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Acceptance of Skipjack Tuna Fish Nuggets with Moringa Leaves to Prevent Stunting in Toddlers

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Skipjack Tuna;
Moringa Leaves;
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ABSTRACT

Background: The problem of stunting in toddlers is a priority for handling because it threatens human quality. Providing nutritious local food rich in animal protein is the key to handling toddler nutrition because it provides essential amino acids. One of the local foods that is rich in protein and easy to obtain in South Sulawesi is Skipjack Tuna (Katsuwonus pelamis) which contains complete protein and is rich in omega-3 fatty acids. Another local food is Moringa leaves (Moringa oleifera) which contain protein, vitamin A, and iron. This study aims to formulate and test the acceptability of skipjack tuna nuggets with the addition of moringa leaves..

Method: This research was conducted in August-September 2024. The formulation process of Skipjack Tuna and Moringa Leaf Nuggets was carried out at the Nutrition Laboratory of the Muhammadiyah University of Parepare, followed by testing the nutritional content at the Makassar Health Center and then organoleptic testing was carried out in Parepare City. The research sample consisted of 15 parents who had toddlers aged 24 months to 59 months by purposive sampling.

Result: This research was conducted in August-September 2024. The formulation process of Skipjack Tuna and Moringa Leaf Nuggets was carried out at the Nutrition Laboratory of Muhammadiyah University of Parepare, nutritional content testing at BBLK Makassar and then organoleptic testing on a research sample of 15 parents who have toddlers aged 24 months to 59 months using purposive sampling.

Conclusion: Formulation F1 has the highest protein and carbohydrate content, while Formulation F2 has the highest fat content. The results of the organoleptic test showed that Formulation F2 was considered the most preferred by respondents, with the highest values for color, aroma, and taste, while Formulation F1 had the highest value for texture.

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INTRODUCTION

All health issues in the Sustainable Development Goals (SDGs) are integrated into one goal, namely goal no. 3, which is to ensure healthy lives and promote well-being for all at all ages. One of the key challenges in achieving this goal is stunting in children, including toddlers, which remains a major issue in the health sector (1). Stunting poses a serious threat to human quality (2–4), making malnutrition in toddlers a priority issue to be addressed (5). Based on data from the 2023 Indonesian Nutritional Status Survey (SSGI), the prevalence of stunting in Indonesia was recorded at 21.5%, only down 0.1% from the previous year which was at 21.6%. This shows that the government has not been able to meet the target of reducing the stunting rate to 14% in 2024. (6)(7) . Meanwhile, in South Sulawesi the prevalence of stunting is 27.2% (8). One of the factors contributing to stunting in toddlers is an imbalanced dietary intake.

Providing complementary foods (PMT, Supplemental Feeding) made from local ingredients is one strategy to address nutritional issues in toddlers (9). The formula recommended by the World Health Organization (WHO) for children experiencing stunting consists of oil, sugar, milk, water, and flour. These ingredients can be replaced with local foods rich in vitamins and protein (10). Animal protein, as a macronutrient, provides the best (9) sources of essential amino acids required by the body.

A source of animal protein is fish ((11), including skipjack tuna (Katsuwonus pelamis), which is abundant and has great potential in the waters of Sulawesi (12) . The nutritional content of skipjack tuna makes it an excellent candidate for further processing into high-nutrition food products. Skipjack tuna contains complete protein and is rich in omega-3 fatty acids. It is also beneficial for lowering blood sugar levels, maintaining heart health, preventing anemia, and reducing the risk of dementia. Another local food with good nutritional content is Moringa leaves (Moringa oleifera), called daun Kelor in Indonesia (13), which are easy to find and rich in nutrients (14). Moringa leaves contain protein, vitamin A, and iron (14). Nutrition between skipjack tuna and several other protein sources, namely chicken, eggs, red beans and tofu beans per 100 grams based on Food Data Central, namely skipjack tuna has a higher number of calories, cholesterol fat, protein, omega-3 fatty acids, calcium and vitamin B12 than other protein sources (15)(16).

