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Formulation, organoleptic test, and nutritional analysis of milkfish (*Chanos chanos*) and red bean (*Phaseolus vulgaris*) flour cookies as a high-protein supplement for malnourished children

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ABSTRAK

Latar Belakang: *Kekurangan gizi masih menjadi permasalahan global yang berdampak pada kesehatan, ekonomi, dan kualitas sumber daya manusia. Upaya intervensi dilakukan melalui Pemberian Makanan Tambahan (PMT) berbasis pangan lokal bergizi tinggi.*
Tujuan: *Mengembangkan cookies berbasis tepung ikan bandeng dan kacang merah sebagai alternatif PMT dengan kandungan gizi seimbang dan penerimaan sensori yang baik.*
Metode: *Penelitian dilakukan secara eksperimental dengan lima formulasi berbeda yaitu F1 (30% : 70%), F2 (40% : 60%), F3 (50% : 50%), F4 (60% : 40%) & F5 (70% : 30%) berdasarkan perbandingan tepung ikan bandeng dan tepung kacang merah. Uji organoleptik melibatkan 30 panelis menggunakan uji hedonik pada aspek warna, aroma, rasa, tekstur, dan keseluruhan. Analisis proksimat dilakukan di laboratorium untuk menentukan kandungan energi, protein, lemak, karbohidrat, kadar air, dan abu.*
Hasil: *Hasil penelitian menunjukkan formulasi F1 memperoleh tingkat penerimaan panelis terbaik secara keseluruhan dengan rata-rata penilaian suka. Semakin banyak penambahan tepung ikan bandeng, tingkat kesukaan panelis terhadap aroma, rasa, dan keseluruhan menurun akibat aroma amis, rasa gurih, dan tekstur lembek yang muncul. Kandungan gizi formulasi F1 meliputi energi 493,10 Kkal/100 g, protein 20,32%, lemak 24,52%, karbohidrat 47,79%, kadar air 4,41%, dan kadar abu 2,97%. Nilai energi dan protein memenuhi standar PMT balita gizi kurang dari Kemenkes, sementara kadar lemak melebihi batas yang ditentukan.*
Kesimpulan: *Cookies ini berpotensi menjadi alternatif PMT berbasis pangan lokal dengan nilai gizi tinggi, tetapi perlu perbaikan khususnya penyesuaian kadar lemak, penambahan flavor, dan pengendalian proporsi tepung untuk meningkatkan penerimaan konsumen.*

KATA KUNCI*: cookies; ikan bandeng; kacang merah; pemberian makanan tambahan (PMT); uji organoleptik*

ABSTRACT

Background: *Malnutrition remains a global problem, impacting health, economy, and quality of human resources. Intervention efforts are carried out through the provision of supplementary feeding (PMT) based on highly nutritious local foods.*

Objectives*: To develop cookies based on milkfish and red bean flour as an alternative PMT with balanced nutritional content and good sensory acceptance.*

Methods: *The study was conducted experimentally with five different formulations (F1–F5) based on the ratio of milkfish flour and red bean flour. Organoleptic testing involved 30 panelists using hedonic tests on colour, aroma, taste, texture, and overall acceptability. Proximate analysis was conducted in the laboratory to determine the energy, protein, fat, carbohydrate, moisture, and ash content.*

Results: *The results showed that the F1 formulation achieved the best overall panelist acceptance rate, with an average liking rating. As the milkfish flour addition increased, panelists' preference for aroma, taste, and overall quality decreased due to the fishy aroma, savory taste, and soft texture that emerged. The nutritional content of the F1 formulation includes energy 493.10 kcal/100 g, protein 20.32%, fat 24.52%, carbohydrate 47.79%, water content 4.41%, and ash content 2.97%. The energy and protein values meet the Ministry of Health's PMT standard for undernourished toddlers, while the fat content exceeds the specified limit.*

