



Biscuit Formulation Substitutes Wheat Flour with Tempeh Flour and Nile Tilapia Fish Flour as Complementary Food to Prevent Stunting

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Abstract— Stunting is one of the nutritional problems in Indonesia. One of the specific interventions for stunting is nutritional support in the form of protein-rich complementary foods, both animal and plant-based protein. This research is expected to provide an alternative to high-protein complementary foods for toddlers, thereby contributing to efforts to reduce stunting problems in Indonesia. The biscuit formulation consists of four treatments of the ratio of wheat flour: tempeh flour: Nile Tilapia fish flour, namely (F1) 100:0:0, (F2) 50:15:35, (F3) 50:25:25, and (F4) 50:35:15. The test parameters in this study were organoleptic tests, chemical tests in the form of proximate analysis, calcium, zinc, dietary fiber, amino acid, and fatty acid content, as well as physical tests in the form of texture and color. The results of the study showed that the best treatment based on the organoleptic test was a ratio of 50:25:25. Chemical tests showed that proximate analysis, calcium, dietary fiber, essential and non-essential amino acid composition, and fatty acid composition of selected biscuits were higher than those of control biscuits. The zinc content of selected biscuits was the same as that of control biscuits. The results of physical tests showed that selected biscuits had the same color description as the control, but had a softer texture than the control. The conclusion obtained was that, based on the composition of nutritional and non-nutritional content, selected biscuits with a 50:25:25 formulation have the potential as complementary food ingredients for breast milk that can help prevent stunting in toddlers.

Keywords— Biscuits; stunting; flour; tempeh flour; nile tilapia fish flour

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I. INTRODUCTION

Stunting in Indonesia remains a significant public health concern, and continued efforts are necessary to prevent and reduce its prevalence. Based on the 2024 Indonesian Nutritional Status Survey results, stunting cases in Indonesia are 19.8 % nationally [1]. Specific stunting interventions must be carried out at various levels, starting from the health of adolescent girls, health checks for pregnant women, and health checks and nutritional support for toddlers. One of the specific interventions for stunting is nutritional support in the form of complementary foods rich in animal and plant-based protein. In addition to protein, support for other nutrients such as fat and carbohydrates is also very important for stunted children [2].

For stunted children, protein can increase levels of Insulin Growth Factor 1 (IGF-1) which is a mediator of growth hormones and bone matrix formation, carbohydrates function to support energy for the body so that it can be active, and fat functions to maintain and regulate body health, and in other studies it is explained that stunted children who are given omega-3 supplements make the child healthier. An increase in immunity contributes to reducing the risk of illness [3]. It can be concluded that carbohydrates, fats, and proteins are necessary for stunted children.

In general, complementary food products on the market are made from biscuits. Biscuits are products made from wheat flour. The protein content in wheat flour is around 8.9 g, so in general, the protein content in biscuit products is 6.9% in

addition to protein. The carbohydrate and fat content in biscuits is also still low. It is estimated that the nutritional content ranges from 75.1% carbohydrates and 14.4% fat [4].

Several alternatives can be used to increase the amount and quality of protein and fat in the biscuit product, one of which is to replace a few percent of the composition of wheat flour with other flours, such as tempeh flour and Nile tilapia fish flour. Tempeh flour has a good amount and quality, with a protein digestibility value of 80.27%, a PER value of 2.12, a BV value of 88.78%, and an NPU value of 71.28%. In addition, the composition of essential amino acids contained in tempeh flour is also very complete and in large quantities, namely 579 mg / g protein. The nutritional content that is also good for growth is essential fatty acids. It is known that tempeh flour contains many essential fatty acids, such as oleic fatty acid, linoleic fatty acid, and linolenic acid [5, 6]. Nile tilapia is also a fish that lives in freshwater and is widely cultivated by the community. The easy and cheap cultivation process makes Nile tilapia abundant in the market. Nile tilapia has a high nutritional content, such as protein (18.48 g/100 g), fat (1.98 g/100 g), and carbohydrates (2.51 g/100 g) [7].

Research on making biscuits as complementary foods by replacing the main ingredient, wheat flour, with local food ingredients has been widely conducted. However, many previous studies have not explained the quality and quantity of nutritional and non-nutritional content in biscuit products, especially in efforts to prevent stunting. In addition, efforts to completely replace wheat flour with other local flour have also been carried out, but the resulting products still do not match the characteristics of biscuits made from wheat flour.