However, the phenomenon is that many people are not aware of the nutritional content of skipjack tuna and moringa leaves, leading to very low utilization. Many still believe in the myth that eating fish can cause intestinal worms, and the strong fishy smell is difficult to eliminate. Similarly, there is a lack of knowledge and enthusiasm regarding the use of moringa leaves, and not many Indonesians consume them due to their distinct odor, which is often disliked (17). Therefore, there is a need to diversify products to increase community consumption of local foods (18). One way to create innovative local food products that align with community preferences is through the development of frozen foods in the form of nuggets, which provide a convenient household option for fulfilling food needs due to their long shelf life and ease of preparation (19). Based on this description, the formulation of the research problem aims to produce modified complementary foods in the form of nuggets made from local ingredients skipjack tuna and moringa leaves that are high in protein for the prevention of stunting in toddlers.

METHOD

Location and Time

This research was carried out for two (2) months, starting from August-September 2024. The formulation of Cakalang Fish Nuggets and Moringa leaves was made at the Nutrition Laboratory of Muhammadiyah University, Parepare. Test the nutritional content of nuggets at the Makassar Health Laboratory Center. Organoleptic tests were carried out in Parepare City. The research sample was a combination of skipjack tuna and Moringa leaf nuggets with a predetermined formula and samples for organoleptic testing were of 15 parents who had toddlers aged 24 months to 59 months from Parepare City taken by purposive sampling. The data collection method to determine the quality or acceptability of Nugget to the public is carried out by compiling a questionnaire to measure the acceptability or liking of the community and determining test samples. Data analysis to determine the level of acceptability of the Moringa leaf formulation was carried out using an organoleptic test using a hedonic scale test, namely very like (5), like (4), somewhat like (3), dislike (2) and very dislike (1).

Research Stages

Stage 1: Data Collection and Formulation Development.

The first step involves creating the formulation of skipjack tuna nuggets combined with moringa leaves at the Nutrition Laboratory of Universitas Muhammadiyah Parepare. At this stage, we have produced products (3 samples) nuggets where Formula 1 (F1) is formulated like conventional nuggets without the addition of Moringa leaves, Formula 2 (F2) is made with the addition of 5 grams of Moringa leaves and Formula 3 (F3) is made with the addition of 10 grams of leaves Moringa. Moringa leaves are known for their antioxidant and anti-inflammatory properties, which can provide health benefits. The addition of moringa leaves at concentrations of 5 grams and 10 grams in nuggets aims to increase the nutritional content, especially protein, vitamin A, vitamin C, calcium, and other additional substances.

Stage 2: Laboratory Testing and Data Analysis

In this stage, the nugget samples were tested at the Central Health Laboratory (BLK) in Makassar to determine their nutritional content (protein) using the difference method, Kjeldahl method, Soxhlet extraction, and atomic absorption spectrophotometry (AAS). To assess the quality and acceptability of the nuggets within the population, a questionnaire was developed to measure community preferences and determine the test samples.