Conclusions: *These cookies have the potential to be an alternative to local food-based PMT with high nutritional value, but need improvement, especially in adjusting the fat content, adding flavor, and controlling the proportion of flour to increase consumer acceptance.*

KEYWORDS*:* *cookies; milkfish; organoleptic test; red beans; supplementary feeding (PMT)*

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INTRODUCTION

Malnutrition remains a serious problem in many countries. According to the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the World Bank Group, 148.1 million children under 5 years of age (toddlers) experience stunting, and approximately 45 million suffer from wasting (1). The 2022 Indonesian Nutritional Status Survey (SSGI) found that the stunting rate in Indonesia reached 21.6%, and wasting, or acute malnutrition, reached 7.70% (2). Children with stunted growth are at risk of delayed cognitive development, impaired immune function, and reduced productivity in the future (3).

One way to address nutritional issues is by providing nutritious and easily consumed supplementary foods. This program aims to improve the nutritional status of malnourished children. Fajar et al. (2022) found that providing supplementary foods (commercial products) led to significant changes in nutritional status (4). Supplementary Feeding (PMT) is prepared for children who are malnourished or at risk of malnutrition. Supplementary Feeding (PMT) should be made from local or locally produced food, ensuring a long-term program within the community (5).

Cookies are a snack typically made from wheat flour and other ingredients. Cookies are a popular food because they are affordable, practical, nutritious, long-lasting, and easy to consume (6). Cookies typically feature sweet flavors, such as milkfish bone cookies. These cookies are a type of dry cake made from the nutritional content of milkfish bone byproducts, making them an alternative snack for people with osteoporosis (7).

The nutritional content of milkfish per 100 grams consists of 17% protein, 4.50% fat, 4.5% vitamins, 2.52% minerals, and omega-3 (19.56%), omega-6 (7.47%), and omega-9 (19.24%) (8). This makes milkfish a highly nutritious food suitable for all age groups, especially growing children. The relatively high levels of omega-3 fatty acids, the amino acid lysine, and PUFAs (Polyunsaturated Fatty Acids) in milkfish can improve children's cognitive function and intelligence (9). Properly processed milkfish provides a practical and highly nutritious primary source of nutrition. The semi-processed milkfish flour is underutilized, offering significant potential for development into cookies.

Red beans (Phaseolus vulgaris) are a good source of vegetable protein, fiber, and iron. Red bean production is high in Indonesia, with total production reaching 74.36 tons in 2017 (10). These beans have a distinctive red colour and a soft texture when cooked. Every 100 grams of red beans contains 127 kkl of energy, 8.70 g of protein, 22.80 g of carbohydrates, ±2.94 mg of iron, 28 mg of calcium, ±48 mg of magnesium, 130 mcg of folate (Vitamin B9), and antioxidants (11). The protein in red beans plays a role in regenerating damaged cells in the body. Their starch content also serves as a source of energy for daily activities (12). Due to their high nutritional content, red beans are suitable as a main ingredient in PMT programs for undernourished children, whether in the form of porridge, healthy snacks, or attractive finger foods.

Therefore, this research focuses on developing cookies based on nutrient-rich local foods, such as milkfish and red beans. This combination was chosen because of its high protein content, which is essential for children's growth and development. The resulting cookie innovation is not only highly nutritious but also helps address the problem of undernourished children in Indonesia. This research aims to develop an optimal cookie formulation, assess its nutritional content, and analyze the product's acceptability.