Modifications to the raw materials used in making biscuits include replacing some of the wheat flour with tempeh flour, which has been proven to have high protein quality and quantity. Nile tilapia fish flour is also expected to be an alternative, high-protein complementary food for breast milk, so that it can contribute to efforts to reduce stunting problems in Indonesia.

II. MATERIALS AND METHODS

A. Materials

The equipment used in this study included sets of tools for producing tempeh flour and Nile tilapia fish flour, as well as equipment for biscuit production. Analytical instruments consisted of tools for organoleptic evaluation, proximate analysis, dietary fiber analysis, amino acid profiling using HPLC, fatty acid profiling using GC-MS, mineral (Ca and Zn) analysis using AAS, texture analysis using a texture analyzer, and color measurement using a color reader.

The main ingredients used in this study were Nile tilapia fish flour, tempeh flour, wheat flour, sugar, margarine, milk powder, eggs, cornstarch, and cocoa powder. Ingredients for proximate analysis, amino acid content analysis, fatty acid content analysis, proximate analysis, amino acid content

analysis, dietary fiber content analysis, fatty acid content analysis, and mineral analysis.

B. Methods

The formulation for making complementary food biscuits in this study used four formulations, using 50% of the main ingredients in wheat flour and 50% other flour [8]. The formulation used in this study is:

- F1 = Wheat flour (100%): Tempe flour (0%): Nile tilapia fish flour (0%) (Control)
- F2 = Wheat flour (50%): Tempeh flour (15%): Nile tilapia fish flour (35%)
- F3 = Wheat flour (50%): Tempeh flour (25%): Nile tilapia fish flour (25%)
- F4 = Wheat flour (50%): Tempe flour (35%): Nile tilapia fish flour (15%)

Making Nile tilapia fish flour [8]

5 kg of fresh Nile tilapia fish meat is cleaned and steamed for 15 minutes, then mixed with 10% lime juice for 30 minutes to remove the fishy smell. The fish meat is thinly sliced and dried in an oven at 50 °C for 15 hours, then ground with a blender, then sieved with an 80 mesh sieve. The results obtained are Nile tilapia fish flour.

Making tempeh flour [5]

5 kg of tempeh is cut into 0.5 cm thick slices, then steamed for 10 minutes at 80 °C using a steamer and oven for 6 hours at 60 °C, then pureed with a blender and sieved with an 80 mesh sieve. The results obtained are from tempeh flour.

Making Biscuit [9]

The process of making biscuits begins with the homogenization of eggs using a mixer, then adding powdered sugar, margarine, cornstarch, cocoa powder, and powdered milk, and stirring with a mixer for ± 5-10 minutes. Next, add wheat flour, Nile tilapia fish flour, and tempeh flour (according to treatment), add other ingredients, and mix well. The dough is flattened and molded using a mold and baked in the oven for ± 30 minutes at a temperature of ± 130 °C, then removed and cooled.

Test Parameters

The test parameters carried out in this study were organoleptic tests (hedonic tests) to determine the best biscuit formulation [10], using a 5-scale, namely 1. Very disliked, 2. Disliked, 3. Somewhat Like, 4. Like, 5. Very Like. A 50 g biscuit sample was given to 25 semi-trained panelists to test the aroma, color, taste, texture, and overall assessment aspects. The chemical content test parameters of biscuits consist of test proximate [11] namely water content using the oven method, ash content using the furnace method, protein content using the Kjeldhal method, fat content using the Soxhlet method, and carbohydrate content using the difference method, amino acid content analysis using the HPLC [11], analysis of fatty acid content using GC-MS [11] method, fiber content analysis food [11], analysis of Ca and Zn minerals using AAS method [11]. The physical properties test parameters for biscuits consist of biscuit texture tests using a texture analyzer [12] and color tests using a color reader [13].

III. RESULTS AND DISCUSSION

C. Product Description

Complementary food biscuits made from wheat flour, substituted with tempeh flour and Nile tilapia fish flour, produce a crunchy texture, brown color, and a savory taste. The description of the biscuit product can be seen in **Figure 1**.

