complementary foods; mackerel fish; mixed food ingredients; stunting; tempeh*

Article info: *Received July 04, 2025; 1st revision July 14, 2025; 2nd revision August 01, 2025; 3rd revision September 11, 2025; 4rd revision October 01, 2025; 5rd revision October 22, 2025; accepted November 10, 2025; available online March 31, 2026; published March 31, 2026.*

INTRODUCTION

Nutritional problems in Indonesia, particularly among vulnerable groups, remain a significant challenge, with stunting and malnutrition continuing to persist (1). Stunting is a state of chronic malnutrition due to a lack of nutrient intake (2) Stunting is indicated by the PB/U index (Body Length-for-Age), reflecting slow growth and development that prevents a toddler from reaching the normal height or length expected for their age (3). Based on WHO (World Health Organization) standards, the category of stunting is if the toddler's Z-score indicator for TB/U is less than -2 SD (Standard Deviation) (4).

Based on the results of the 2018 Riskesdas (5), the prevalence of nutritional status (PB/U) in Central Java Province for toddlers aged 0-23 months, there were 33.3% cases of stunting consisting of 13.9% very

short and 19.4% short. Semarang City, located in Central Java Province, faced a stunting prevalence of 3.10% among toddlers in 2021. The highest number of cases was found in North Semarang, where 260 out of 4,048 toddlers were affected. North Semarang is a lowland coastal area, with fish being the main local food source (6).

Providing toddlers with foods rich in macronutrients particularly protein and key micronutrients such as iron, zinc, and calcium is directly associated with their growth and development (7). Feeding practices play an important role in determining toddlers' energy and nutrient intake, which can influence the risk of stunting. A child's food intake is closely linked to parenting patterns, particularly in the provision of breast milk and complementary foods. Providing complementary foods (MP-ASI) with balanced nutrition is essential to meet toddlers' daily dietary needs and support their healthy growth (8). The provision of complementary food marks the transition from exclusive breastfeeding to family food, without replacing the essential role of breast milk. MP-ASI, such as baby porridge, should provide a variety of nutrients needed by toddlers, referring to the Nutritional Adequacy Rate and adjusted to their age and stage of growth (3).

According to regulations from the Indonesian Ministry of Health, complementary food formulations such as BMC instant porridge must contain 400 - 440 kcal of energy, 15 - 22 grams of protein, 5 - 8 mg of iron, and 200 - 400 mg of calcium (9). In making BMC (Mixed Food Ingredient), the raw materials generally used are rice flour, milk, and vegetable oil (10). To develop BMC for stunted toddlers, it is important to enhance its nutritional value by substituting raw materials with functional local foods rich in protein and iron. One of the leading local food sources in Central Java Province is soybeans, which are well known for their high protein content that can be easily absorbed by the body (11). Tempeh, a traditional fermented soybean product, is rich in protein and calcium nutrients that are essential to support toddlers' growth and development. Another local food in Central Java, especially in Semarang city that is a functional food is mackerel fish. Based on data from Semarang City's capture fisheries, mackerel is ranked first in production in the Semarang City Region, reaching 10,621 kg in 2019 (6). Mackerel is rich in protein, essential minerals, and omega-3 fatty acids.

This research is important to carry out as part of efforts to help reduce stunting in Semarang City by developing functional food based on local ingredients mackerel and tempeh as substitutes in BMC formulations. The formulation used in this study was adapted from previous research, with modifications made to the choice of raw materials for producing complementary food (MP-ASI) (12). In this study, brown rice flour as the main ingredient of BMC instant porridge was substituted with mackerel flour and tempeh flour in various treatments. The resulting formulations were then tested for acceptability by semi-trained panelists, specifically mothers of toddlers, as they can

best represent the likely acceptance of MP-ASI in terms of taste, color, smell, and texture. The four formulations of BMC instant porridge were analyzed for nutritional content, physical characteristics (appearance), and microbiological safety. The purpose of these research was to compare the effects of different substitution treatments with the control formulation. In addition, the BMC instant porridge as complementary food for stunted toddlers was evaluated against the Ministry of Health standards for instant porridge production and the 2019 Recommended Dietary Allowance (RDA) toddlers (13).