Research Procedure Stages

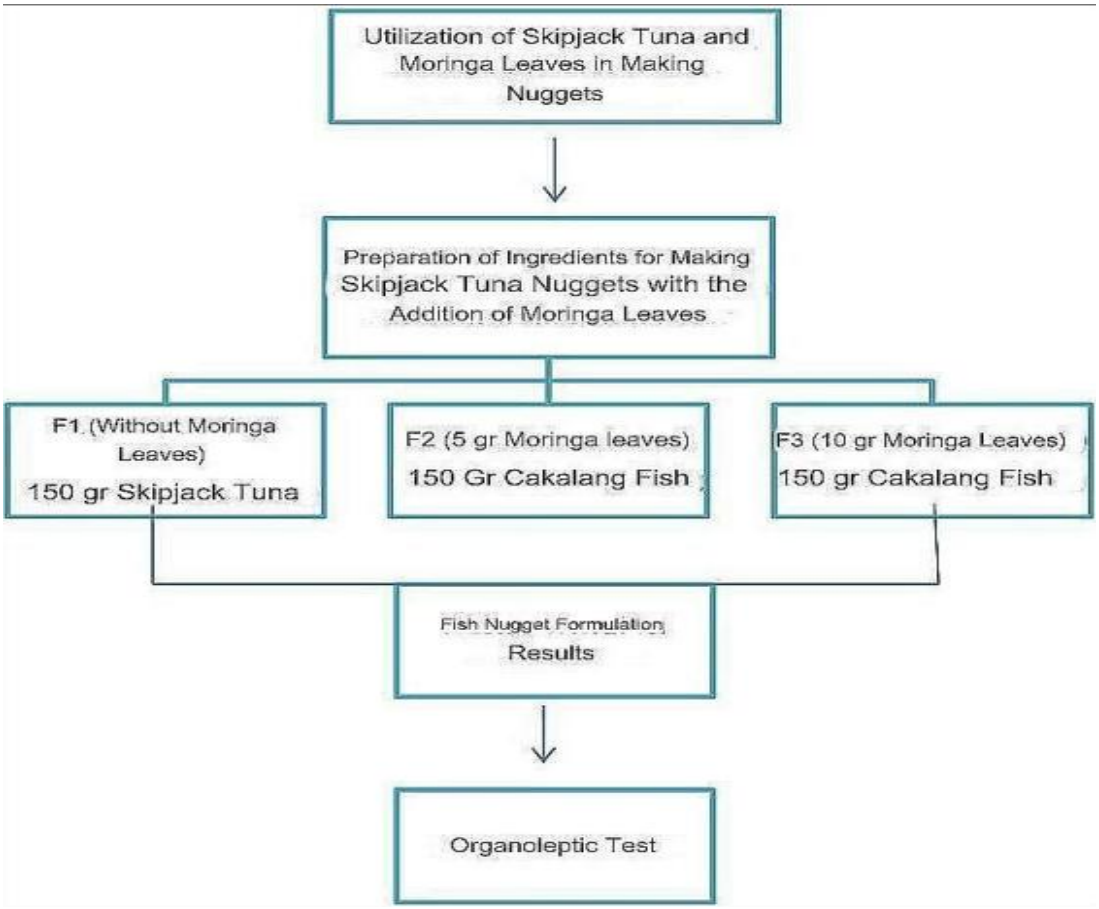

Figure 1. Research Flow Diagram

Preparation of Skipjack Tuna Nuggets with Moringa Leaves
Tools and Ingredients
Tools:
2 mixing bowls
2 trays
1 oven
1 blender
1 food scale
1 sieve
1 stove
1 food steamer

Composition of Cakalang fish nuggets with the addition of Moringa leaves using three (3) formula trials

Formula 1: without Moringa leaves
150 g skipjack tuna
20 g wheat flour
20 g tapioca flour
4 cloves garlic
5 shallots
1 egg
1 tsp salt
1 tsp sugar
50 ml water

Formula 2: 5 grams of Moringa leaves
150 g skipjack tuna
20 g wheat flour
20 g tapioca flour
5 g moringa leaves
4 cloves garlic
5 shallots
1 egg
1 tsp salt
1 tsp sugar
50 ml water

Formula 3: 10 grams of Moringa leaves
150 g skipjack tuna
20 g wheat flour
20 g tapioca flour
10 g moringa leaves
4 cloves garlic
5 shallots
1 egg
1 tsp salt
1 tsp sugar
50 ml water

How to make Skipjack Tuna with Moringa leaf combination

Clean the skipjack tuna by separating the skin from the brown flesh, then wash and grind it until smooth. Combine the ground skipjack tuna with wheat flour, tapioca flour, garlic, shallots, egg, salt, sugar, and water. Mix well until the dough is smooth.

For Formula 2, follow the same steps but add 5 grams of moringa leaves to the mixture. For Formula 3, repeat the same process, adding 10 grams of moringa leaves for a stronger flavour.

Prepare the steamer and lightly grease the tray to prevent sticking. Steam the nuggets for 20-25 minutes until cooked. Once steamed, remove the nuggets and let them cool. After cooling, cut the nuggets into the desired size and coat them with breadcrumbs.

If serving immediately, the nuggets can be fried in hot oil until golden brown. If storing for later use, the nuggets can be frozen.

RESULTS

The characteristics of the subjects based on age, education level, Mother's Occupation and the age of the children are outlined in Table 1.

Table 1. Subject Characteristics Based on Age, Education Level, Mother's Occupation, and Toddler Age

Characteristics	N	%
Mother's Age		
> 20	2	13,33
21-30	5	33,33
31-40	7	34,67
< 40	1	6,67
Total	**15**	**100**
Mother's Education Level		
SMA	8	53,33
S1	6	40,00
S2	1	6,67
Total	**15**	**100**
Mother's Occupation		
IRT (Housewife)	6	40,00
PNS (Civil Servant)	5	33,33
Entrepreneur	2	13,33
Private Employee	2	13,33
Total	**15**	**100**
Toddler's Age (Months)		
24-36	3	20,00
37-49	7	34,67
50-59	5	33,33
Total	**15**	**100,00**

Table 1. illustrates the distribution of subject characteristics, including the mother's age, education level, occupation, and toddler age. Based on the presented data, the majority of mothers participating in the study are aged between 31-40 years (34.67%), with the fewest being over 40 years. In terms of the mother's education level, most have completed high school (53.33%), while the lowest percentage holds a master's degree (6.67%). Regarding mothers' occupations, the majority are housewives (IRT) at 40%, followed by civil servants (PNS) at 33.33%. The most common age range for toddlers is 37-49 months (34.67%), while the lowest percentage is in the 24–36-month range (20.00%).