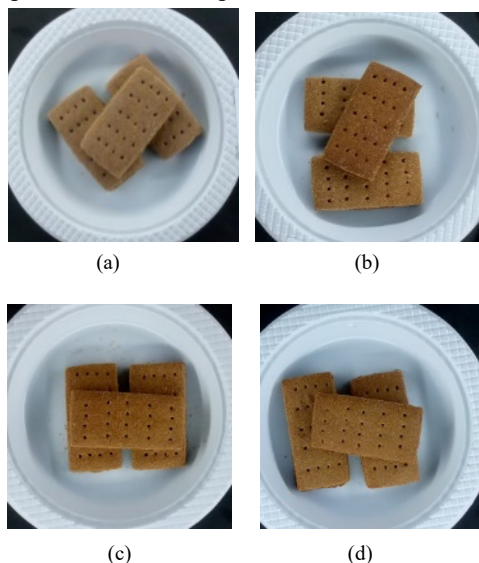


Fig 1. Wheat Flour Biscuits (a) F1 Treatment; (b) Treatment F2; (c) F3 treatment; and (d) Treatment F4

D. Organoleptic Test

Organoleptic tests were conducted on biscuit formulation products by 25 semi-trained panelists. The organoleptic test conducted was a hedonic test of the panelists' level of preference for biscuit formulation products made from wheat flour, tempeh flour, and fish flour. The description of the organoleptic test results on wheat flour, tempeh flour, and Nile tilapia fish flour formulation products can be seen in **Table 1**.

TABLE 1
 ORGANOLEPTIC TESTING RESULTS OF WHEAT FLOUR, TEMPE FLOUR, AND NILE FLOUR FORMULATION PRODUCTS

Treatment	Color	Aroma	Flavor	Texture	Overall
100%:0%:0%	3.88 ^a	4.08 ^a	4.52 ^a	4.32 ^a	4.36 ^a
50%:15%:35%	3.12 ^b	3.28 ^c	3.28 ^b	3.44 ^c	3.16 ^c
50%:25%:25%	3.84 ^a	3.88 ^b	3.6 ^c	3.88 ^b	3.52 ^b
50%:35%:15%	3.4 ^c	3.4 ^c	3.48 ^b	3.4 ^c	3.32 ^c

Description: Numbers followed by the same lowercase letter are not significantly different at the 5% level according to the DNMRT test.

1. Very disliked, 2. Disliked, 3. Somewhat Like, 4. Like, 5. Very Like

Based on the table above, it is known that the results of organoleptic testing on wheat flour, tempeh flour, and Nile tilapia fish flour formulation products with a formulation of 50% Wheat Flour, 25% Tempeh Flour, and 25% Nile tilapia fish flour are the best treatments compared to other formulations. In comparison to the control, the organoleptic test outcomes for the three treatments remained below those of the control biscuits. The cause of the lower level of panelist

preference is suspected to be due to the addition of tempeh and Nile tilapia fish flour, which can produce a reasonably strong aftertaste in the biscuit product.

The resulting aftertaste, which is bitter, can be caused by the hydrolysis of amino acids that occurs in the Maillard reaction, both during the process of making tempeh flour and when baking biscuits. Types of amino acids that cause a bitter taste include lysine, arginine, proline, phenylalanine, and valine. Lysine has the most bitter taste compared to other amino acids [14].

The test results showed that of the three treatments given, the treatment with substitution of tempeh flour and Nile tilapia fish flour with each concentration of 25%, produced a higher value compared to the other two treatments. Based on comments from respondents, biscuits with substitution treatment of tempeh flour 25% and Nile tilapia fish flour 25% were less bitter and also less fishy. However, it still tasted bitter and fishy when compared to the control biscuits. Based on the results of organoleptic testing, the best treatment obtained was the treatment with a substitution formulation of 50% wheat flour, 25% tempeh flour, and 25% Nile tilapia fish flour. These results were continued with the next stage of research.

E. Chemical Content Test

Proximate test results, minerals, and dietary fiber Proximate content testing is a measurement of the levels of nutrients contained in a food ingredient. The results of measurements in proximate analysis can provide an overview of the nutritional content of food ingredients in general. The principle of proximate analysis is to separate food components into groups or fractions that include water, ash, protein, fat, and carbohydrate content [15]. An overview related to the results of proximate analysis, minerals, and dietary fiber can be seen in **Table 2**.