MATERIALS AND METHODS

Design, Location, and Time of Research

One of the key efforts to address nutritional problems in infants and toddlers is by providing safe, nutrient-dense foods that can meet their dietary needs, such as complementary foods (14). This study aims to develop a BMC instant porridge formulation specifically designed for stunted toddlers was chosen as the main complementary food because it provides energy-dense nutrition, is easy to prepare, has a long shelf life, and offers a soft texture that makes it suitable for consumption starting at 6 months of age (12). These formulations were evaluated based on panelists' acceptance as well as their nutritional content, with the goal of determining the appropriate serving size as complementary food for toddlers. The preparation process began with mixing all the required ingredients. Water is then incorporated at a ratio of 1:2 (w/w), and the mixture is heated to 100˚C. The resulting porridge is dried at 55˚C for 6 hours, then ground using a grinder to obtain a fine texture. The initial formulation is based on the results of research by Darningsih, et al. (12) have been modified in the use of the main raw materials of substitution and adjusted as shown in **Table 1.**

Table 1. Percentage of raw materials to mixed food ingredients (BMC) for instant porridge

Raw Material	F1 (Control)	F2	F3	F4
	%			
Mackerel fish flour	0	2	5	8
Tempe Flour	0	2	5	8
Brown rice flour	50	46	40	34
Skim milk	35	35	35	35
Vegetable oil	10	10	10	10
Granulated sugar	5	5	5	5
Total	**100**	**100**	**100**	**100**

This research was carried out from April to November 2024 using a quantitative experimental approach. The study applied a Completely Randomized Design (CRD) with three replications for chemical analysis and microbiological test to get accurate data. The

object of this study was BMC instant porridge with three treatment groups involving substitutions of tempeh flour and mackerel flour, along with one control group without substitution. The formulations were evaluated through an acceptability (organoleptic) test. The test involved mothers of toddlers as panelists and was conducted at the Delima Integrated Health Post in the Kedungmundu Health Center area, Semarang City. BMC instant porridge was analyzed for its nutritional content, including water, ash, protein, carbohydrates, fat, fiber, vitamin A, vitamin C, iron, and zinc. In addition, physical tests using the bulky density, and microbiological tests were conducted using the ALT method. All analyses were carried out at the Chemistry Laboratory, Faculty of Science and Mathematics, Satya Wacana Christian University, Salatiga. Based on the results of the acceptability test, the most preferred BMC instant porridge formulation was then compared against the SNI 01-7111.1-2005 standard and the Recommended Dietary Allowance (AKG) 2019 for toddlers aged 6–12 months to determine the appropriate serving size per consumption.

Preliminary Stage

The preliminary stage of developing BMC as complementary food for stunted toddlers involved preparing the raw materials for instant porridge production, conducting trial-and-error to refine the formulations, defining panelist criteria for the organoleptic test, and selecting the nutritional analysis methods to be applied. Making BMC instan porridge, by mixing the formulated ingredients and drying using a freeze drier.

Main Research

This study used three formulations of BMC instant porridge made from brown rice flour substituted with mackerel and tempeh flour in various treatments, along with one control formulation without substitution. The preparation process involved mixing all raw materials according to each treatment group, cooking them thoroughly, then drying the mixture. The dried product was then ground and sieved to obtain a fine, uniform flour.

Acceptability or Organoleptic Test

The acceptability of BMC as complementary food for stunted toddlers was evaluated using a hedonic or preference test. Each formulation was rehydrated with 60 grams of porridge and given the same treatment to ensure consistency during testing. The panelists used 30 selected semi trained mothers toddlers, not sick, and wanted to participate who had been given counseling on MP-ASI and organoleptic test method training. The requirements for non-standard (semi trained) panelists in organoleptic. The assessment of the acceptability test includes the color, smell, taste, and texture of the baby porridge using a scale of 1 for dislike, a scale of 4 for very like (15). Once the BMC instant porridge is brewed and ready to serve, it is placed in a container and presented to the panelists. The evaluation begins with formula

1 (control). Before moving on to formula 2, the mothers of toddlers are asked to drink the water provided to help neutralize the taste of the previous porridge and prevent bias. The same procedure is then repeated for formulas 3 and 4.

Chemical Analysis (Nutritional Content)

The four formulations of BMC instant porridge were analyzed for their nutritional content. Protein was measured using the Kjeldahl method, carbohydrates with the Luff Schoorl method, fat and fiber using Soxhlet extraction, iron (Fe) using spectrophotometry, and zinc using Atomic Absorption Spectrophotometry (AAS) (16). Water and ash contents were determined using the gravimetric method, followed by energy calculation. Each analysis was conducted in triplicate to ensure accuracy of the results (11).

Microbiological Analysis

A microbiological test was conducted to detect possible contamination in the BMC instant porridge. The analysis used the Total Plate Count (TPC) method and was performed in three replications to ensure accuracy of the results.

Physical Test (Bulk Density) of BMC Instant Porridge

The physical analysis test used the solubility test to determine the ability of BMC instan porridge to dissolve in water when served and density tests to deterimine the composition and quality of BMC instant porridge.

