FORMULATION OF LOCAL FOOD INGREDIENTS FROM RED BEANS AND CATFISH IN THE FORM OF NUGGET SNACKS AS WASTED UNDER FIVE YEARS OLD CHILDREN SUPPLEMENTARY FOOD

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Abstract: *This study aims to analyze the empirical nutritional quality (energy, protein, fat, carbohydrates, vitamin A, calcium, iron and phosphorus), organoleptic quality and determine the best treatment level of Nuggets with red bean and catfish formulation as supplementary food for wasted under five years old children. This study employed an experimental approach with a Completely Randomized Design (CRD) consisting of three treatment levels. The nugget formulation was developed by modifying the proportions of catfish, chicken meat, and red beans with the following ratios: P0 = 0:100:0, P1 = 25:48:27, P2 = 33:40:27, and P3 = 41:32:27. Organoleptic tests by 25 semi-trained panelists assessed color, aroma, taste, and texture using a hedonic scale. Statistical analysis utilized Kruskal-Wallis and Mann-Whitney tests to determine significant differences, while the best formulation was identified using effectiveness index analysis. In this study the best formulation, consisting of 41% catfish, 32% chicken, and 27% red beans (P3), showed an Overcome Value (OV) of 0.884 and provided 359.94 kcal, 15.67g protein, 20.94g fat, and 27.17g carbohydrates per 100g. No significant preference difference was found between the control and P3 treatments. Future studies should focus on optimizing frying conditions to improve nugget color.*

Keywords: Formulation; Red Beans; Catfish; Nugget; Wasted

INTRODUCTION

Malnutrition and wasting is one of the main health problems in developing countries, including Indonesia. The increasing prevalence of malnourished toddlers is also a worrying problem in Indonesia, especially in East Java Province. According to the 2018 Basic Health Research data (Riskesdas), the prevalence of wasted children in Indonesia reached 13.8%, with a similar figure in East Java Province reaching 13.43% (Ministry of Health of the Republic of Indonesia, 2018).

At the health center level, as seen from the annual report of the nutrition performance indicators of the Arjowinangun Health Center in Malang City, there was an increase in the prevalence of wasted children from 2.63% in 2022 to 4.95% in 2023.

Wasted under-five children are determined based on the Weight-for-Height (WHZ) index. The weight-for-height index indicates acute malnutrition, which results from events occurring over a relatively short period (Riskesdas, 2013).

Nutritional problems are caused by various factors, UNICEF (1998) developed a framework that introduces the main causes and basic causes of malnutrition, namely lack of nutritious food intake and/or frequent infection with disease as one of the direct causes of nutritional problems while one of the indirect causes is parenting. Feeding habits or patterns in toddlers include the amount of frequency, and types of food given, supervision and control of activities, hygiene and sanitation in toddlers (Engle et al., 1999)

Micronutrient deficiencies, often grouped together, result from insufficient intake of essential vitamins and minerals. These micronutrients play a critical role in enabling the body to produce enzymes, hormones, and other substances necessary for growth and development. Among these, vitamin A, and iron are particularly significant from a global public health perspective, as their deficiencies pose serious risks to the health and development of populations, especially children in low-income regions (WHO, 2024)

Handling toddlers who are wasted is an urgent need. The effects of lack of nutritional intake during childhood can cause serious disorders in physical growth and cognitive abilities. In addition, children who are malnourished usually have a weak immune system, increasing the risk of developing various infectious and chronic diseases (United Nations Children's Fund, 2018).

Various government efforts in handling the problem of malnutrition have been carried out to overcome malnutrition in toddlers at the national level through various programs including the Provision of Additional Supplementary Food made from local food is one strategy for handling nutritional problems in toddlers with malnutrition.

One type of fishery product that is rich in protein and essential amino acids is catfish. Catfish contains the amino acids lysine and leucine which function for children's growth, tissue repair, producing antibodies, and helping calcium absorption (Murniyati, et al., 2013). Vitamin A contained in catfish plays a crucial role in maintaining eye health and supporting the immune system of toddlers. A deficiency in vitamin A can lead to eye health problems such as night blindness and increase the risk of infections in toddlers (Haryono & Maulidina, 2021).

Food sources of vegetable protein are needed to balance the content of animal protein ingredients, such as red beans (Vigna angularis). Red beans are an abundant source of vegetable protein.. The average production of red beans since 2009-2014 was 102,000 tons (Ministry of Agriculture, 2015), while in East Java in 2014, red bean production was 891 tons (BPS Jatim, 2015).