MATERIALS AND METHODS

This research was a laboratory experiment with a completely randomized design (CRD). The study was divided into three main stages: formulation development, organoleptic testing by 30 semi-trained panelists (Bachelor of Nutrition Students), and nutritional content analysis. Formulation development and organoleptic testing were conducted from May to June 2025 at the Food Processing Laboratory of Medika Suherman University (UMEDS). Nutritional content analysis of the cookies with the best organoleptic properties (F1) was conducted with two replications. Laboratory analysis was in the form of a proximate test (carbohydrates using the 18-8-9/MU method (calculation), protein using the 18-8-31/MU method (titrimetry), fat using the 18-8-5/MU method (gravimetry), ash content using the SNI 01-2891-1992 method point 6.1, and water content using the SNI ISO 712:2015 method) was conducted in July 2025 at PT. Saraswati Indo Genetech (SIG) Laboratory in Bogor, under the test number SIG.MARK.R.VI.2025.001096.

The independent variables were five different cookie formulations, each with a ratio of milkfish flour to red bean flour of F1 (30%:70%), F2 (40%:60%), F3 (50%:50%), F4 (60%:40%), and F5 (70%:30%) (13). Other ingredients, such as margarine, powdered sugar, egg yolk, lemon, skim milk, cornstarch, and baking powder, were prepared in the same ratio. The dependent variables were the level of preference and proximate content of the milkfish and red bean flour-based cookies.

The first step in cookie production began with the preparation of ingredients, one of which was milkfish flour. The researcher prepared the milkfish flour, while the red bean flour was purchased from an e-commerce platform. The milkfish used for the flour came from the Muaragembong area and was purchased from a traditional market in North Cikarang. The equipment used to make the cookies includes a basin, tray, blender, sieve, oven, spoon, fork, digital food scale, baking sheet, bowl, spatula, pan, plate, and cutting board. The process of making milkfish flour and red bean flour cookies is similar to that of a typical cookie, from mixing the ingredients to baking to finish the cookies. The cookie production process is shown in **Figure 1**.

During the organoleptic testing, the equipment used included test forms, pens, paper plates, and souvenirs. Additionally, 150 cookie samples and bottled water were required for each sample transfer to neutralize the sense of taste. The effect of the milkfish flour and red bean flour formulations on each organoleptic characteristic (colour, aroma, taste, texture, and overall appearance) was assessed, with score interpretations of 1: very dislike; 2: dislike; 3 = somewhat dislike; 4: neutral; 5: somewhat like; 6: like; and 7: very like. The results of the data recap were analyzed using statistical tests using software