Data Analysis

The results of nutritional content analysis organoleptic test were tested for data analysis using SPSS 16.0 with descriptive and normality test, one-way ANOVA with a 95% confidence interval. Data on the significant differences in BMC formulations as MP-ASI for stunted toddlers will be analyzed using Tukey's Post Hoc test. Meanwhile, the acceptability of BMC as MP-ASI, as assessed by panelists, will be evaluated using the Friedman test. The results from all data analyses will then be presented in detail.

RESULTS AND DISCUSSIONS

Mackerel and Tempeh Flour Making Stage

The main preparation involves producing mackerel and tempeh flour. The mackerel used was freshly harvested and sourced from Karangayu Market, Semarang City, while the tempeh was locally produced from soybeans with a 48-hour fermentation period, obtained from Sendangguwo Market, Semarang City. The process of making mackerel flour begins with cleaning the fish, cutting it into small pieces, and grinding it into a paste. The ground mackerel is then baked at 150°C for 40 minutes to halt chemical reactions and oxidation that naturally occur in fish. Once partially dried, the mixture is further dried for 12 hours to achieve the desired dry texture. Finally, the dried fish is ground again and sieved using a 40-mesh sieve to produce

a fine, uniform flour. The process of making tempeh flour follows the same general steps as producing mackerel flour, but with a different initial treatment. The tempeh is first cut into small pieces and then steamed at 100°C for 30 minutes. This step is intended to halt the fermentation process and to deactivate anti-nutritional compounds, which can be effectively reduced through heating at temperatures of 108-110°C (17).

The drying and milling of mackerel and tempeh are carried out to reduce their water content. Foods with high water content are more prone to spoilage, as excess moisture can speed up the process of decay (18). The use of mackerel and tempeh in flour form is intended to preserve the quality of these ingredients while also reducing the risk of microbiological contamination. This approach is supported by Ananda et al., that lower moisture content in lemuru fish flour contributes to longer storage stability (19).

Formulation Stage of Mixed Food Ingredients (BMC) Substitution of Mackerel Flour and Tempeh Flour

The preparation of instant complementary foods porridge should be designed to meet the nutritional needs of toddlers. To be considered adequate, every 100 grams of MP-ASI should provide at least 400 kcal of energy, 15-22 grams of protein, and 250-350 µg of vitamin A (16). The main ingredient commonly used to make porridge for toddlers is rice, which is rich in carbohydrates. In this study, brown rice flour was substituted with local food sources—specifically mackerel and tempeh—in various formulations to enhance the nutritional quality of the porridge. Mackerel and tempeh were chosen because both are rich in protein as well as essential vitamins and minerals, making them highly suitable for complementary foods Per 100 grams, mackerel contains about 19.4 grams of protein, while tempeh provides around 20.8 grams, highlighting their potential as valuable ingredients in improving the protein content of instant porridge (20). The formulation of MP-ASI for toddlers is designed to meet protein and micronutrient requirements in accordance with the 2019 Recommended Dietary Allowance (RDA).

A food is considered an excellent source of protein if each serving provides at least 20% of the recommended Nutritional Adequacy Intake (13). This formulated BMC instant porridge is high in protein, largely due to the substitution of mackerel and tempeh flour, with a content of 14.67 g/100 g. This meets the SNI standard for instant powder and fulfills the daily protein requirements for toddlers aged 6-12 months according to the RDA. Adequate protein intake can improve children's nutritional status and body weight, helping to prevent stunting (21). From the results of research by Haryani, et al., animal protein intake for toddlers based on local food can reduce the risk of stunting (21). The micronutrient content measured in BMC instant porridge included vitamin C, vitamin A, iron, and zinc. Zinc plays an important role in

the growth and development of children. The selected BMC instant porridge contains 19.27 mg of zinc per 100 g, which meets the SNI standard and can fulfill the daily zinc requirement for toddlers aged 6–12 months according to the RDA. Research shows that zinc intake affects the incidence of stunting, as zinc is essential for growth hormone synthesis, bone elongation, immune system function, and enhancing taste sensitivity (22).

Acceptability Test (Organoleptic Test) of BMC Instant Porridge

Acceptability, or organoleptic, testing was conducted to identify the most preferred instant porridge formula based on panelists' preferences. The panelists consisted of 30 mothers of toddlers who had received counseling on MP-ASI. In this test, mothers of toddlers were chosen as panelists because the acceptability of complementary foods for young children is often assessed based on the mother's evaluation (10). Additional food for children can be accepted if the mother likes the taste of the additional food.

