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RUTF Biscuit Made From Mung Bean Flour and Anchovy Flour for Stunting Toddlers

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ABSTRACT

Stunting remains a significant malnutrition issue in Indonesia. According to the 2022 Indonesian Nutrition Status Survey (SSGI), the prevalence of stunting among toddlers in Central Java is 20.8%, while in Semarang City it is 10.4%. Ready-to-Use Therapeutic Food (RUTF) is an energy-dense, micronutrient-rich product given to toddlers with uncomplicated wasting. Wasting children are three times more likely to become stunted compared to well-nourished children, and stunted children have a 1.5 times greater risk of becoming wasted. The use of RUTF for stunted children has not been extensively studied, particularly regarding formulations that use affordable, nutritious local ingredients. This study aims to develop an RUTF biscuit formulation from mung beans and anchovy flour that is acceptable to toddlers, with appropriate nutritional values and recommended serving sizes. This quantitative experimental study employed a Completely Randomized Design. The objects studied were three treatment groups of RUTF biscuits using mung bean and anchovy flour as substitutes for wheat flour: F2 with 12%, F3 and F4 with 15%, and F1 as a control. Formulation 2, with 10% mung bean and 2% anchovy flour substitution, was the most preferred by panelists, providing energy of 525.60 kcal, fat 25.86 g/100g, carbohydrates 54.73 g/100g, calcium 398.20 mg/100g, and phosphorus 375.63 mg/100g, and passed microbiological contamination tests. However, protein, vitamin C, zinc, and iron levels did not meet the general RUTF and biscuit RUTF standards. With a serving size of 30-40 grams (equivalent to 3-4 pieces), this RUTF biscuit has potential as a locally based supplementary food alternative to support toddler nutritional needs, especially for prevention and recovery from nutritional problems.

Keywords : RUTF; stunting; mung bean flour; anchovy flour

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INTRODUCTION

Stunting remains one of the major health issues in Indonesia. According to the 2023 Indonesia Nutrition Status Survey (SSGI), the prevalence of stunting in Central Java was 20.7% and 10.9% in the city of Semarang. Stunting is a condition in which measurements of height-for-age (HAZ) fall within the z-score range of -3SD to < -2SD (1). Physical and cognitive development in stunted children is likely to be suboptimal, which impacts their learning abilities and other opportunities in life (2). Addressing stunting requires appropriate and effective nutritional interventions to improve nutritional status and support optimal growth.

Ready-to-Use Therapeutic Food (RUTF) is widely recognized as an energy- and micronutrient-dense product provided to severely acutely malnourished infants and toddlers, specifically those with wasting without complications (3). The use of RUTF for stunted children has not yet been extensively studied, particularly regarding formulations using affordable and nutritious local food ingredients. RUTF products developed worldwide include paste/cream, biscuit, and wafer forms, made from ingredients such as milk, oil, peanuts, and vitamins and minerals. These products have nutritional values including 520–550 kcal/100 grams of energy, 10%–12% of total energy from protein, and 45%–60% from fat; however, they rely on expensive imported ingredients and are often less palatable to children. RUTF products developed from local food sources are more readily accepted by infants and toddlers aged 6–59 months, and these local products demonstrate the same efficacy as standard RUTF, as measured by weight gain comparable to that of standard RUTF (4).

Paste- and cream-based RUTF products have been widely developed in Indonesia, whereas the development of RUTF in biscuit form remains limited. RUTF with high energy content, complete protein, and essential micronutrients has the potential to serve as an effective nutritional intervention to support long-term recovery and linear growth in stunted infants and toddlers. Stunted children are 1.5 times more likely to become wasted, and wasted children are three times more likely to become stunted compared to well-nourished children (5). The administration of RUTF as a long-term preventive supplement to monitor both wasting and stunting, when given routinely, has been proven effective in improving height-for-age z-scores in toddlers (6). To develop RUTF for stunted children, it is important to enhance the nutritional value such as animal and plant-based proteins and iron from local foods in Semarang, namely mung beans and anchovies. Mung beans are rich in plant-based protein and minerals such as iron and phosphorus and are consumed daily by the local community. Anchovies are a local food in Semarang that serve as a functional food. Anchovy production in Semarang in 2020 totaled 27,017 kg, indicating that this food source is readily available (7). The protein content of anchovies is 10.3 grams per 100 grams (8).