Nutritional Content of Skipjack Tuna Nuggets with Moringa Leaf Combination

The analysis of the nutritional content of skipjack tuna nuggets with the addition of moringa leaves, focusing on protein, fat, and carbohydrate parameters, is presented in Table 2.

Table 2. Nutritional Content Value of Nugget Formulation 100gr

Indicator	**Skipjack Tuna Nuggets with Moringa Leaf Combination**		
	F1	**F2**	**F3**
Energy (kcal)	227,78	229,09	177,1
Protein (g)	16,44	14,55	12,69
Fat (g)	10,15	12,53	8,42

Carbohydrate (g)	16,88	14,53	12,04

Table 2 shows that the total energy content of formula 2 (F2) of 229.09 kcal is higher than formula 1 (F1) of 227.78 kcal and formula 3 (F3) of 177.1 kcal. Energy is used to support activities carried out daily. Based on the 2019 Nutrition Adequacy Rate, it is known that the total energy requirement for children aged 1-3 years is 1350 kcal. The calorie content of F1 nuggets per 100 g can meet 16.87% of the calorie needs of children aged 1-3 years, F2 meets the calorie needs of 16.96% and for F3 meets 13.11%.

The total protein content of F1 amounted to 16.44 grams F2 amounted to 14.55 grams while F3 amounted to 12.69 grams. The total protein content of Nugget is contributed from skipjack fish, eggs and also partly from the use of high protein wheat flour. There is a difference in protein content after the provision of moringa leaves, this happens because moringa leaves themselves have protein content, but the amount is not as much as the protein found in skipjack fish. So that when moringa leaves are added, the total amount of protein measured in the final product becomes lower than if only using tuna without additional moringa. Nugget consumption per 100 grams of F1 (without moringa) can meet 82% of the protein needs of children aged 1-3 years. Whereas in F2 (5 g Moringa) can fulfill 72.6%. The amount of protein requirement for children aged 1-3 years is 20 grams and 4-6 years is 25 grams (AKG, 2019). Protein is needed by children for growth and to prevent stunting.

Based on fat content, the total fat content presentation in F2 was higher at 12.53%. This amount is higher because more oil is used in the manufacture of F1 and F3. Fat content also comes from the use of eggs in making nuggets. The results of the examination of carbohydrate content showed that the amount of content in formula 1 (F1) was higher at 16.88%, differing by 2.35% from formula 2 (F2) of 14.53%.

Acceptability of Skipjack Tuna Nuggets with Moringa Leaf Addition

The average acceptance analysis of the subjects towards the formulations with moringa leaves shows significant results across four indicators: color, aroma, texture, and taste, as presented in Table 3.

Table 3. Average Subject Response to Skipjack Tuna Nugget Formulation

Indicator	Skipjack Tuna Nuggets with Moringa Leaf Combination		
	F1(Without Moringa)	F2 (5 g Moringa)	F3 (10 g Moringa)
Color	3,16	3,23	3,10
Aroma	3,62	3,74	3,24
Texture	4,06	3,89	3,73
Taste	3,73	4,12	3,92

Table 3 presents the results of the acceptance test conducted with subjects regarding three formulations of skipjack tuna nuggets combined with moringa leaves (F1, F2, and F3), based on the indicators of color, aroma, texture, and taste. The results indicate that formulation F2 received the highest scores for color (3.23), aroma (3.74), and taste (4.12), demonstrating that this formulation was the most preferred by the subjects in these three categories. Meanwhile, formulation F1 achieved the highest score for texture (4.06).

DISCUSSION

Skipjack tuna (Katsuwonus pelamis L) is rich in protein, fat, and vitamins, making it a common raw material for food products such as canned fish, shredded fish, nuggets, and other processed items. In this study, the fish nuggets are made from tuna meat combined with various ingredients such as spices, binding agents, and moringa leaves, then shaped into appealing forms (20). The production of fish nuggets aims to create practical, nutritious, and long-lasting processed products that utilize the protein, fat, and vitamin content in fish (21). This is in line with Eman Darmawan's research which utilizes protein from catfish to make nuggets (22) and these nuggets also seek to expand the variety

of fish products available to various demographics, especially as a healthy alternative to fast food (23). The development of fish-based food products is essential given the high protein content of fish and aims to enhance the economic value of fish (24) (25,26).