For the taste test, BMC instant porridge was rehydrated and served to the panelists. Each mother first tasted formulation 1, then drank the provided water before sampling formulation 2. This process, repeated through formulation 4, helped neutralize the taste from the previous sample and reduce bias in the evaluations.

The results of the organoleptic test based on the parameters using a hedonic test with 4 scales, namely scale 1 (dislike), scale 2 (rather like), scale 3 (like), and scale 4 (very like).

Table 2. Results of organoleptic test of instant porridge BMC

	Taste	Color	Smell	Texture
	Average ± SD			
Formulation 1 (control)	2.90 ± 0.18[a]	3.63 ± 0.14[a]	3.83 ± 0.19[a]	2.86 ± 0.20[b]
Formulation 2	3.03 ± 0.18[a]	3.72 ± 0.13[a]	3.60 ± 0.20[a]	3.69 ± 0.17[a]
Formulation 3	3.73 ± 0.14[b]	3.87 ± 0,13[a]	3.40 ± 0.14[a]	3.86 ± 0.15[a]
Formulation 4	3.43 ± 0.16[b]	3.80 ± 0.14[a]	3.23 ± 0.08[b]	3.85 ± 0.58[a]

a)30 panelists

Taste is the main factor in the acceptance of food besides color, smell, and texture. The taste that appears in food comes from the raw materials used and the processing process. Taste parameters of BMC instant porridge differ significantly between formulation 1 (control) and formulations 3 and 4. This difference is likely due to the concentration of mackerel and tempeh flour used in the substitutions. Of the 30 panelists who were assessed the most preferred (23) tempeh flour substitution. This is likely because increasing the amount of mackerel and tempeh flour enhances the savory flavor and gives BMC instant porridge a distinctive taste.

However, if the substitution is too high, panelists tend to dislike it, as the bitter taste of tempeh becomes more pronounced. Color is the first characteristic that consumers assess

visually. As shown in **Table 2**, there was no significant difference in color among the four BMC instant porridge formulations. Based on panelist evaluations, formulation 3, with 5% mackerel flour and 5% tempeh flour substitution, was the most preferred, receiving ratings from “like” to “very like,” followed by formulations 2, 4, and 1 (control).

Increasing the amount of mackerel and tempeh flour in BMC instant porridge results in a darker reddish-brown color when rehydrated with warm water, as these ingredients are slightly darker than brown rice flour. This aligns with the findings of Anam, C., et al., in their study on instant porridge enriched with patin and snakehead fish, which found no significant color difference between the treatment and control groups (without added fish) (23).

The panelists' assessment of BMC instant porridge smell, shown in Table 2, indicates that formulation 4 differs significantly from formulations 1 (control), 2, and 3. The study found that BMC formulations containing mackerel and tempeh flour substitution had a noticeable fishy smell. Among the 30 toddler mothers who evaluated the BMC instant porridge, the preferred smell was found in formulation 1 (control), followed by formulations 2, 3, and 4. Increasing the substitution of mackerel and tempeh flour made the smell more fishy and reduced the preference for the tempeh smell.

According to SNI MP-ASI standards, natural flavor extracts such as vanilla or pandan can be used to mask less-preferred smells (16). Texture refers to the physical characteristics of food as perceived during consumption. Organoleptic testing of texture showed that formulation 1 (control) differed significantly from the treatment group formulations. BMC instant porridge formulations 3 and 4 received similar ratings, ranging from 'like' to 'really like.'

The texture of the porridge with mackerel and tempeh flour substitution was rougher and more astringent compared to the control, yet it was still preferred by the panelists. According to Tienchen (2016) as cited in Anam, C., et al., texture is an important factor influencing the amount of food consumed by infants (24).

Overall Acceptance Level

The organoleptic test results indicate that variations in food formulation can influence the panelists' level of preference and overall acceptance. The results of the panelist assessment of the instant porridge BMC followed by 30 panelists can be concluded that the instant porridge BMC formulation 3 with 5% mackerel flour and 5% tempeh flour substitution is the most acceptable from the assessment of taste, color, and texture with a range of like - very like.

The most preferred taste was savory, with a distinct fish flavor, slightly dark reddish-brown color, and a somewhat coarse, astringent texture. In contrast, the most preferred smell was found in formulation 1 (control), which did not include any mackerel

or tempeh flour substitution, in formulation 3 the results were not significantly different from the control group with an average assessment of like-very like.