This study is important as part of efforts to help reduce stunting in Semarang City by developing a recovery food product based on local ingredients namely mung beans and anchovies as a substitute in RUTF. The formulations used in this study were adapted from previous research, with modifications in

the selection of raw materials for producing RUTF (9),(10). In this study, wheat flour was replaced with mung bean flour and anchovy flour in various treatment groups. The resulting formulations were then tested for acceptability by a semi-trained panel consisting of mothers of toddlers, who could represent potential RUTF acceptance in terms of color, taste, aroma, and texture, and by stunted children aged 3–5 years. The selected formulation, based on acceptability analysis, will be tested for its nutritional and microbiological content. The objective of this study is to compare the effects of various substitution treatments with the control formulation. Additionally, RUTF biscuits as a long-term preventive supplement for stunted children aimed at preventing wasting while improving overall nutritional status will be evaluated against the WHO RUTF standards and recommended serving sizes per consumption.

METHOD

This study is an experimental study**.** It employed a completely randomized design with three replicates for nutritional analysis and microbiological testing to obtain accurate data. The study subjects were RUTF biscuits with three treatment groups substituting mung bean flour and anchovy flour and one control group without substitution. The formulations were evaluated through acceptability tests involving mothers of toddlers and stunted children aged 3–5 years in the service area of the Kedungmundu Community Health Center, Semarang City. The nutritional components of the RUTF biscuits analyzed were energy, fat, protein, carbohydrates, vitamin C, calcium, phosphorus, zinc, iron, moisture, and ash. In addition, microbiological testing was conducted using the ALT and MPN methods. All analyses were performed at the Chemistry Laboratory, Faculty of Science and Mathematics, Satya Wacana Christian University, Salatiga. Based on the results of the nutritional analysis of the selected formulation, the acceptability test was then compared with the 2007 WHO RUTF general standards, the 2019 UNICEF RUTF biscuit standards, and the recommended serving size per consumption based on the 2019 Dietary Reference Intakes.

The development of the RUTF biscuit formulation began with preparing raw materials for RUTF biscuit production, conducting trials to refine the formulation, establishing panelist criteria for the acceptability test, and determining methods for nutritional analysis. The production of RUTF biscuits involves three stages: dough preparation, molding, and baking. Dough preparation was carried out using *the creaming method*, which involves gradually mixing the ingredients according to each established formulation. The next stage was molding the dough using *heart-shaped* molds with a thickness of 1 cm. The final stage was baking the cookies in an electric oven at 120°C for 40 minutes. These three stages of RUTF biscuit production were applied identically to all four formulations. The initial formulations were based on the research by Ambarwati et al. (9) on the development of *RUTF* cookies using banana flour as a substitute, and the research by Reni Novia et al.(10) on the development of bar-shaped *RUTF* products made from mung beans, cereals, and modified and adapted vegetable oils, as shown in Table 1. The acceptability test used a sample of semi-trained panelists consisting of 30 mothers of toddlers and 15 toddlers with stunting aged 3–5 years in the service area of the Kedungmundu Community Health Center.

Table 1. Composition of *RUTF* Biscuit Ingredients

Ingredient	Formulation (%)			
	F1 (Kontrol)	F2	F3	F4
Full Cream milk	40	40	40	40
Sugar	10	10	10	10
Coconut Oil	5	5	5	5
Peanuts	8	8	8	8
Mung Bean flour	0	10	12	10
Anchovy flour	0	2	3	5
Wheat flour	18	6	3	3
Egg yolk	10	10	10	10
Vanilla	2	2	2	2
Baking Soda	2	2	2	2
Vitamin and mineral mix	5	5	5	5

Modified from the study by Ambarwati et al. and the study by Reni et al.

The sample was selected using *non-probability sampling* with a *purposive sampling* method based on the following inclusion criteria: participants must not have any impairments in their sense of smell, taste, or vision; must not have any allergies; and must be willing to participate after receiving a briefing on RUTF and training on the acceptability test method, as evidenced by signing *an informed consent form.* These requirements constitute the requirements for non-standard (semi-trained) panelists in the acceptability test. For toddler panelists, written consent was obtained from their parents, and they were accompanied by their parents during the assessment. Acceptability assessments by the toddler's mothers include aspects of color, aroma, taste, and texture using a 5-point scale: scale 1 (strongly dislike), scale 2 (dislike), scale 3 (somewhat like), scale 4 (like), and scale 5 (strongly like). The assessment of acceptability by toddler panelists used three facial expression images, interpreted as 1 = dislike, 2 = neutral, and 3 = like (11). One sample of each formulation (F1, F2, F3, and F4) was packaged in an airtight plastic container and assigned an identification code. All samples were then arranged in a single container and presented to the panelists. Thus, each panelist received one container containing samples from all four formulations for evaluation. The evaluation began with formulation 1 (control). Before moving on to formulation 2, the panelists were asked to drink plain water provided to help neutralize the taste of the previous biscuit and prevent bias. The same procedure was then repeated for formulations 3 and 4.