The nutritional value contained in 100 g of red beans contains 171 kcal of energy, 11 g of protein, 2,2 g of fat, 28,7 g of carbohydrates, 4,5 mg of Vitamin C, 293 mg of calcium, 134 mg of phosphorus, and 3,7 mg of iron (The Indonesian Food Composition Table, 2019).

In addition to protein, red beans contain more omega 3 than other types of beans, which are important for brain growth and function (Yaumi, 2011). As an innovation in processing supplementary food for toddlers, nuggets have been introduced. In this study, Nuggets will be developed with catfish and red beans. These food ingredients were chosen because of the high availability of nutrients, the availability of catfish and red beans is easily accessible to the community, the price is affordable and easy to make. Based on these facts, it is necessary to formulate catfish and red beans that can help overcome malnutrition in toddlers by utilizing local food
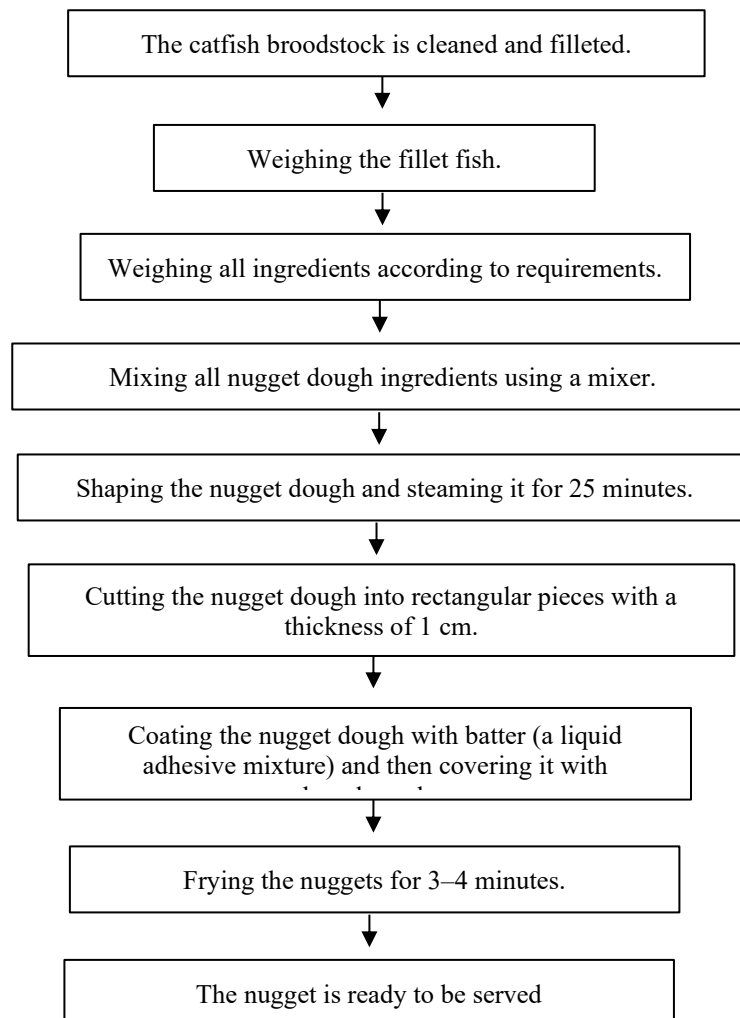
METHODS

This study employed an experimental approach with a Completely Randomized Design (CRD) consist of three treatment levels. The nugget formulation was developed by modifying the proportions of catfish, chicken meat, and red beans with the following ratios: P0 = 0:100:0, P1 = 25:48:27, P2 = 33:40:27, and P3 = 41:32:27. These ratios were determined based on the standard composition of locally fortified complementary foods for children aged 24–59 months as outlined in the Technical Guidelines for Providing Local Complementary Foods for Toddlers and Pregnant Women. According to the Indonesian Ministry of Health (2023), the nutritional standards for complementary foods for toddlers are 300–450 kcal of energy, 6–18 g of protein, 7.5–29.3 g of fat, and 21.5–32.25 g of carbohydrates.