The addition of moringa leaves in the skipjack tuna nuggets aims to provide variations in flavor and color, as well as enhance the health benefits of the product, making it more appealing from both nutritional and market perspectives (25–28). Furthermore, this study may explore the utilization of local foods like moringa leaves in processed products to increase added value and diversify food offerings (29). This is in line with research by Raden et al. in 2018 which stated the need to develop local food in the form of fish nuggets to provide healthy and nutritious food while improving community welfare (30). The organoleptic testing of skipjack tuna and moringa nuggets is conducted to assess the preferences of panellists regarding the color, taste, texture, and aroma of the resulting products. The sensory experience perceived by human senses regarding the characteristics of a product can only be measured through organoleptic testing methods.

Nutritional Content of Skipjack Tuna Nuggets

The results indicate that formulation F1 has the highest, protein and carbohydrate content, at 16.44 g and 16.88 g, respectively. Meanwhile, formulation F2 contains the highest energy fat content at 299.09 kcal and 12,53g. The difference in protein levels after the addition of moringa leaves may be attributed to the fact that while moringa leaves themselves contain protein, the amount is significantly lower than that found in skipjack tuna. Therefore, when moringa is added, the total protein measured in the final product may be lower compared to using only skipjack tuna without any additional leaves. Moreover, the nugget processing, particularly involving heating, can contribute to the reduction of certain nutrients, such as protein and carbohydrates. This is especially true when additional ingredients like moringa leaves are included, which may undergo nutritional degradation during cooking. Despite the variations in protein and carbohydrate content, moringa leaves still contribute to the overall nutritional value by adding vitamins, minerals, and antioxidants, which are vital for health and disease prevention.

Color

The color of food products is a crucial factor in determining consumer acceptance, as it forms the first visual impression. As an initial indicator of appearance, color significantly influences consumer perceptions of product quality, playing an essential role in purchasing decisions (27,31–33). The color of a food product results from various processing methods, where chemical, physical, and biochemical reactions occur, affecting the product's quality. Changes in color during processing can provide important information regarding quality and suitability, aligning with consumer expectations and ultimately impacting acceptance levels (34). In this study, Formula 2 received higher ratings compared to others, as the nuggets with 5 grams of moringa were found to be more visually appealing to panelists than Formula 3, which exhibited a darker green color. Color is especially influential for children, who typically prefer vibrant hues. Attractive and naturally appearing food colors can enhance perceived flavor. Therefore, the addition of moringa leaves should be executed with precise measurements to maintain a balance between color aesthetics, flavor, and texture, ensuring optimal consumer acceptance.

Aroma

Aroma is one of the most important factors in assessing the quality of skipjack tuna and moringa leaves, yet it is often challenging to measure objectively. The evaluation of aroma and flavor in this product typically relies on sensory testing methods involving panelists (35). The variability in individual responses to the intensity and quality of aroma makes the selection of panelists a crucial aspect to ensure accurate and representative evaluation results (36). Aroma is a significant element that stimulates the sense of smell and influences consumer preference. Through aroma, consumers can recognize the quality of food even before seeing or tasting it, as it can be detected from a distance by the olfactory senses (37). In this study, Formula 2 was rated as having a more balanced aroma, with a blend of skipjack tuna and moringa that was not overpowering. In contrast, Formula 1, which did not include moringa, was perceived by subjects to have a strong fish aroma, making it less favorable. Formula 3, which contained 10 grams of moringa, had a sharper moringa aroma that was less preferred by some subjects. This finding aligns with research by Nastiti (2021), which indicates that excessive moringa can produce a pungent aroma that affects subject acceptance, especially if they are unaccustomed to that flavor. Therefore, food processing methods should be

carefully considered to maintain the desired aroma. Aroma plays a vital role in assessing product quality, allowing consumers to make evaluations without tasting.