The acceptability test analysis for the semi-trained panelists was conducted using *the Kruskal-Wallis test* because the data were ordinal and did not meet the assumption of a normal distribution. Prior to analysis, a normality test was performed using the Shapiro-Wilk test. The nutritional content data for the selected formulations were analyzed using *an independent t-test* after meeting the assumption of normality ($p > 0.05$).

RESULTS

Acceptability Test of *RUTF* Biscuits

Still, since this study was a one-group pretest posttest design without a control group, the results must be cautiously interpretedAcceptability test for color, aroma, taste and texture of RUTF cookie using trained semi-trained panelist with 5-point scale: scale 1 (strongly dislike), scale 2 (dislike), scale 3 (somewhat like), scale 4 (like), and scale 5 (strongly like). The assessment of acceptability by toddler panelists used three facial expression images, interpreted as 1 = dislike, 2 = neutral, and 3 = like. The test showed that the most liked formulation in taste, color and aroma was formulation 2. The comparison of the respondents' acceptability scores for colour, aroma and taste among the four formulations were significant according to Duncan's post-hoc test. These differences were likely due to the concentrations of mung bean flour and anchovy flour used in the substitutions.

The results of Duncan's post-hoc test in Table 3 show significant differences between Formulations 1 and 2 on one hand, and Formulations 3 and 4 on the other. This indicates that the addition of 10% mung beans and 2% anchovy flour results in similar organoleptic characteristics. The high level of acceptability for formulation 2 is likely due to the substitution proportions of mung bean and anchovy flour, which produced flavor, aroma, color, and texture that better align with toddlers' preferences. On the other hand, formulation 4 was given the lowest score as a result of the substitution ratio in that formulation which led to low acceptance resulting from greater characteristic aroma of anchovies with dark color and taste and texture which were less favoured by toddlers.

Table 2. Results of the *RUTF* Biscuit Acceptability Test Among Mothers of Toddlers*

Formulation	Color	Aroma	Texture	Taste
	Rerata ± SD			
F1 (Kontrol)	3.90±0.548b	4.03±0.490b	3.83±0.531b	3.87±0.507b
F2	4.50±0.572a	4.57±0.504a	4.40±0.621a	4.73±0.450a
F3	3.40±0.563c	3.33±0.606c	3.67±0.547b	3.33±0.547c
F4	2.80±0.714d	2.13±0.776d	2.13±0.629d	2.00±0.830d

* Number of respondents: 30 mothers of toddlers. Different letters indicate significant differences at α = 0.05

Table 3. Results of the *RUTF* Biscuit Acceptability Test Among Toddler Panelists*

RUTF Biscuits	Mean ± SD	Kruskal-Wallis (Sig.)
Formulation 1	2.47 ± 0.640 [a]	0.000
Formulation 2	2.88 ± 0.414[a]	
Formulation 3	2.00 ± 0.756[b]	
Formulation 4	1.53 ± 0.743[b]	

* Number of toddler respondents: 15 panelists; Different letters indicate significant differences at α = 0.05

Nutritional Value of *RUTF* Biscuits

The nutrient content of *RUTF* biscuits from Formulation 1 (control) and Formulation 2 (selected) that were analyzed included energy, fat, protein, carbohydrates, vitamin C, calcium (Ca), phosphorus (P), zinc (Zn), iron (Fe), moisture content, and ash content to determine the comparison of the effects of mixing mung bean flour and anchovy flour in the formulations on nutritional values. The nutritional analysis aimed to determine whether the nutrient levels in the *RUTF* biscuits of the selected formulation met the WHO RUTF standards and UNICEF *RUTF* biscuit standards, as well as to determine the serving size to be provided to stunted toddlers to meet their daily nutritional intake based on the Recommended Dietary Allowances (RDAs). The results of the *RUTF* biscuit nutritional analysis are presented in Table 4.