Nutrient Content of Instant Porridge BMC

This analysis was conducted to compare how substituting mackerel flour and tempeh flour in the formulations affected the nutritional value. Protein is a basic building block of cell structure in the body and is needed for the growth and development of body tissue (18). Analysis of protein content showed that formulation 4 had significantly higher protein levels than formulations 1, 2, and 3. This indicates that increasing the addition of mackerel flour and tempeh flour raises the protein content, as both ingredients contain more protein than brown rice, thereby enhancing the protein level in BMC instant porridge.

Table 3. Nutritional value analysis of BMC instant porridge (rehydrated) in various formulations

Parameter	Formulation 1 (control)	Formulation 2	Formulation 3	Formulation 4
Water content (%)	2.85±0.13^{a}	2.61±0.13^{a}	2.47±0.14^{a}	2.38±0.13^{a}
Ash content (%)	1.64±0.03^{a}	1.66±0.24^{a}	1.50±0.243^{a}	1.34±0.15^{a}
Protein (%)	10.44±0.13^{a}	12.95±0.14^{a}	14.67±0.143^{a}	17.39±0.08^{b}
Carbohydrate (%)	78.54±0.14^{a}	72.92±0.20^{a}	60.69±0.143^{b}	48.51±0.03^{c}
Fat (%)	15.05±0.13^{a}	13.33±0.15^{b}	15.39±0.28^{a}	15.61±0.23^{a}
Fiber (%)	13.79±0.12^{a}	16.36±0.10^{a}	25.66±0.17^{ab}	38.01±0.13^{b}
Vitamin A (µ/100g)	6.99±0.14^{a}	11.73±0.13^{b}	14.56±0.18^{b}	17.59±0.33^{b}
Vitamin C (mg/100g)	136.72±0.3^{a}	223.30±0.14^{b}	226.50±0.27^{b}	242.70±0.14^{b}
Iron / Fe (mg/100g)	0.12±0.04^{a}	0.24±0.14^{b}	0.29±0.10^{b}	0.34±0.16^{b}
Zink (mg/100g)	12.81±0.13^{a}	15.94±0.23^{b}	19.27±0.13^{ab}	20.31±0.05^{b}

*Notation with different alphabets indicate real differences α = 0.05

This aligns with the findings of the study 'Tempe Nuggets Provision Improves Energy Adequacy and Protein Intake in Underweight Under-Five Children', which showed that the protein content in nuggets increased when tempeh flour was added compared to the control without tempeh flour (11). In addition, the results of the study using fish meal in making biscuits as MP-ASI can significantly increase the protein content of the control group (25). The results of the analysis of carbohydrate and fat content explain that formulation 1 has the highest carbohydrate and fat content compared to the other three formulations. This is because formulation 1 was made without substituting mackerel flour or tempeh flour. Since brown rice flour is high in carbohydrates and fat, the resulting BMC instant porridge also had high carbohydrate and fat levels. This study is in line with the research of Pomalingo, A., and Misnati (2021) the more tuna fish flour is added to moringa biscuits, the lower the carbohydrate and fat content (27). The fiber content of BMC instant porridge is presented in **Table 3**. A significant difference was found between formulations 1

and 2 compared with formulations 3 and 4. This can be due to the addition of tempeh flour which has a fiber content twice as high as brown rice which can affect the fiber content of processed food products (17). These results are consistent with previous research showing that increasing the substitution of milkfish flour raises fiber content, since fish flour contains more fiber than wheat flour. As a result, biscuits made with higher amounts of fish flour also have higher fiber levels (28). Vitamin A, iron, and zinc are important micronutrients in preventing stunting (29).. According to the Indonesian Food Composition Table (5), mackerel contains 62 µ/100 g of vitamin A in the form of carotene, while brown rice and tempeh contain little to no vitamin A or carotene. This is different from the results of the study by Mumpuni, C. and Khasanah, T.A (23) if there is no significant difference between biscuits substituted fish flour and the control. Toddlers who do not get vitamin A and micronutrients are at greater risk of stunting (24).

Vitamin C is essential for toddlers to support their immune system and grow optimally. In BMC instant porridge, vitamin C comes from skim milk, one of the main raw ingredients. The vitamin C content in BMC instant porridge explains that there is no significant difference between control group and the treatment group. The analysis of iron and zinc content in BMC instant porridge showed a significant difference between the control and treatment groups. The treatment group had higher iron and zinc levels, which increased with the greater substitution of mackerel flour and tempeh flour compared to the control group. Insufficient intake of these minerals can raise the risk of stunting among toddlers aged 6–23 months (30).

Physical Test (Bulk Density) of BMC Instant Porridge

Bulk density is the ratio of a material's weight to its volume and is an indicator of the nutrient and energy density in complementary foods. From the results of the bulk density test on BMC instant porridge formulation 3 (formulation most acceptable), the result was 0.54 g/mL. This value shows that the density of BMC instant porridge is above 50%, indicating better quality compared to commercial instant porridge, which typically has a bulk density of 0.37–0.50 g/mL (10). A higher bulk density in MP-ASI reflects greater nutritional density, making it suitable for infants and toddlers (31).