Texture

Texture is a crucial sensory attribute in assessing food quality, including skipjack tuna nuggets with the addition of moringa leaves. Texture plays a significant role in determining consumer acceptance, as it provides tactile perception that influences satisfaction and comfort during consumption (38). The ideal texture in nuggets is generally a combination of softness on the inside and chewiness on the outside, achieved through proper processing (38). The inclusion of moringa leaves in skipjack tuna nuggets can directly affect the final product's texture. Due to their high fiber content, moringa leaves have the potential to increase the roughness of the texture if not processed properly (39). Formula 1 received the highest ratings, indicating that subjects preferred the conventional nuggets over those with added moringa, as the latter provided a denser or coarser sensation in the mouth, which some consumers may not favor when expecting a smoother texture. However, when combined well, the fiber from moringa can add a new dimension to the nugget's texture, providing a slight chewiness that may appeal to consumers seeking healthier, high-fiber products.

The processing method also plays a critical role in maintaining the desired texture. Frying at the correct temperature can help achieve a crispy outer layer while keeping the inside soft. Improper processing, such as excessively high or low temperatures, can disrupt the texture balance, resulting in nuggets that are either too hard or too soft, thereby reducing consumer acceptance. Additionally, the distribution of moringa fiber in the nugget mixture should be considered to ensure homogeneity, as uneven texture can diminish product quality and affect consumer perceptions of its overall quality (10). Therefore, in developing skipjack tuna nuggets with moringa, it is essential to pay attention to appropriate processing techniques to achieve the desired texture, ultimately enhancing consumer acceptance of this product.

Taste

Taste is a key factor influencing consumer acceptance of food products, including skipjack tuna nuggets with added moringa leaves (40). The combination of flavors from the primary ingredient, skipjack tuna, and moringa has the potential to create a unique and distinctive taste. Skipjack tuna is known for its strong savory flavor due to its high protein content (41), while moringa has a slightly bitter taste and a characteristic herbal aroma. Achieving a balance between these two ingredients is crucial to ensure broad consumer acceptance (42). The addition of moringa in nugget formulation aims not only to enhance nutritional value but also to introduce flavor variation. Moringa contains various bioactive compounds, such as flavonoids and tannins, which can influence the flavor profile of the nuggets. The bitterness from moringa needs to be balanced with appropriate seasonings and cooking methods to prevent it from overwhelming the overall taste. If this bitterness is too pronounced, it may reduce consumer acceptance, particularly among those unaccustomed to herbal flavors (43). Therefore, using moringa in the right proportions is essential to achieving optimal flavor, as excessive amounts can mask the dominant savory taste of the skipjack tuna (44).

The addition of seasonings such as salt, pepper, and other spices must be adjusted to create a harmonious balance of flavors. Overall, the taste of skipjack tuna nuggets with the addition of moringa leaves requires careful formulation. The balance between the savory flavor of the fish and the herbal notes of the moringa will greatly influence consumer acceptance of this product. With the right combination, these nuggets not only offer a unique flavor variation but also enhance the appeal for consumers seeking nutritious and delicious food products (42,45). Formula 2 also excels in terms of taste, where panelists felt that the addition of 5 grams of moringa did not dominate the overall flavor of the nuggets but still provided a unique and enjoyable taste. Formula 3, which used 10 grams of moringa, was assessed to have a stronger flavor, which most panelists did not prefer. Overall, Formula 2, which included an additional 5 grams of moringa, was the most balanced in terms of appearance, aroma, texture, and taste, making it the favourite formula among panelists in this study. This research aligns with the study conducted by (42), which stated that the addition of moringa leaves provides a new and unique flavor but must consider the amount used, as increasing the quantity of moringa can lead to a stronger moringa taste, affecting acceptance among toddlers. The addition of moringa in moderate amounts has proven to provide additional nutritional benefits without compromising product acceptance among toddlers.

Recommendations for Future Research

Protein content varies among the three formulations with the addition of moringa leaves. To stabilize the protein content, it is recommended to control the temperature during steaming and frying, Developing recipes with the addition of ingredients that have the potential to increase protein content, such as moringa flour or other ingredients that are rich in nutrients, then testing the effectiveness of nuggets for preventing stunting can be carried out and implementing skipjack tuna and moringa leaf nuggets in preventing stunting through case studies in stunting risk groups.

CONCLUSION

Formulation F1 had the highest protein content at 16.44% and carbohydrate content at 16.88%. Formulation F2 stood out with the highest content energy at 229,09 and fat content at 12.53%. The organoleptic test results showed that Formulation F2 received the highest scores for color (3.23), aroma (3.74), and taste (4.12), indicating that this formulation was the most preferred by the subjects based on these three indicators. Formulation F1 achieved the highest score for texture (4.06).

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