Table 4. Nutritional Values of *RUTF* Biscuits

Parameter	F1 (control)	F2 (Selected)	General Standards for *RUTF**	*RUTF Biscuit/Compress Bar* Standards**	% of RDA for Toddlers Aged 1–3 Years***	% of RDA for Toddlers Aged 4–5 Years***
Energy (kcal)	501.78[a]	525.60 [a]	520-550	Min. 500	1350 kkal	1400 kkal
Fat (g/100g)	27.50 [a]	25.86[a]	25.8-36.3	24.8-33.0	45 g	50 g
Protein (g/100g)	2.41 [a]	2.69 [a]	12.8-16.2	12.3-15.5	20 g	25 g
Carbohydrates (g/100g)	56.29 [a]	54.73 [a]	-	44.5-59.9	215 g	220 g
Vitamin C (mg/100g)[1]	0.56[a]	2.31[b]	Min. 50	>50	40 mg	45 mg
Calcium (mg/100g)	380.16 [a]	398.20 [a]	300-600	300-600	650 mg	1000 mg
Phosphorus (mg/100g)	360.73 [a]	375.63 [a]	300-600	300-600	460 mg	500 mg
Zinc (mg/100g)	1 [a]	1,23 [a]	11-14	11-14	3 mg	5 mg
Iron (mg/100g)[2]	0.76[a]	1.57[b]	10-14	10-14	7 mg	10 mg
Moisture Content (g/100g)[1]	4.1[a]	6.36[b]	Max 2.5	Max. 4	-	-
Ash Content (g/100g)	4.26 [a]	5.01 [a]	-	Max. 5	-	-

Different letters indicate significant differences ($p<0.05$), *WHO (2007), ** UNICEF (2019), ***AKG 2019, [1] Independent t-test, [2] Wilcoxon test, - Not available

Table 4 shows that the levels of protein, vitamin C, zinc, and iron are below the general RUTF standards and the RUTF biscuit standards. The low protein content is thought to be due to the relatively small proportions of protein-source substitute ingredients—namely, 10% mung bean flour and 2% anchovy flour—which limit their contribution to the product's total protein content. The very low vitamin C content is likely due to the minimal inclusion of vitamin C sources and high losses during the baking process. The low zinc and iron content in both the control and selected RUTF biscuits is likely due to the relatively small proportions of these substitute ingredients. The findings revealed that the

moisture level of the selected formulation is above the WHO standard, and the product might have a shorter shelf-life than conventional RUTF. Increased water activity due to high moisture content can speed up microbial growth, catabolism of chemical constituents, and development of sogginess in biscuits stored.

Microbiological Contamination Testing of *RUTF* Biscuits

Microbiological testing of food products is conducted to determine whether they are contaminated, ensuring they are safe for consumption. Table 5 presents the results of microbiological contamination testing, which measured the Total Plate Count (TPC) and Total Coliform Count for the two *RUTF* biscuit formulations.

Table 5. Microbiological Contamination Testing of RUTF Biscuits[n]

Parameter	Formulation 1 (control)	Formulation 2
ALT (cfu/g)	2.8×10^2	2.5×10^2
Total Coliforms (MPN/g)	negative	negative

[n] Analysis was conducted at the Food Chemistry Laboratory of Satya Wacana Christian University

DISCUSSION

RUTF Biscuit Acceptability Test

Color is an important factor in food products because it can enhance consumer appeal and determine the level of consumer preference or acceptance when choosing a product (12). Table 2 shows that the highest color preference for the biscuits was for formulation 2, which contained a 10% mung bean flour blend and 2% anchovy flour. Panelists preferred a yellowish-brown color with a hint of grayish-green. Color changes that occur during food processing depend on the physicochemical characteristics of the raw ingredients, including reducing sugars, amino acids, moisture content, and the conditions of the overall process. The more mung bean flour and anchovy flour used, the darker the *RUTF* biscuit color becomes due to the Maillard reaction. Meanwhile, the color of Formulation 1 biscuits is pale white or cream-colored because no mung bean flour or anchovy flour was added. Panelists were less interested in this color because they perceived the biscuits as undercooked (13).

Research findings on **aroma** parameters indicate that *RUTF* biscuit formulations containing mung bean flour and anchovy flour (2%) have a slightly fishy aroma. Increasing the amount of mung bean flour or anchovy flour in the biscuits results in an off-flavor and fishy aroma that is disliked, as seen in Formulation 4. Makfoeld et al., 2002, as cited in Mardiyah, U., et al., 2022, explained that aroma is closely related to various chemical reactions that may occur during processing, such as the formation of the aroma compound furaneol from the Maillard reaction between proteins and reducing sugars (14). The panelists' evaluation of the aroma of Formulation 1—without the addition of mung bean flour and anchovy flour—was interpreted as "liked," as the characteristic aroma of the biscuit without substitution was considered ordinary and unvarying by the panelists.