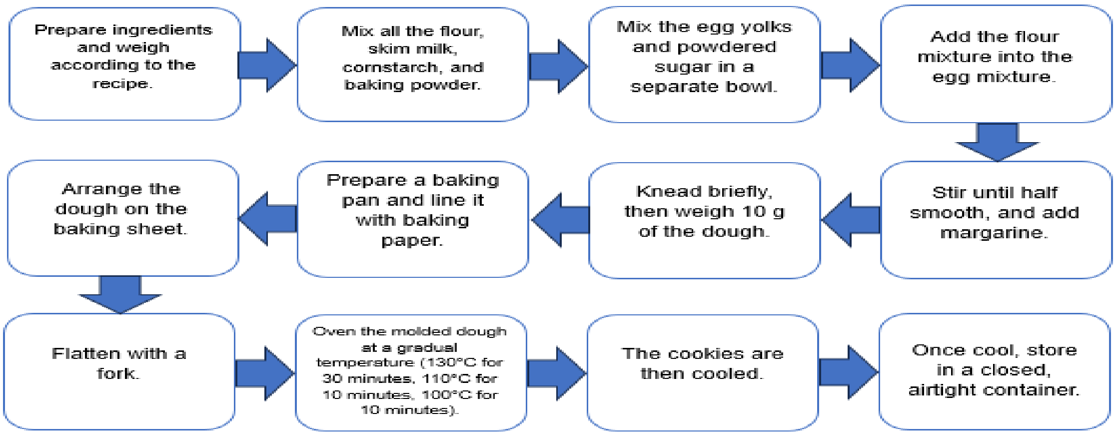

Figure 1. Cookies Production Process

RESULTS AND DISCUSSIONS

The milkfish flour production process aims to reduce the water content of the ingredients, thus extending the shelf life of the cookies. Furthermore, making cookies is easier with flour as the basic ingredient. The main ingredients used in these cookies are milkfish and red beans. Other additional ingredients are also available, as shown in **Table 1**. The milkfish flour manufacturing process aims to reduce the water content of the ingredients to a safe limit (12%) to extend shelf life (14). Foods with high water content tend to spoil more quickly due to microbial growth, enzymatic reactions, and chemical reactions. Flour, as a base ingredient, has more homogeneous physical characteristics, making it easy to mix with other dry ingredients such as wheat flour, sugar, and other additives. This results in a more uniform cookie dough, which is easier to shape and has a better texture after baking (15). The high-quality protein content of milkfish, due to its complete essential amino acids, is maintained after being processed into flour, also contributing to the increased nutritional value of the cookies (16).

Organoleptic testing of cookies utilizes the human senses (the eyes, nose, tongue, and skin) to assess colour, aroma, taste, texture, and overall appearance. Thirty semi-trained panelists conducted the testing. The organoleptic test results are shown in **Table 2**.

Table 1. Recipe of Soft Cookies Reference

Composition	Unit	Formulation				
		F1	F2	F3	F4	F5
Milkfish Flour	%	11	15	19	22	26
Red Bean Flour		26	22	19	15	11
Margarine		22	22	22	22	22
Refined Sugar		22	22	22	22	22
Egg Yolk		7	7	7	7	7
Lemon		2	2	2	2	2
Skim Milk		3	3	3	3	3
Maizena		6	6	6	6	6
Baking Powder		1	1	1	1	1

Colour

Based on the organoleptic test, most panelists preferred the colour of F3 cookies, with an average rating of 5.50, interpreted as "like". Meanwhile, F4 cookies received the lowest average rating of 4.90, interpreted as "somewhat like". The Kruskal-Wallis test for colour parameters showed p>0.05, and H0 was accepted, indicating no significant difference between the treatments (F1, F2, F3, F4, and F5) in the colour of milkfish and red bean flour-based cookies. The appearance of the cookie color can be seen in **Figure 2**. Organoleptic test results showed that F3 cookies achieved the highest colour preference compared to other formulations. However, as milkfish flour content increased, panelists' preference for cookie colour tended to decrease.

This is because the composition of its ingredients strongly influences the colour of a food product. Protein-rich milkfish flour is prone to non-enzymatic browning (Maillard reaction) when baked with carbohydrates from refined sugar or other ingredients. This Maillard reaction produces brown melanoidin compounds that affect the final appearance of cookies (17).

Table 2. Organoleptic test results of milkfish and red bean flour cookies

Parameter	Mean Value of Sample Hedonic Test				
	F1	**F2**	**F3**	**F4**	**F5**
Colour	5.06 ± 1.22^{a}	4.93 ± 1.08^{a}	5.50 ± 1.13^{a}	4.90 ± 1.29^{a}	5.23 ± 1.16^{a}
Aroma	5.10 ± 1.18^{a}	$4.90 \pm 1.42^{a,b}$	$4.83 \pm 1.36^{a,b}$	$4.26 \pm 1.41^{b,c}$	3.73 ± 1.36^{c}
Taste	5.06 ± 1.08^{a}	$4.50 \pm 1.45^{a,b}$	$4.30 \pm 1.78^{a,b}$	3.96 ± 1.40^{b}	3.06 ± 1.50^{c}
Textur	5.26 ± 1.17^{a}	5.10 ± 1.02^{a}	5.10 ± 1.06^{a}	5.10 ± 1.02^{a}	4.83 ± 1.26^{a}
Overall	5.23 ± 1.07^{a}	4.80 ± 1.27^{a}	$4.60 \pm 1.45^{a,b}$	$4.03 \pm 1.24^{b,c}$	3.43 ± 1.38^{c}

Source: *Primary Data, 2025*

Description: 1 = dislike very much; 2 = dislike; 3 = dislike somewhat; 4 = neutral; 5 = like somewhat; 6 = like; 7 = like very much. a, b = Similar letter notation in one row indicates no significant difference at the Mann-Whitney test level with a 95% confidence level.