Microbiological Contamination Test on Instant Porridge BMC

Microbiological contamination testing examines changes in microbial properties in the environment to identify whether food products are contaminated and safe for consumption. One common method is the Total Plate Count (TPC), which measures the number of microorganisms present in food. According to the SNI standard for instant powdered complementary foods, the microbiological contamination limit for TPC is a maximum of 1.0×10^2 colonies per gram.

The test results of the formulated BMC instant porridge formulation 1 are 50 × 10^2, formulation 2 are 9 × 10^2, formulation 3 are 2 × 10^2, and formulation 4 × 10^2 have showed values below this limit, indicating that the product is safe from contamination.

BMC Instant Porridge Intake as MP-ASI for Toddlers

This is consistent with the findings of Novita et al., which showed a significant relationship between nutritional intake and the incidence of stunting in toddlers (32). Toddlers with low nutritional intake are 1.28 times more likely to experience stunting compared to those with adequate nutrition. This finding aligns with UNICEF's theoretical framework, which identifies insufficient food consumption as one of the key factors contributing to stunting (14).

Table 4. Nutritional value of instant porridge BMC formulation

Nutritional Value	Formulation 3 (Selected formulation)	SNI Standards SNI: 01-7111.1-2005	% Recommended Dietary Allowance 6 – 12 bulan
Energy	439.95 kkal	400 – 450 kkal	800 kkal
Water content	2.47 g/100g	≤ 4 g/100g	-
Ash content	1.50 g/100g	≤ 3.5 g/100g	-
Protein	14.67 g/100g	8 – 22 g/100g	15 g
Carbohydrate	60.69 g/100g	≤ 30 g/100g	105 g
Fat	15.39 g/100g	6 – 15 g/100g	35 g
Fiber	25.66 g/100g	≤ 5 g/100g	11 g
Vitamin A	14.56 µ/100g	250 – 700 µ/100g	400 RE
Vitamin C	226.50 mg/100g	≥ 27 mg/100g	50 mg
Iron / Fe	0.29 mg/100g	≥ 5 mg/100g	11 mg
Zink	19.27 mg/100g	≥2.5 mg/100g	3 mg

Based on a comparison with the SNI standard for instant powdered complementary foods, the BMC instant porridge meets the requirements for energy, water content, ash content, protein, vitamin C, and zinc. However, the levels of carbohydrates, fat, fiber, vitamin A, and iron do not yet meet the standard.

BMC instant porridge is primarily intended for toddlers aged 6 months and above, as it has a smooth, semi-liquid texture suitable for early complementary feeding. **Table 4** BMC instant porridge is categorized as a main food, with a minimum contribution of 25% toward daily nutritional requirements. For each serving of main food, toddlers in this age group need 200 kcal of energy, 3.75 g of protein, 26.26 g of carbohydrates, 8.75 g of fat, 2.75 g of fiber, 100 RE of vitamin A, 12.5 mg of vitamin C, 2.75 mg of iron, and 0.75 mg of zinc. Each serving of BMC instant porridge—equivalent to 20 grams of dry weight or 60 grams when rehydrated—can fully meet toddlers' needs for protein,

carbohydrates, fat, fiber, vitamin C, and zinc in one main meal. However, the content of vitamin A and iron is still insufficient for a single meal. These micronutrient gaps can be addressed through additional sources of vitamin A, breast milk, or other main meals.

CONCLUSIONS AND RECOMMENDATIONS

The most preferred BMC instant porridge was formulation which contained 5% mackerel fish flour and 5% tempeh flour, contained 439.95 kcal of energy, along with 14.67 g of protein, 60.69 g of carbohydrates, 15.39 g of fat, and 25.66 g of fiber per 100 g. It also provided 14.56 µg of vitamin A, 226.5 mg of vitamin C, 0.29 mg of iron, and 19.27 mg of zinc per 100 g. Based on physical and microbiological tests, the product met the SNI standard for instant powdered complementary foods (MP-ASI). BMC instant porridge is safe and suitable for toddlers, particularly those experiencing stunting. A single serving 20 grams in dry form or 60 grams when rehydrated provides 395.93 kcal of energy and fulfills 100% of the recommended intake for protein, carbohydrates, fat, fiber, vitamin C, and zinc for toddlers aged 6 - 12 months.