Texture is a characteristic of a food product's form that becomes apparent when consumed. Based on the analysis results in Table 2, it can be concluded that the proportion of the mixture of wheat flour, mung bean flour, and anchovy flour can affect the level of crispness. According to the research by Wirakartakusumah (1986) cited in Dhiyaul Haq, A., et al. (15), ood texture is highly dependent on moisture content, fat content, total carbohydrates, and protein. Amylopectin also affects texture; the higher the level of amylopectin in a food product, the greater expansion ability it has. The texture of the resultant cookies was most importantly impacted by the addition of the anchovy flour: The more anchovy flour added, the more crushed and grainy were the cookies. This is caused due to the anchovy flour can prevent sugar from caramelizing and hence act as a binder between ingredients. Additionally, the mineral content in anchovy flour can make the resulting biscuits have a gritty texture (14).

Taste is one of the key criteria in evaluating a food product, involving the sense of taste—specifically, the tongue. Taste is a sensation detected by the human taste buds in response to a substance (16). Table 2 shows that there are significant differences in the taste parameters of *RUTF* biscuits between formulation 1 (control), formulation 2, formulation 3, and formulation 4. These significant differences are attributed to the proportions of wheat flour, mung bean flour, and anchovy flour in the mixtures. This is likely because the addition of mung bean flour and anchovy flour at moderate levels resulted in *RUTF* cookies that were more savory, sweet, and slightly salty compared to the cookie formulation without substitutions (Formulation 1). But when figuring out with high percentages of mung bean flour or anchovy flour, panelists tended to dislike the biscuits due to a novelty taste characterized as bitter and slightly astringent (presence of > 4% miscellaneous flour, other than wheat) associated with small amounts added. On the other hand, a high anchovy flour content yields a pungent fishy-natured salty-bitter biscuit flavor.

Overall Acceptance Level

Based on the results of the organoleptic test, it can be concluded that differences in the treatment of a food product will affect the panelists' liking and acceptance levels. Based on the panelists' evaluations in Table 2 regarding color, aroma, texture, and taste of the *RUTF* cookies—assessed by 30 mothers of toddlers —and the toddlers' evaluations in Table 3, it can be concluded that *RUTF* cookie formulation 2, with 10% mung bean flour and 2% anchovy flour substitutions, is the most acceptable. Formulation 2 has a savory, fishy flavor; a brownish-yellow color with hints of grayish-green; and a crisp, slightly coarse texture with a characteristic biscuit aroma and a faint fishy note. Therefore, based on the overall average ratings from both the mothers of toddlers and the 3–5-year-old children, Formulation 2 is the selected formulation.

Nutritional Value of *RUTF* Biscuits

The results of the analysis of energy, fat, protein, carbohydrates, calcium, phosphorus, zinc, and ash content in the control formulation and the selected formulation showed no statistically significant differences ($p > 0.05$). The overall average nutritional value of the selected formulation was higher than

that of the control formulation. This indicates that substituting wheat flour with mung beans and anchovy flour has the potential to improve the nutritional value of *RUTF* biscuits.

The fat content in the *RUTF* biscuits of the control formulation and the selected formulation did not differ significantly. This is likely due to the high-temperature processing and the duration of the processing, which caused fat degradation, even though the selected formulation included the addition of mung bean flour and anchovy flour containing 1.5 grams of fat and 6.4 grams of anchovy flour, respectively (8). The fat content of the *RUTF* biscuits in the selected formulation met the general *RUTF* standard of 25.8–36.3 grams and the *RUTF* biscuit standard of 24.8–33 grams.

The average protein content of the *RUTF* biscuits increased in the selected formulation, but this difference was not statistically significant ($p > 0.005$). This is likely due to the high-temperature processing method. The heating process causes protein denaturation, leading to coagulation and a reduction in solubility (17). The protein content of the selected *RUTF* biscuits was well below both the general *RUTF* standard (<12.8 grams) and the *RUTF* biscuit standard (<12.3 grams), presumably due to the relatively low proportion of protein-source substitute ingredients, 10% mung bean flour and 2% anchovy flour which limited their contribution to the product's total protein. The total protein content of a product is greatly influenced by the proportion of protein-contributing ingredients in the formulation (18). The low protein content is a major limitation of this study.

Carbohydrates are a source of energy for humans. Carbohydrate content is influenced by other compounds such as moisture content, ash content, protein and fat content, and crude fiber content. The nutritional value of carbohydrates in the selected *RUTF* biscuit formulation meets the *RUTF* biscuit standard of 44.5–59.9 grams; therefore, it can be recommended as a biscuit to meet the carbohydrate intake needs of toddlers.

The energy content of the *RUTF* biscuits was higher in the selected formulation but did not differ significantly from the control formulation. This is likely because total energy content is influenced by fat, protein, and carbohydrate levels, which were not statistically significantly different. However, the energy content of the *RUTF* biscuits in the selected formulation meets the general *RUTF* standard of 520–550 kcal (3) and the *RUTF* biscuit standard of a minimum energy content of 500 kca (19), making them a potential source of energy for stunted toddlers as part of their supplementary feeding program (PMT).