The parameters evaluated included empirical measurements of energy and nutrient content (protein, fat, carbohydrates), organoleptic quality (color, aroma, taste, texture), acceptability, and the determination of the best treatment level

Table 1. Composition and Treatment Levels of Catfish and Red Bean Snack Nugget Formulation

Ingredients (grams)	Treatment Levels			
	P0	P1	P2	P3
Catfish	0	75	100	125
Chicken Meat	300	145	120	95
Red Beans	0	80	80	80
Wheat Flour	20	20	20	20
Tapioca Flour	60	60	60	60
Garlic	4	4	4	4
Chicken Eggs	60	60	60	60
Cooking Oils	30	30	30	30
Breadcrumbs	60	60	60	60

The equipment used in this research included baking trays, scales, knives, spoons, bowls, plates, basins, a chopper/mixer, mortar and pestle, stove, steamer pot, frying pan, and strainer. The ingredients used were fresh catfish purchased from a local market in Malang, red beans, "Segitiga Biru" wheat flour, "Pak Tani Gunung" tapioca flour, salt, garlic, pepper, cooking oil, eggs, and breadcrumbs. Before nugget preparation, the red beans were pre-processed by steaming for 10 minutes, soaking in water for 12 hours, and then preparing them for mixing into the nugget dough. The research was conducted from April to June 2024 at the Food Technology Laboratory of the Nutrition Department, Health Polytechnic of Malang.

Figure 1. Flowchart of the Nugget Formula Processing (Modified from Utiarahman et al., 2013)

The observation parameters included organoleptic testing, determination of the best treatment, nutritional composition analysis comparison of the nutritional composition of the catfish and red bean nuggets with the standard composition for locally fortified complementary foods for children aged 24–59 months (Indonesian Ministry of Health, 2023).

The organoleptic test involved 25 semi-trained panelists. The organoleptic attributes assessed were color, aroma, taste, and texture. A hedonic scale test method was employed to gauge panelists' preferences regarding the product, using a scale ranging from 1 (dislike very much) to 4 (like very much).

Data analysis was performed using Microsoft Excel 2013 and further statistically analyzed with IBM SPSS Statistics 25. A non-parametric Kruskal-Wallis test was applied to evaluate significant differences among the nugget formulations. If significant differences were detected, the Mann-Whitney test was conducted to identify specific group pairs with significant differences. The determination of the best treatment level was conducted using an effectiveness index calculation, which was analyzed descriptively according to the established standards.

RESULTS AND DISCUSSION

Product Description

The development of PMT (Supplementary Feeding) nuggets utilized local food ingredients, including catfish, chicken meat, and red beans. The nuggets formulated in this study consist of combinations of catfish, chicken meat, and red beans with proportions of (25:48:27), (33:40:27), and (41:32:27).

The determination of treatment levels was based on the Technical Guidelines for Local Supplementary Feeding for Toddlers and Pregnant Women set by the Indonesian Ministry of Health in 2023 for 100 grams of the product. The product was specifically formulated to meet the nutritional composition standards for toddlers with malnutrition, aiming to provide an acceptable and applicable alternative PMT product in the community.

The nuggets produced from the formulations, both before and after coating with breadcrumbs, exhibited specific characteristics. Prior to breadcrumb addition, the nuggets displayed a yellow to yellow-brown color, influenced by the varying proportions of catfish and red beans. The texture was dense and cohesive, yet chewy, with a non-fishy aroma and savory, slightly salty taste
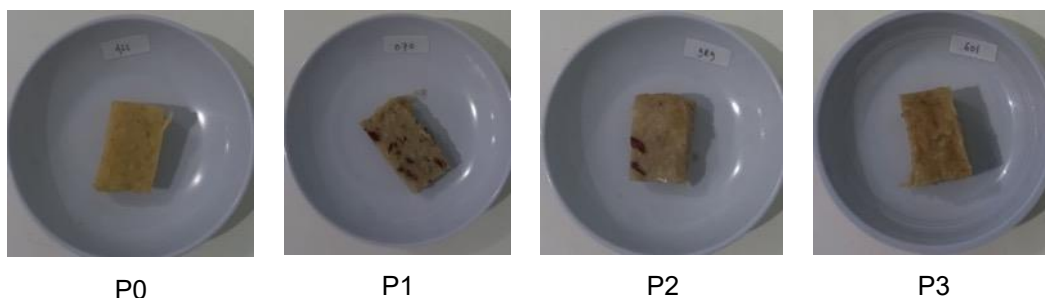