ACKNOWLEDGMENT

This study is part of the Beginner Lecturer Research program, funded by the Directorate General of Higher Education in the 2024 fiscal year.

REFERENCES

1. Hardinsyah, dkk. Ilmu Gizi Teori dan Aplikasi. EGC. Hardinsyah IDS, editor. Jakarta: EGC; 2017.
2. Falmuariat Q, Febrianti T, Mustakim M. Faktor Risiko Kejadian Stunting pada Balita di Negara Berkembang. Jurnal Ilmiah Kesehatan Sandi Husada. 2022;11:308–15.https://doi.org/10.35816/jiskh.v11i2.758
3. de Onis M, Branca F. Childhood Stunting: A Global Perspective. Maternal & Child Nutrition. 2016;12:12–26. https://doi.org/10.1111/mcn/12231
4. Kemenkes RI. Survei Kesehatan Indonesia (SKI). pdf. 2024. Retrieved from : https://share.google/2ehjOMgXoSjAXNbXk
5. Badan Penelitian dan Pengembangan Kesehatan. Laporan Riskesdas 2018 Nasional.pdf. Retrieved from : https://repository.badankebijakan.kemkes.go.id/id/eprint/3514/1/Laporan%20Riskesdas%202018%20Nasional.pdf
6. Perikanan Kota Semarang. Data Kapal Penangkap Ikan Kota Semarang Tahun 2019 Kota Semarang Tahun 2019. 2019; 1–25. Available from: perikanan.semarangkota.go.id
7. Kusdalinah, Suryani D. Asupan Zat Gizi Makro dan Mikro Pada Anak Sekolah Dasar yang Stunting di Kota Bengkulu.

AcTion Aceh Nutrition Journal. 2021;6(1):93.https://doi.org/10.30867/action.v6i1.385

8. Al Rahmad AH. Pemberian ASI dan MP-ASI terhadap Pertumbuhan Bayi Usia 6–24 Bulan. 2017; Jurnal Kedokteran Syiah Kuala 8–14.
9. Hapsari, Distra R, Novidahlia, Noli, Mukriman, Siti. Karakteristik Fisikokimia dan Sensori Bubur Bayi Instan Berbahan Dasar Tepung Kacang Kedelai Organik dan Tepung Wortel dengan Flavor Apel. Jurnal Ilmiah Pangan Halal Vol 6 No 1 10-21. 2024. https://doi.org/10.30997/jiph.v6i1.10877
10. Putranto K. Pembuatan Bahan Makanan Campuran (BMC) Sapihan Balita (Weaning Food) dengan Karakteristik Organoleptik dan Kandungan Gizi yang Baik. J Agribisnis dan Teknol Pangan) [Internet]. 2021;1(02):177–93. https://doi.org/10.32627/agritekh.v1i02.25
11. Permatasari O, Murwani R, Rahfiludin MZ. Tempe Nuggets Provision Improves Energy Adequacy and Protein Intake In Underweight Underfive Children. Curr Res Nutr Food Sci. 2018;6(1):89–96. http://dx.doi.org/10.12944/CRNFSJ.6.1.09
12. Sri Darningsih, Nur Ahmad Habibi, Zurni Nurman I. Pengembangan Makanan Pendamping Air Susu Ibu (MP- ASI) Bubur Instant Dengan Substitusi Tepung Ikan Lele. 2023;18(1):94–102. https://doi.org/10.20473/mgi.v18i1.94-102
13. Kementerian Kesehatan Republik Indonesia. Angka Kecukupan Gizi yang Dianjurkan Untuk Masyarakat Indonesia. Peraturan Menteri Kesehatan Republik Indonesia Nomor 28 Tahun 2019. Retrieved from: https://share.google/YawcUynL3dXZgBOWm
14. Dewi EK, Nindya TS. Hubungan Tingkat Kecukupan Zat Besi Dan Seng Dengan Kejadian Stunting Pada Balita 6-23 Bulan. Amerta Nutition. 2017;1(4):361. https://doi.org/10.20473/amnt.v1i4.2017.361-368
15. Adam M, Arbie FY. Uji Daya Terima Konsumen Terhadap Cookies Yang Disubstitusi Tepung Biji Nangka. Health Nutr J. 2018;IV:90–7. http://dx.doi.org/10.52365/jhn.v4i2.174
16. Putri, Destiana A, dkk. Analisis Kualitas Gizi MP-ASI Instan Berbasis Gembili dengan Fortifikasi Tepung Daun Kelor, Ikan Teri dan Telur Puyuh. Jurnal Teknologi dan Mutu Pangan Vol 4(2) 126-137. 2026. DOI: http://dx.doi.org/10.30812/jtmp.v4i2.5926
17. Winarti, Sri. Makanan Fungsional. Surabaya : Graha Ilmu. 2020.
18. Winarno, F.G. Kimia Pangan dan Gizi. Jakarta: PT. Gramedia Pustaka Utama; 2015.
19. Ananda RA, Hermanuadi D, Brilliantina A, Novita EK. Karakteristik Tepung Ikan Lemuru Dengan Variasi Perlakuan Pendahuluan (Characterization of