Vitamin C is essential for toddlers to maintain their immune system, so they do not get sick easily and can grow and develop properly (20). The vitamin C content in *RUTF* cookies shows that there is a significant difference ($p<0.05$) between the control group and the treatment group. The higher the proportion of mung beans added, the higher the vitamin C content in the biscuits, consistent with the findings of Tandi, R., et al. (21), The WHO reported that the vitamin C content in biscuits made with a 75:25 substitution of chayote and mung beans was higher than in those without mung bean substitution. However, when compared to the WHO RUTF standards, the vitamin C levels in the selected RUTF biscuits did not meet the standards. This is because vitamin C is thermolabile, meaning it is easily degraded during high-temperature processing due to oxidation reactions and changes in chemical structure (22).

The analysis of iron content in the *RUTF* cookies showed significant differences ($p<0.05$). The higher the substitution of mung bean flour and anchovy flour, the higher the iron content. This is consistent with the study by Ramadhan et al. (23) which states that the greater the substitution of anchovy flour, the higher the iron content in anchovy cookies. However, compared to WHO standards, the iron content remains below the standard. This is likely due to the presence of phytic acid in mung bean flour, which binds to iron and thereby reduces its bioavailability (24).

The average nutritional values for calcium, phosphorus, and zinc in the *RUTF* cookies of the treatment groups were higher with the substitution of mung bean flour and anchovy flour compared to the control group. However, these differences were not statistically significant, likely due to *the dilution effect* : a condition where mineral-rich ingredients are added in relatively small proportions, causing their contribution to be distributed and diluted by the main ingredients used in larger quantitie (25). The calcium and phosphorus levels in the selected RUTF biscuit formulation already meet the WHO's general *RUTF* standards and *RUTF* biscuit standards, making them suitable for consumption by stunted toddlers; however, the zinc levels do not yet meet the standards, likely due to the presence of phytic acid, which can bind to zinc and thereby reduce its concentration.

There is a significant difference in moisture content between the control formulation and the selected formulation. The study results show an increase in moisture content with the substitution of mung beans and anchovy flour. The moisture content of the *RUTF* biscuits in the selected formulation remains high based on the general *RUTF* standards and *RUTF* biscuit standards. The fiber content in mung beans binds water, making it difficult to release even through heating (26). High moisture content suggests that the product could have a lower shelf life than standard RUTF. Increased moisture content would provide more water which in turn elevates water activity to enhance microbial growth and rapid chemical decomposition leading to biscuits being lost their crispness during storage.

The ash content was however similar ($p > 0.05$) for both control-formulation and selected-formulation RUTF biscuits. The ash content itself originates from anchovy flour, which contains several minerals essential for the body. Ramadhan *et al.* (2019) noted that the ash content of food products increases as the substitution rate of anchovy flour rises (23). However, this is likely because the proportion of anchovy flour and other mineral sources such as the vitamin-mineral mix used in the selected *RUTF* biscuit formulation accounted for only 7% of the total weight of all ingredients. When compared to the *RUTF* biscuit standard, the selected formulation does not yet meet the *RUTF* biscuit standard, despite a very small difference of 0.01%.

Microbiological contamination testing involves assessing changes in microbial behavior in response to the environment. Microbiological testing of food products is conducted to determine whether a food product is contaminated, ensuring it is safe for consumption. The Total Plate Count (TPC) is one method for calculating the number of microorganisms present in food. According to the 2007 WHO *RUTF* standards, the limit for microbiological contamination regarding TPC is no more than 1.0 $\times 10^4$colonies per gram, and the product must be coliform-negative (3). Based on the measurement results

for the formulated *RUTF* biscuits, they can be considered safe from contamination because their values are below the established standards.

RUTF Biscuit Intake for Stunted Toddlers

The Recommended Dietary Allowances (RDAs) for the Indonesian population are values that indicate the average daily nutrient requirements that must be met by all individuals based on specific characteristics such as age, sex, physiological condition, and level of physical activity in order to lead a healthy life (27). Daily nutritional requirements based on the RDA for children aged 1–5 years are shown in Table 4. Based on a comparison with general RUTF standards and RUTF biscuit standards, the product meets the requirements for energy, fat, carbohydrates, calcium, and phosphorus. However, the levels of protein, vitamin C, zinc, iron, moisture, and ash do not yet meet these standards.