P0 P1 P2 P3

Figure 2. Characteristics of Catfish and Red Bean Snack Nuggets Before Breadcrumb Coating for Each Treatment Level
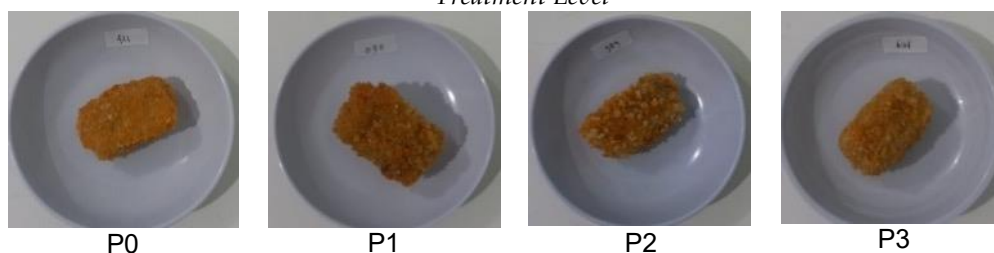

P0 P1 P2 P3

Figure 3. Characteristics of Catfish and Red Bean Snack Nuggets After Breadcrumb Coating for Each Treatment Level

Quantitative Nutritional Analyisis

The nutritional content of the catfish and red bean nugget formulations was analyzed using the Indonesian Food Composition Table rather than proximate laboratory analysis. The Indonesian Food Composition Table outlines the nutritional composition of various food ingredients, including energy, protein, fat, carbohydrates, vitamins, and essential minerals (Aziz, 2022).

The protein content of the nugget formulations ranged from 15.68 to 17.81 g per 100 g, meeting supplementary food standard of 6–18 g per 100 g. This protein content is derived from high-protein ingredients such as chicken, catfish, red beans, and eggs. The high protein levels in supplementary food are expected to support weight gain in toddlers. Studies indicate that high-protein nuggets can significantly enhance weight gain (Veronica & Siregar, 2023).

Table 2. Analysis of Energy and Nutritional Content for Each Treatment Level of Catfish and Red Bean Nugget per 100 g

Nutritional Value	P0	P1	P2	P3	Standard
Energy (kcal)	401,76	366,91	363,43	359,94	300-450
Protein (g)	17,80	15,95	15,82	15,68	6-18
Fat (g)	28,50	22,14	21,55	20,95	7,5 - 29,3
Carbohydrate (g)	18,49	25,94	26,56	27,18	21,5-32,25
Vitamin A(µg)	192,9	100,78	86,40	72,03	40
Phosphorus (mg)	37,52	97,63	99,07	100,51	65
Calcium (mg)	216,29	205,90	206,84	207,78	46
Iron (mg)	2,34	2,69	2,67	2,64	0,7

Note: P0 = Control, P1–P3 = Treatment formulations. Supplementary food standard values refer to Technical Guidelines for Local Supplementary Feeding for Toddlers and Pregnant Women (Ministry of Health, 2023).

The quantitative nutritional quality assessment considered empirical nutrient levels calculated based on the Indonesian Food Composition Table (Ministry of Health, 2019), adjusted to the local supplementary food standards for toddlers aged 24–59 months, as stipulated by the Technical Guidelines for Local Supplementary Feeding for Toddlers and Pregnant Woman and Indonesian Recommended Daily Allowance 2019

The analysis results show that all four nugget formulations (P0, P1, P2, and P3) meet the PMT (Supplementary Food) standards established by the Ministry of Health of Indonesia. All treatment levels exhibited energy content within the range of energy, with protein, fat, carbohydrate also aligning with the standards.

The energy content in each nugget formulation ranged from 359.94 to 401.77 kcal per 100 g, which falls within the recommended range for supplementary food. Adequate energy intake is critical for preventing malnutrition, as insufficient energy consumption triggers the body to utilize energy reserves, such as muscle and fat, leading to impaired growth (Bush, 2015). Energy is essential for sustaining life, supporting growth, and enabling physical activity (Sutrio, 2017).

This finding aligns with research by Santoso (2023), which demonstrated that nuggets made with moringa leaves and catfish positively affected infant weight gain. According to Sundari et al. (2015), fish protein is nutritionally advantageous due to its high digestibility, with protein levels in fish meat ranging from 17–20%.

The fat content in the catfish and red bean nugget formulations ranged from 20.95 to 28.51 g per 100 g, within the range required to ensure adequate fat intake for children. Red beans provide an advantage in fat emulsification compared to carbohydrate-based binders and fillers (Justisia, 2016).