Lemuru Fish Flour Using Pretreatment Variation). 2022;1(1):40–8. https://doi.org/10.25047/jofe.v1i1.3083

20. Kementerian Kesehatan. Tabel Komposisi Pangan Indonesia. 2018.
21. Haryani VM, Putriana D, Hidayati RW. Asupan Protein Hewani Berhubungan dengan Stunting pada Balita di Wilayah Kerja Puskesmas Minggir. Amerta Nutr. 2023;7(2):139–46.https://doi.org/10.20473/amnt.v7i2SP.2023.13 9-146
22. Purwandini S, Atmaka DR. Pengaruh Kecukupan Konsumsi Zink dengan Kejadian Stunting : Studi Literatur The Effect of Adequate Zinc Consumption with the Occurrence of Stunting in Indonesia : Literature Review. Media Gizi Kesmas. 2023;12(1):509–15. https://doi.org/10.20473/mgk.v12i1.2023.509-515
23. Choiroel Anam, Kawiji, Usada Nur Ariyogam RF. Karakteristik Fisik dan Organoleptik MP-ASI Instan Diperkaya Ikan Patin dan Ikan Gabus Metode Freeze Dryer. 2021;21(2):116–23. https://doi.org/10.25047/jii.v21i2.2650
24. Mumpuni, CE, Khasanah, TA. Pengaruh Formulasi Tepung Ikan Haruan, Tepung Buah dan Biji Labu Kuning Pada Biskuit Terhadap Kandungan Gizi Dan Daya Terima. Journal of Nutrition College. 2021;10(1):1–9.https://doi.org/10.14710/jnc.v10i1.28486
26. Badan Pengawas Obat dan Makanan Republik Indonesia. 2020. Peraturan BPOM Nomor 34 Tahun 2019 tentang Kategori Pagan (atau peraturan teknis terkait lainnya). Jakarta: BPOM RI. Retrieved from : https://standarpangan.pom.go.id/oldspo/dokumen/peraturan/2019/PerBPOM_Nomor_34_Tahun_2019_Kategori_Pangan_Salinan.pdf
27. Pomalingo AY, Misnati. Pengaruh Penambahan Tepung Ikan Tuna Terhadap Daya Terima Dan Nilai Gizi Biskuit Kelor. Gorontalo Journal Health and Science Gorontalo. 2021;5(1):155–66.https://doi.org/10.35971/gojhes.v5i1.9229
28. Husain R, Umar NS, Suherman SP. Formulasi Tepung Ikan Bandeng (Chanos chanos) Dalam Pembuatan Biskuit Sebagai Makanan Pendamping ASI (MP-ASI). Jambura Fish Process J. 2023;5(1):47–59.https://doi.org/10.37905/jfpj.v5i1.15786
29. Aritonang TR, Ode W, Fitriani I, Manulang RS, Simanjuntak FM, Child Y. Relationship of MP ASI Processing with Infant 6 to 12 Months Old Baby Growth and Development (Study at Umi Rahma Maternity Clinic in 2019). Sci Midwifery. 2021;9(2):377–82.
30. Hasanah S, Masmuri M, Purnomo A. Hubungan Pemberian ASI dan MP ASI Dengan Kejadian Stunting pada Baduta (Balita Bawah 2 Tahun) di Wilayah Kerja Puskesmas Kampung Dalam. Khatulistiwa Nurs J. 2020;2(1):13–21. https://doi.org/10.53399/knj.v2i1.18
31. Ajani SA, Ruhana A. Hubungan Praktik

Pemberian MP – ASI dengan Status Gizi Anak di Bawah Dua Tahun di Desa Wringin, Kabupaten Bondowoso. J Gizi Univ Negeri Surabaya. 2023;3(3):351–7.

32. Ni Made Ayu Novita Anugerah, Luh Gede Pradnyawat AEP. Hubungan Tingkat Pengetahuan Ibu Tentang Gizi dengan Kejadian Stunting Balita 12 - 59 Bulan di Wilayah Kerja Puskesmas Tegallalang 1 konsekuensi yang jarang diingat , tetapi. 2024;4(2):275–81.https://doi.org/10.22225/amj.4.2.2024.275-281