RUTF biscuits fall into the category of supplementary foods in the form of snacks for toddlers, meeting at least 10% of the RDA. Nutrient composition of this supplementary food for toddlers (1–3 years) per serving is as follows: 135 kcal energy, 4.5 g fat, 2 g protein, 21.5 g carbohydrate, 4 mg vitamin C, 65 mg calcium, 46 mg phosphorus, 0.3 mg zink, 0,7 mg Fe. Standards required fulfill by toddlers 4–5 years : per serving, energy: 140 kcal; fat: 5 g; protein: 2.5 g; carbohydrates:22 g; vitamin C:4.5 mg; calcium (Ca):100 mg; phosphorus (P):50 mg; Zinc (Zn):0.5mg and iron (Fe)1 mg for children, 30–40 g (3-4 pieces) of biscuits can meet around 10% of energy, fat, carbohydrate, calcium, phosphorus and zinc requirements for those aged 1–5 years. However, this amount still does not meet the recommended intake for protein and vitamin C in a single supplementary meal .

Supplementary foods could help fill the gap to meeting the energy and nutrient needs of toddlers in regions where stunting is endemic; the RUTF biscuits used for this study provide necessary energy, protein, and micronutrients that are implicated in growth/development. Energy and protein are necessary to support synthesis of body tissue and bone growth, and micronutrients (such as iron, zinc, calcium, vitamin C) participate in metabolism, formation of tissues during recovery from injuries and immune functions. Thus, this study demonstrated that locally made RUTF biscuits have potential to be used as a supplementary food in toddlers aimed at improving nutrient adequacy; however their effect on stunting prevention requires direct intervention trial.

However, the protein and vitamin C content in the RUTF biscuits in this study still do not meet 10% of the nutritional requirements per serving of the toddler's supplemental food. This represents a limitation of the formulation, as protein and vitamin C play crucial roles in supporting children's growth, development, and immune function. Therefore, increasing the proportion of protein and vitamin C sources or combining them with other food sources should be considered in future formulation development. In addition to acceptability and nutritional content, RUTF biscuit formulations based on local foods have potential for further development due to their easy availability, relatively simple processing, and estimated economic feasibility.

CONCLUSIONS AND RECOMMENDATIONS

The *RUTF* biscuit made from mung beans and anchovy flour in Formulation 2 exhibits good acceptability in terms of color, aroma, texture, and taste, and meets microbiological safety requirements. With a serving size of 30–40 grams, equivalent to 3–4 pieces, these RUTF biscuits have the potential to be developed as a locally sourced complementary food to support the nutritional needs of infants and toddlers, particularly in efforts to prevent and address nutritional deficiencies. However, the protein and vitamin C content in the selected formulation still does not meet 10% of the Recommended Dietary Allowance (RDA) per serving; therefore, this product cannot yet fully meet nutritional requirements as a recovery food supplement and needs to be combined with other food sources or supplementation. Another limitation is that product quality evaluation is still limited to chemical analysis of nutrient content and does not yet include micronutrient bioavailability, water activity, and product shelf life. Additionally, the measurement of acceptability among toddlers uses a pictorial expression scale that does not yet fully or comprehensively reflect sensory preferences. Future research should focus on optimizing the formulation to improve the product's compliance with WHO RUTF specifications by improving nutrient composition and micronutrient fortification, and on conducting further evaluations of nutrient bioavailability, protein digestibility, storage stability, food safety, and the effectiveness of the intervention in toddlers with nutritional problems.

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REFERENCES

1. Kemenkes R. Peraturan Kementerian Kesehatan tahun 2020. Vol. 2507. p. 1–9.
2. Goals SD. Global Action Plan on Child Wasting.
3. WHO. Community-based management of severe acute malnutrition. A Jt Statement by World Heal Organ World Food Program United Nations Syst Standing Comm Nutr United Nations Child Fund. 2007;
4. Unicef Indonesia. Kajian Pentingnya Produksi Massal Ready-to-Use Therapeutic Food (RUTF) Lokal Di Indonesia. 2022;1–14.
5. Thurstans S, Sessions N, Dolan C, Sadler K, Cichon B, Isanaka S, et al. The relationship between wasting and stunting in young children: A systematic review. Matern Child Nutr. 2022;18(1).
6. Sheila Isanaka, BA, Nohelly Nombela, MPH, Ali Djibo, MD, Marie Poupard, MD D, Van Beckhoven, MD, Valérie Gaboulaud, MD, Philippe J. Guerin, MD, PhD and RF, Grais P. Effect of preventive supplementation with ready-to-use_therapeutic food on the nutritional status, mortality and morbidity of children 6 to 60 months in Niger: a cluster randomized trial. NIH Public Access. 2011;301(3):277–85.
7. Perikanan Kota Semarang. Data Kapal Penangkap Ikan Kota Semarang Tahun 2019. 2019.
8. Kementerian Kesehatan. Food Composition Table—Indonesia (Daftar Komposisi Bahan Makanan).