In addition to ingredient factors, the baking process also plays a crucial role in determining a cookie’s colour. High temperatures and baking times can improve the intensity of browning, resulting in darker cookies. This process aligns with research by Ridhani et al. (2021), which states that dry heat processing, such as baking, triggers colour changes due to sugar caramelization and the Maillard reaction (18). The oven used is also a determining factor, as each oven type (e.g., electric and gas ovens) has a different heat distribution. This difference in heat distribution can affect the degree of doneness and colour of the product. Ovens with uneven heating can potentially produce cookies with less uniform colour. According to Pratama et al. (2024), the condition of the processing equipment significantly determines the baking temperature, which in turn affects the product's organoleptic qualities, including colour (19).

F1 (30% : 70%) F2 (40% : 60%) F3 (50% : 50%) F4 (60% : 40%) F5 (70% : 30%)

Source: *Primary Data, 2025*

Figure 2. Milkfish and Red Bean Cookies

Aroma

The cookie with the most preferred aroma was F1. The average score was 5.10, indicating a liking. Cookie F5 had the lowest colour acceptance at 3.73, interpreted as neutral. The Kruskal-Wallis test for aroma parameters showed p<0.05, rejecting H0. There was a significant difference between the treatments (F1, F2, F3, F4, and F5) in the aroma of milkfish and red bean flour cookies. To determine which groups differed, a further Mann-Whitney test was conducted.

The Mann-Whitney test showed that the aroma preference of milkfish and red bean flour cookies did not differ significantly (p>0.05) for F1 and F2, F1 and F3, F2 and F3, F2 and F4, F3 and F4, and F4 and F5. However, there were significant differences ($p<0.05$) for F1 and F4, F1 and F5, F2 and F5, and F3 and F5 in the aroma preference of milkfish and red bean flour cookies. Organoleptic test results showed that the greater the proportion of milkfish flour and the less red bean flour added, the lower the panelists' preference for the smell of the cookies. This result happened because milkfish flour has a characteristically strong or fishy aroma. This aroma can still be detected even after the flour has undergone processing. Fishmeal has characteristics similar to other flours, but retains a distinctive fishy aroma that can influence consumer acceptance of food products (20).

In cookie products, panelists generally expect an aroma consistent with commonly used base ingredients, such as butter, milk, chocolate, or pandan. The fishy aroma of milkfish flour mismatches these expectations, resulting in a lower preference score. Aroma is a sensory factor that significantly determines consumer acceptance because it is directly related to previous experiences and preferences with a food product (21). Furthermore, using less red bean flour also impacts the aroma of cookies. Red bean flour has a distinctive nutty aroma that tends to be neutral to slightly sweet, which can partially mask the fishy smell of milkfish flour. As the proportion decreases, the ability to neutralize these aromas decreases, resulting in a more dominant fishy aroma. A balanced composition of ingredients in food product formulations is crucial for creating sensory characteristics acceptable to panelists (22).

Taste

The highest level of taste acceptance was found in F1 cookies, with an average panelist rating of 5.06. This rating was interpreted as "like." The lowest average rating was found in F5 cookies, at 3.06, with a neutral rating. The Kruskal-Wallis test for taste parameters showed $p<0.05$, rejecting H0. This result indicates a significant difference between the treatments (F1, F2, F3, F4, and F5) in the taste of milkfish and red bean flour cookies. Further tests were conducted using the Mann-Whitney test to determine which groups differed. The Mann-Whitney test results showed no significant differences ($p>0.05$) in the taste of milkfish and red bean flour cookies between F1 and F2, F1 and F3, F2 and F3, F2 and F4, and F3 and F4. However, there were significant differences ($p<0.05$) between F1 and F4, F1 and F5, F2 and F5, F3 and F5, and F4 and F5 in the taste preferences of milkfish flour and red bean cookies.