TABLE 2
 PROXIMATE ANALYSIS RESULTS, CALCIUM LEVELS, ZINC LEVELS, AND DIETARY FIBER LEVELS

Chemical content	100% Wheat Flour : 0% Tempeh Flour : 0% Nile Tilapia Fish Flour	50% Wheat Flour: 25% Tempeh Flour: 25% Nile Tilapia Fish Meal
Ash content (%)	1.34	1.78
Water content (%)	2.7	2.18
Protein content (%)	17.32	20.53
Fat content (%)	19.5	23.81
Carbohydrate content (%)	59.14	51.7
Calcium content (mg/100g)	79.7	97.16
Zinc content (mg/100g)	0.104	0.103
Dietary fiber content (%)	6.83	7.02

Based on the table above, it is known that the ash content in biscuits made from wheat flour substituted with tempeh flour and Nile tilapia fish flour (1.78%) is higher than that of the control biscuits (1.34%). The high ash content is due to the ash content in tempeh flour, which is around 1.98% [16], and the fish meal value is 9.64% [8] higher than that of wheat flour, which is 0.63% [17]. However, the use of tempeh flour and

tilapia flour at 25% each caused an increase in ash content of 0.44% compared to the control.

The water content in the control treatment was 2.7% higher than the biscuit treatment made from wheat flour substitution with tempeh flour and Nile tilapia fish flour, which was 2.18%. This is thought to be due to the water content of tempeh flour (2.82%) [5] and Nile tilapia fish flour (9.93%) [8], while the water content of wheat flour is 14.53% [18]. The water content of this biscuit product follows the SNI standard, namely, a maximum 5% [19]. The protein content of biscuits made with tempeh flour and Nile tilapia flour substitution is higher (20.53%) compared to biscuits made only from wheat flour (17.32%), or there is an increase in protein content of 18.53%. This is because tempeh and Nile tilapia are food sources that are rich in protein. The protein value contained in biscuits in both the control and the best treatment follows the SNI standard, namely a minimum of 4.5% [19]. The higher protein content in biscuits formulated with tempeh flour and Nile tilapia fish flour makes these biscuits good to be consumed as additional food for stunted children.

The fat content of biscuits made from tempeh flour and wheat flour substitutes is higher (23.81%) compared to biscuits made from wheat flour (19.5%), or has increased by 22.1%. This is thought to be due to the fat content in tempeh flour (29.57%) [5] and Nile tilapia (1.88%) [20], higher than wheat (2.29%) [21]. The higher fat content in biscuits formulated with tempeh flour and Nile tilapia flour makes these biscuits good to consume as additional food for stunted children. The carbohydrate content in biscuits using wheat flour (15.91%) is higher than in biscuits substituted with tempeh flour and Nile tilapia flour. This is thought to be due to the carbohydrate content in tempeh flour (18.21%) [5] and Nile tilapia (0.32%) [22], which is relatively lower when compared to wheat flour (78.36%) [23], or there was a decrease of 14.39% when compared to the control group.

Based on the table above, it is known that the calcium content of biscuits substituted with tempeh flour and Nile tilapia fish flour (97.16%) is higher than biscuits made only from wheat flour (79.7%) or has increased by 21.9%. Tempeh flour contains 292.8 mg/100g [16] of calcium, and Nile tilapia meat contains 74.38 mg/100g [22] calcium. Meanwhile, wheat flour contains 16 mg/100g [24] of calcium. The use of 25% tempeh flour and 25% Nile tilapia flour in making biscuits can increase calcium content, so that it can potentially help increase calcium intake for stunted children. The results of the previous study stated that stunted children consume less calcium compared to normal children [25].

The zinc content in biscuits with the best treatment, namely the substitution of 50% wheat flour with 25% tempeh flour and 25% Nile tilapia fish flour, had a slightly lower zinc content (0.103 mg/100 g) when compared to control biscuits (0.104 mg/100 g). Zinc content in fresh tempeh is 1.14 mg/100g [26], fresh Nile tilapia fish is 0.33mg/100g [4] and wheat flour ranges between 2.8mg/100g [4]. Although tempe and Nile tilapia contain zinc, the substitution of tempe flour and Nile tilapia flour in making biscuits does not increase the zinc

content in the biscuits produced. Zinc is one of the minerals that is very important for preventing stunting. The results of the study explain that several studies have shown the effect of zinc consumption on the incidence of stunting. This is because the various functions of zinc in the body that are important for growth include playing a role in the synthesis of growth hormones, helping bone elongation, improving the immune system, and increasing the sensitivity of the sense of taste, which makes appetite eating increased [27].