Tabel Komposisi Pangan Indonesia. 2017. 135 p.
9. Ambarwati R, Rahmawati VA, Gizi J, Kementrian P, Semarang K. Nutrient Density Cookies RUTF (Ready To Use Therapeutic Food) Dari Pangan Lokal Untuk Intervensi Balita Wasting. J Nutr Coll. 2023;12(2):179–83.
10. Novia R, Setiawan B, Marliyati SA. Development of Ready to Use Therapeutic Food (RUTF) Bar Product Made from Mungbean, Cereal, and Vegetable Oils. Media Gizi Indones. 2022;17(1):21.
11. Varela P, Galler M. Capturing food-elicited emotions : Facial decoding of children ' s implicit and explicit responses to tasted samples. 2022;99(November 2021).
12. Puspitasari. "Substitusi Labu Kuning (Curcubita moshcata) Untuk Perbaikan Mutu Bakso Ikan Nila (Oreochromis niloticus)." Pros Semin Nas Lingkung Lahan Basah. 2018;3(1):53–6.
13. Dr. Eva Derndorfer. Colours and their influences on sensory perception of products. DLG Expert Rep. 2017;3.
14. Mardiyah U, Jamil SNA, Muqsith A, Rodiyah S. Substitution of Anchovy Flour (Stolephorus sp.) in the Production of Semprong Cookies as a Calcium Source for School-Age Children. Samakia J Ilmu Perikan. 2022;13(2):155–61.
15. Haq AD, Ratnaningsih N, Lastariwati B. Substitution of Anchovy Flour (Stolephorus sp.) in the Production of Semprong Cookies as a Calcium Source for School-Age Children. J Pengolah Has Perikan Indones. 2021;24(3):292–300.
16. Sogen MDP, Permatasari O, Damayanti A, Rahmawati MMM. Formulation of Cookies Made from Tempe Flour and Red Spinach Flour for Toddler Supplementary Feeding (PMT). J Kesehat. 2022;10(3):162–7.
17. Sundari D, Astuti Lamid dan, Almasyhuri. Effect Of Cooking Process OFf Composition Nutritional Substances Some Food Ingredients Protein Source. Media Litbangkes. 2015;25(4):235–42.
18. Ertan Ermis, Ismail Hakki Tekiner, Chi Cihng Lee, Sumeyye Ucak HY. An overview of protein powders and their use in food formulations. Food Process Eng. 46(5).
19. UNICEF division supply. UNICEF - RUTF Biscuits Specs.pdf.
20. Maggini S, Wenzlaff S, Hornig D. Essential role of vitamin c and zinc in child immunity and health. J Int Med Res. 2010;38(2):386–414.
21. Tandi R, Hastuti S, Mulyani S. Analysis of Vitamin A, C, and E Content in Biscuits from Formulations of Chayote (Sechium edule) Flour and Mung Bean (Vigna radiata L.) Flour. J Banua Oge Tadulako. 2021;1(1):40–6.
22. Yin, X., Chen, K., Hao, C., Xing, C., & Chen X. Chemical stability of ascorbic acid integrated into commercial products: A review on bioactivity and delivery technology. PMC. 2022;11(1):153.
23. Ramadhan R, Nuryanto N, Wijayanti HS. Kandungan Gizi dan Daya Terima Cookies Berbasis Tepung Ikan Teri (Stolephorus sp) Sebagai PMT-P Untuk Balita Gizi Kurang. J Nutr Coll. 2019;8(4):264–73.
24. Zhang, Y. Y., Stockmann, R., & Ng K. Revisiting phytate-element interactions: implications for iron, zinc and calcium bioavailability, with emphasis on legumes. Crit Rev Food Sci Nutr. 2022;62(6):1460–82.
25. Winarno FG. Kimia Pangan dan Gizi. Jakarta: Gramedia Pustaka Utama; 2008.
26. Ponelo F, Bait Y, Ahmad L. The Effect Of The Addition Of Annealing Modified Mung Been Flour On The Physical, Chemical And Organoleptic Characteristics Of French Baquette Bread. Jambura J Food Technol. 2022;4(2):185–97.
27. Kementrian Kesehatan RI. Angka Kecukupan Gizi Yang Dianjurkan Untuk Masyarakat Indonesia. 2019;561.