Taste is the most dominant sensory factor in determining consumer acceptance of food products. Organoleptic test results showed that panelists' preference for the taste of cookies decreased with increasing proportions of milkfish flour and decreasing use of red bean flour. It is likely due to the characteristic savory flavor of milkfish flour, which is due to its high protein and fat content (23). This savory flavor significantly deviates from consumer expectations, as cookies are generally known to be predominantly sweet (24). Consumers prefer cookies with a sweet taste. This sweetness comes from sugar, which functions not only as a sweetener but also as a texturizer and flavor balancer in the dough. Sugar plays a crucial role in covering any unwanted off-flavors that may arise from additional ingredients, while also increasing product acceptability (25). Therefore, when the cook added milkfish meal in larger quantities, the sugar content needed to be adjusted to mask the savory flavors.

Furthermore, reducing the proportion of red bean flour also affects flavor acceptance. Red bean flour generally provides a neutral to slightly sweet flavor, thus balancing the savory flavor of milkfish meal (26). When the amount of red bean flour is reduced, its ability to neutralize the savory flavor is less, making the fishy flavor more dominant and decreasing panelists' preference. The combination of plant-based and animal-based ingredients in cookie formulations requires careful management to achieve a flavor balance acceptable to consumers (27).

Texture

Panelists' assessment of texture showed the highest score for F1 cookies. The average score was 5.26, interpreted as "like." The lowest average score was 4.83 for F5 cookies, interpreted as "somewhat like." The Kruskal-Wallis test for texture parameters showed $p>0.05$, H0 is accepted, so there is no significant difference across treatmentsn (F1, F2, F3, F4, and F5) in the texture of milkfish and red bean flour cookies.

Texture is a sensory parameter that significantly determines the acceptability of food products, including cookies. Cookies generally have a characteristic crunchy texture. However, texture is strongly influenced by the product's water content. Higher water content results in softer cookies, while lower water content results in a crunchier texture preferred by consumers (28). Organoleptic test results showed that increasing the amount of milkfish flour added and decreasing the amount of red bean flour added decreased panelists' preference for texture. This is because milkfish flour contains protein and fat, which are hygroscopic, absorbing and retaining water in the dough. Consequently, the water content of cookies increases, resulting in a softer and less crispy texture. This finding aligns with the findings of Nandiyanto et al. (2022), who stated that the protein and lipid components of flour affect the water absorption capacity, thus affecting the mechanical properties and texture of cookie products (29).

Meanwhile, red bean flour contains starch, which plays a role in creating a crispy texture. Reducing the proportion of red bean flour in the formulation reduces the dough's ability to form a stable dry structure during baking. Starch contributes to the formation of a hard matrix in cookies, thus increasing their crispiness (30). Therefore, a balanced use of milkfish flour and red bean flour is crucial to produce cookies that remain crispy and acceptable to consumers.

Overall

Overall, the panelists' average score was 5.23, interpreted as "like". The lowest average score was 3.43, interpreted as "neutral". The Kruskal-Wallis test for overall parameters showed $p<0.05$, rejecting H0. These data indicate a significant difference between the treatments (F1, F2, F3, F4, and F5) in overall milkfish and red bean flour cookies. Further Mann-Whitney tests were conducted to determine which groups exhibited differences.

The Mann-Whitney test results showed that overall preference for milkfish and red bean flour cookies did not differ significantly ($p>0.05$) between F1 and F2, F1 and F3, F2 and F3, F3 and F4, and F4 and F5. However, there were significant differences ($p<0.05$) between F1 and F4, F1 and F5, F2 and F4, F2 and F5, and F3 and F5 in overall preference for milkfish and red bean flour cookies.The overall assessment in organoleptic testing reflects the panelists' overall acceptance of a food product. This parameter is the accumulation of colour, aroma, taste, and texture, each of which is influenced by ingredient composition, processing techniques, and external factors during the production process (31).