The dietary fiber content in wheat flour substitute biscuits with tempeh flour and Nile tilapia fish flour (7.02%) is higher than biscuits made only from wheat flour (6.83%), or 2.78% higher than wheat flour biscuits. The dietary fiber content in wheat flour is 2.7g [4] lower than the dietary fiber content in tempeh, namely 5.35g [5], while Nile tilapia does not contain dietary fiber. Dietary fiber plays an important role in preventing stunting, especially by supporting digestive health, increasing nutrient absorption, and strengthening the immune system. Consuming foods rich in fiber can help children get the nutrients they need to grow optimally, thereby reducing the risk of stunting, which can affect their physical and cognitive development.

Essential Amino Acid Content

The results of the analysis of the essential amino acid composition of tempeh flour and Nile tilapia fish flour substitute biscuits compared to control biscuits are presented in **Table 3**. The types of amino acids that make up the biscuits are divided into essential amino acids and non-essential amino acids. Essential amino acids are types of amino acids that cannot be synthesized by the body, so they must be obtained from food. Non-essential amino acids are amino acids that can be synthesized by the body, so they do not have to be obtained from food [28].

TABLE 3
 ESSENTIAL AMINO ACID CONTENT IN BISCUITS

Essential amino acids	100% Wheat Flour: 0% Tempeh Flour: 0% Nile Tilapia Fish Flour (mg/kg protein)	50% Wheat Flour: 25% Tempeh Flour: 25% Nile Tilapia Fish Flour (mg/kg protein)
L-Arginine	2520.12	6822.8
L-Histidine	2895.695	3916.855
L-Isoleucine	1860.46	3955.83
L-Leucine	5094	10107.315
L-Methionine	30.78	148.525
L-Tryptophan	Not detected	1235.425
L-Valine	2601.76	5089.865
L-Phenylalanine	3969.43	6493.985
L-Threonine	2413.56	4451.955
Total	21385.8	42222.5

Based on the table above, it is known that the total amino acids contained in biscuits with tempeh flour and Nile tilapia fish flour substitution (42222.5 mg/kg protein) are higher than biscuits made from wheat flour (21385.8 mg/kg protein) or have increased by 97.4% when compared to biscuits made from wheat flour. This is thought to be due to the large amino acid content of tempeh flour and Nile tilapia fish flour, which contain relatively high protein. Biscuit products made from

wheat flour do not contain the amino acid tryptophan. Meanwhile, when compared to biscuits made from tempeh flour and Nile tilapia fish flour, the tryptophan content is 1235.4 mg/kg body weight. Thus, biscuits made from wheat flour substituted with tempeh flour and Nile tilapia fish flour have great potential as biscuit products for stunted children.

Non-Essential Amino Acid Content

The results of the analysis of non-essential amino acid content in making biscuits are presented in **Table 4**. Non-essential amino acids are amino acids that can be produced by the body itself, so they do not need to be obtained directly from food. Although not essential in the diet, these amino acids still have an important role in various body functions, such as protein formation, tissue maintenance, and metabolic processes [28]. Examples of non-essential amino acids include alanine, asparagine, aspartic acid, and glutamic acid. Under certain conditions, such as stress or illness, the need for some non-essential amino acids may increase, so supplements or additional intake from food may be needed to support optimal health.