The results showed that F1 cookies achieved the highest overall score, indicating that the combination of ingredients in the formulation achieved the balance of colour, aroma, taste, and texture that best met panelists' expectations. Meanwhile, the greater the addition of milkfish flour and the lesser the use of red bean flour, the lower the panelists' acceptance of the cookies. This indicates a direct influence of ingredient proportions on organoleptic characteristics. This is in line with research by Amu et al. (2025), which found that panelists' preference levels decreased with increasing proportions of skipjack tuna flour in complementary feeding biscuits (32).

Sensory-logically, milkfish flour has a light brown colour, which can affect the appearance of cookies. This colour change is likely due to the protein content in the fish flour, which participates in the Maillard reaction during the baking process, resulting in a darker colour (29). In terms of aroma and taste, milkfish flour provides a distinctive savory fishy character that can offset the sweetness consumers expect from cookies. This aligns with research by Husein et al. (2023), which found that adding milkfish flour to complementary feeding biscuit formulations can increase protein nutritional value but has the potential to reduce sensory acceptability due to the dominant fishy flavor and aroma (33).

In addition to ingredients, external factors such as oven type and heat distribution also influence the final characteristics of cookies. Ovens with uneven heat distribution can cause uneven colour and texture, thus affecting panelists' overall assessments (34).

Energy and Nutrient Content

The energy and nutrient content of milkfish and red bean flour cookies were analyzed to determine energy, protein, fat, carbohydrate, water, and ash content. Nutritional content analysis was conducted on the F1 cookie formulation with a ratio of milkfish flour and red bean flour (30%:70%) because it had the best organoleptic acceptance among the other formulas. This is a quality requirement for food products, allowing comparison with the quality requirements for supplementary foods for malnourished toddlers. The results of testing the nutritional content of F1 cookies can be seen in **Table 3**.

Table 3. Nutritional content laboratory test results

Energy and Nutritional Content	Unit	Laboratory Test Results (mean of two replicates)	Quality Requirements
Energy	Kkal	493.10	Min. 400**
Protein	%	20.32	Min. 5* 8-12**
Fat	%	24.52	10-18**
Carbohydrate	%	4779	Max. 70***
Water content	%	4.41	Max. 5*
Ash content	%	2.97	Max. 5***

*Standar Nasional Indonesia (35)
**PMK No. 51 Tahun 2016 (36)
***Winarti *et al,* 2024 (37)

The energy content of F1 cookies was 493.10 kcal/100 g. The energy content of these cookies meets the quality requirements for supplementary foods for malnourished toddlers, as stipulated in Minister of Health Regulation (PMK) No. 51 of 2016, which is 400 kcal. Each cookie weighs approximately 10 g. Therefore, as a supplementary food for toddlers aged 6-59 months, approximately 10 cookies should be consumed daily. Cookies based on milkfish and red bean flour F1 have an energy content of 493.10 kcal/100 g. This value exceeds the minimum energy standard of 400 kcal/100 g as stipulated in the Regulation of the Minister of Health of the Republic of Indonesia No. 51 of 2016 concerning supplementary food for undernourished toddlers aged 6-59 months (36). This energy comes from a combination of carbohydrates, protein, and fat, making it a potentially nutritious alternative supplementary food for undernourished toddlers. Processed products with a combination of animal and plant ingredients can improve protein quality due to the complementary amino acids in the ingredients and the food's energy density (38).