TABLE4
 NON.ESSENTIAL AMINO ACID CONTENT IN BISCUITS

Non-Essential Amino Acids	100% Wheat Flour : 0% Tempeh Flour : 0% Nile Tilapia Fish Flour (mg/kg protein)	50% Wheat Flour: 25% Tempeh Flour: 25% Nile Tilapia Fish Flour (mg/kg protein)
L-Aspartic Acid	4484,975	11765,155
Glycine	4016.72	6113.46
L-Glutamic Acid	21994.61	24550,485
L-Cystine	3286,375	3570,045
L-Lysine	2314,445	7542.01
L-Proline	8271.01	8265,305
L-Serine	4912.12	4507,125
L-Tyrosine	1817.13	3285,245
Total	51097,385	69598.83

Based on the table above, the total content of non-essential amino acids in biscuits made from wheat flour substituted with tempeh flour and Nile tilapia fish flour (69598.8 mg/kg protein) is higher than that in biscuits made from wheat flour (51097.3 mg/kg protein) or has increased by 36.2%. The high content of aspartic acid and glutamic acid in both types of biscuits gives them a savory and delicious taste [5].

Fatty Acid Content

The results of the analysis of fatty acid content in biscuits can be seen in **Table 5**. Based on the test results, the fatty acid content in both types of biscuits is quite complete. The fatty acid content in biscuits substituting wheat flour with tempeh flour and Nile tilapia flour is higher than in control biscuits. It is known that the fatty acid content in biscuits with tempeh flour and wheat flour substitution is higher compared to biscuits made from wheat flour. This is because tempeh flour has a good content of essential and non-essential fatty acids [5]. Among the fatty acids that make up the biscuits, three types of fatty acids are essential for humans, namely oleic, linoleic, and linolenic fatty acids. Specifically, a comparison of the fatty acid profile that is important for the human body can be seen in **Table 6**

TABLE5
 FATTY ACID CONTENT IN BISCUITS

Fatty Acid Composition	100% Wheat Flour : 0% Tempeh Flour : 0% Nile Tilapia Fish Flour (%)	50% Wheat Flour: 25% Tempeh Flour: 25% Nile Tilapia Fish Meal (%)
C 4:0 (Butyric Acid)	0.0163	0.119792
C 6:0 (Caproic Acid)	0.0239	0.171875
C 8:0 (Caprylic Acid)	0.1433	1.004167
C 10:0 (Capric Acid)	0.12005	0.830903
C 12:0 (Lauric Acid)	0.83245	5.817361
C 14:0 (Myristic Acid)	0.5525	4.287847
C 14:1 (Myroxyleic Acid)	0.0081	0.075347
C 15:0 (Pentadecanoic Acid)	0.0174	0.144792
C 16:0 (Palmitic Acid)	7.53375	84574.5
C 16:1 (Palmitoleic Acid)	0.04765	1.523958
C 17:0 (Heptadecanoic Acid)	0.02535	0.207639
C 17:1 (Heptadecanoic Acid)	0.0072	0.00915
C 18:0 (Stearic Acid)	1,1034	13049
C 18:1 W9C (C-Oleic Acid)	7,2968	86,087.5
C 18:2 W6 (Linoleic Acid / W6)	1.8374	24,7175
C 18:2 W6C (C-Linoleic Acid)	1.8374	24,7175
C 18:3 W3 (Linolenic Acid / W3)	0.0572	0.400694
C 18:3 W6 (Linolenic Acid / W6)	0.0053	0.0065
C 20:0 (Arachidic Acid)	0.067	0.520139
C 20:1 (Eicosenoic Acid)	0.02855	0.427778
C 20:2 (Eicosadienoic Acid)	Not detected	0.192708
C 20:4 W6 (Arachidonic Acid)	0.0282	0.492708
C 21:0 (Heneicosanoic Acid)	Not detected	0.18125
C 22:0 (Behenic Acid)	0.01225	0.114931
C 23:0 (Tricosanoic Acid)	0.00275	0.00395
C 24:0 (Lignoceric Acid)	0.0149	0.160764
C 24:1 W9 (Nervonic Acid)	0.007	0.126042

Based on **Table 6**, it is known that the content of linoleic, linolenic, and oleic fatty acids in biscuits made from wheat flour substitution with tempeh flour and Nile tilapia fish flour is much higher compared to biscuits made only from wheat flour, namely 24.72%, 0.77% and 86.09% for substitute biscuits compared to wheat flour biscuits which are only 1.84%, 0.06%, and 7.3%. The intake of these essential fatty acids is also very important for children with stunting nutritional status, namely to support physical growth, brain and cognitive development, improve the immune system, improve nutritional status, and reduce inflammation [3].

TABLE 6
 FATTY ACID PROFILE IN BISCUITS

Fatty Acid Profile	100% Wheat Flour : 0% Tempeh Flour : 0% Nile Tilapia Fish Flour (%)	50% Wheat Flour: 25% Tempeh Flour: 25% Nile Tilapia Fish Meal (%)
Saturated fat	10.47	11.72
Unsaturated Fats	9.32	11.61
Polyunsaturated Fats	1.93	2.68
Monounsaturated Fats	7.40	8.93
Omega 3 Fatty Acids	0.06	0.10
Omega 6 Fatty Acids	1.87	2.55
Omega 9 Fatty Acids	7.30	8.61
Linoleic Acid	1.84	24.72
Linolenic Acid	0.06	0.77
Oleic Acid	7.30	86.09

E. Physical Properties Test Color Test

Color is a factor that can be used as an indicator of the freshness or ripeness of a product. The color aspect is one of the attractions of enjoying a food ingredient. Color analysis using L, a, and b values is very important in assessing the quality of food products. Biscuits with these values can be considered attractive if they are in accordance with consumer expectations of appearance. Color in food can increase consumer acceptance of a product. The lightness color correction value ranges from 0 for the darkest color (black) and 100 for the lightest color (white) [29]. The description of the physical properties of biscuit color can be seen in **Table 7**.

TABLE 7
 PHYSICAL PROPERTIES OF COLOR IN BISCUITS

Color analysis	100% Wheat Flour : 0% Tempeh Flour : 0% Nile Tilapia Fish Flour (mg/kg protein)	50% Wheat Flour: 25% Tempeh Flour: 25% Nile Tilapia Fish Flour (mg/kg protein)
L	43.1	40.4
a	8.5	9.4
b	14.2	15.1
Description	<i>Mostly desaturated dark orange</i>	<i>Mostly desaturated dark orange</i>

Based on the table above, the results of measuring the color of biscuits in both sample and control biscuits produce the same description, namely, mostly desaturated dark orange. In the context of biscuits, the L value of 43.1 in the control biscuits and 40.4 in the best treatment indicates that the product has a relatively low level of brightness, indicating that the biscuits tend to be dark in color. This could be because this study used cocoa powder to make biscuits.

Texture test

Texture is one of the important factors in determining the quality of a biscuit. This texture is also known as crispiness, influenced by the water content of the biscuit or the gluten-type protein contained in the wheat flour used [30]. The description

of the physical properties of the biscuit texture can be seen in **Table 8**.

TABLE 8
 TEXTURE ANALYSIS

Treatment	Texture
100% wheat flour: 0% tempeh flour, 0% Nile tilapia fish flour	1,936.4 gF
50% wheat flour: 25% tempeh flour, 25% Nile tilapia fish flour	1,151.2 gF

Based on the table above, it is known that the texture of the control biscuits is 1,936.4 gF higher than the best treatment of 1,151.2 gF. This value refers to the hardness parameter measured using a texture-measuring instrument. This value provides information about how hard or soft the biscuits are, an important indicator of product quality. Biscuits with high hardness values tend to have a denser structure and may be more difficult to chew than softer biscuits.

The high texture value indicates that the control biscuit is significantly hard. This may be due to the use of pure wheat flour, which has a high gluten content and provides a denser and harder structure to the biscuit [31].

IV. CONCLUSION

The results of this study showed that the best treatment based on organoleptic tests was a ratio of 50% wheat flour: 25% tempeh flour, and 25% Nile tilapia fish flour. Chemical tests showed that the proximate analysis, calcium, dietary fiber, essential and non-essential amino acid composition, and fatty acid composition of the selected biscuits were higher than those of the control biscuits. The zinc content of the selected biscuits was the same as that of the control biscuits. The results of physical tests showed that the selected biscuits had the same color description as the control, but had a softer texture than the control. The conclusion obtained was that, based on the composition of the nutritional and non-nutritional content, the selected biscuits had the potential as complementary foods for breast milk that could help prevent stunting in toddlers.

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CONFLICT OF INTEREST

Authors declare no conflict of interest to disclose.

USE OF ARTIFICIAL INTELLIGENCE (AI) TOOLS STATEMENT

We used Grammarly (Grammarly Inc., 2025) to improve the clarity and grammar of the manuscript. The authors reviewed and approved all changes

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