Laboratory tests showed that the protein content of F1 cookies was 20.32%. Compared to the biscuit quality requirements according to the Indonesian National Standard (SNI) and supplementary foods for malnourished toddlers, as stipulated in PMK No. 51 of 2016, the results met the standards. These standards require a protein content of 5% and 8-12%, respectively. The protein content of the cookies is 20.32%, significantly higher than the minimum protein standard for biscuits according to the Indonesian National Standard (SNI) (5%) and the quality requirements for supplementary food for undernourished toddlers according to PMK No. 51 of 2016 (8–12%) (36). This high protein content comes primarily from milkfish flour, a source of animal protein with a complete essential amino acid composition. This finding supports research by Husein et al. (2023), which showed that substituting fish flour in biscuits can increase the protein content and nutritional quality of the final product (33). In addition, these results align with previous research, which found that the combination of local food PMT has a higher protein content than the standard and has the potential to serve as an alternative to manufactured PMT (39).

The fat content of F1 cookies was 24.52%. This exceeds the fat content required by PMK No. 51 of 2016 for supplementary foods for malnourished toddlers, which is 10- 18%. The fat content of F1 cookies was 24.52%, exceeding the standard of PMK No. 51 of 2016 (10–18%) (36). This high-fat content is thought to originate from the milkfish fat remaining in the flour and other additives such as margarine or butter. Fat functions as a dense energy source and can improve the texture of cookies, but excessively high levels can increase energy density. Biscuit formulations for functional foods need to maintain a balanced fat content to meet health standards while maintaining sensory quality (40).

The carbohydrate content of F1 cookies is 47.79%. These results indicate that the carbohydrate quality requirements have been met, as per the research by Winarti et al. (2024), which is a maximum of 70%. The carbohydrate content of F1 cookies was 47.79%, which still meets the quality requirements of a maximum of 70% (37). Carbohydrates are the main energy-contributing component in cookies, in addition to contributing to texture and sweetness. Carbohydrate levels within the standard range indicate that the cookie formulation maintains a balance between energy sources from carbohydrates, protein, and fat (41).

The moisture and ash content of F1 cookies were 4.41% and 2.97%, respectively. These levels meet the respective quality requirements. Based on the Indonesian National Standard (SNI), with a maximum moisture content of 5% and a maximum ash content of 5%. The cookie moisture content of 4.41% remains below the 5% maximum limit according to the Indonesian National Standard (SNI), ensuring the product is relatively safe from microbial growth and has a longer shelf life. The ash content of 2.97% also meets the 5% maximum quality standard, indicating that these cookies contain minerals within safe limits for consumption (37). The low moisture and ash content are important indicators that F1 cookies are not only highly nutritious but also have good physical quality for storage (42).

CONCLUSION AND RECOMMENDATION

The milkfish flour manufacturing process has been shown to reduce the water content of the ingredients, extending shelf life and simplifying cookie production. Furthermore, the high-quality animal protein content of milkfish flour increases the nutritional value of the cookies. Fresh milkfish has a moisture content of approximately 74%, while fish meal has a moisture content of approximately 7.41% (43,44).

F4 cookies formulated with a relatively high proportion of milkfish flour (60%) tend to be darker in color due to the Maillard reaction, thus decreasing panelists' preference. The aroma of the cookies decreased with increasing milkfish flour due to the existence of a fishy aroma that was not in line with cookie expectations. The taste of the cookies became more savory with the addition of milkfish flour, thus reducing the preference of panelists who expected the typical sweetness of cookies. The texture of the cookies became softer due to the hygroscopic nature of milkfish flour, while the red bean flour, which contributes to crispiness, remained. Overall, the F1 formulation was most preferred by panelists because it achieved a good balance of colour, aroma, taste, and texture.

The nutritional content of F1 cookies met the energy and protein quality standards for supplementary food for undernourished children, with 493.10 kcal/100 g of energy and 20.32% protein. However, the fat content of 24.52% still exceeded the standard (10–18%). Meanwhile, the carbohydrate content (47.79%), moisture content (4.41%), and ash content (2.97%) all met applicable quality standards.

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