The vitamin A content decreases from 192.9 µg in P0 to 72.03 µg in P3. Despite this reduction, all formulations exceed the minimum standard of 40 µg. Relative to the RDA of 400 µg, P0 provides 48.23%, while P3 provides 18.01%. The high vitamin A is vital for immune function, providing protection to the skin and mucous membranes, supporting antibody production, and contributing to the development of the eyes, ears, heart, skin, hair, bones, mucous membranes, and teeth (Grober, 2012

Iron content, on the other hand, increases substantially from 2.34 mg in P0 to 100.51 mg in P3, exceed the standard of 65 mg. This is primarily attributed to the high iron content of red beans. Iron plays a critical role in cellular energy production, particularly in mitochondrial electron transport during ATP synthesis, and supports immune function. Iron deficiency can lead to appetite loss and growth disturbances in children (Grober, 2012).

Calcium content rises from 37.52 mg in P0 to 100.51 mg in P3, surpassing the standard of 65 mg. In terms of the RDA (650 mg), P0 fulfills 5.77%, while P3 contributes 15.47%. Red beans are a rich source of calcium, which is essential for the mineralization of bones and teeth (Grober, 2012).

Meanwhile, phosphorus content remains consistent across formulations, ranging from 216.29 mg in P0 to 207.78 mg in P3, all exceeding the standard of 46 mg. Compared to the Recommended Daily Allowance (460 mg), P0 fulfills 47%, and P3 contributes 45.17%. Phosphorus is crucial for metabolic energy processes such as ATP formation during protein biosynthesis and contributes to bone mineralization (Grober, 2012).

All formulations of catfish and red bean nuggets meet or exceed the nutritional standards for supplementary feeding. However, as supplementary food products, these nuggets are designed to complement a child's main meals. Thus, while they provide significant contributions to energy and nutrient intake, they are not a substitute for a balanced primary diet but should still ensure that any shortfall in meeting daily requirements is compensated by the main meal. These findings highlight the potential of these formulations to serve as a balanced and nutrient-rich food source for toddlers. This in accordance with the statement that Supplementary Feeding (PMT) is designed to provide additional nutrition and is not intended to replace main meals.

It serves to complement the daily diet, ensuring that nutritional needs are met alongside regular food intake (Kemenkes, 2023)

Organoleptic Analysis

The organoleptic testing of the catfish and red bean nuggets involved a hedonic test to evaluate preferences based on attributes such as color, aroma, taste, and texture. This process included 25 semi-trained panelists, consisting of dietitian students from Poltekkes Kemenkes Malang, who provided subjective assessments for each attribute. Organoleptic testing, also known as sensory evaluation, uses human senses as the primary tool to measure product acceptance, including sight, smell, taste, and touch (Gusnadi et al., 2021).

The results of the organoleptic testing revealed several key aspects of the sensory quality of the nuggets. Figure 4 illustrates the mode for each attribute based on panelist assessments, highlighting differences among the formulations.
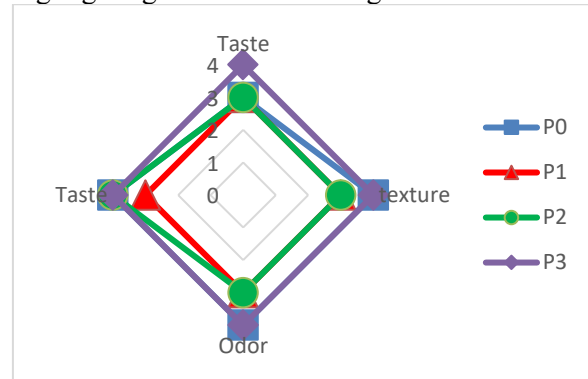

Figure 4. *Mode of Organoleptic Test Results for Catfish and Red Bean Nugget Formulations*

The results showed that increasing the proportion of catfish improved panelist acceptance, with formulation P3 achieving the highest ratings. The soft texture of the catfish and its non-fishy taste contributed to the panelists' preference. The statistical analysis results are summarized in Table 3, which includes the modes and statistical significance for all sensory attributes

Table 3. Mode and Statistical Analysis of Organoleptic Test Results

Treatment Levels	Taste		Texsture		Aroma		Color	
	Mode	p-value	Mode	p-value	Mode	p-value	Mode	p-value
P0	3[ac]	0,001	4[a]	0,004	4[ab]	0,011	4[a]	0,000
P1	3[b]		3[b]		3[a]		3[b]	
P2	3[ab]		3[b]		3[a]		4[a]	
P3	4[c]		4[a]		4[b]		4[a]	

Note: Modes with different superscript letters (a, b, c) indicate significant differences ($\alpha = 0.05$).

The Kruskal-Wallis test revealed significant differences among the formulations (P0, P1, P2, and P3) for taste, texture, aroma, and color. The control (P0) and treatment P3 received the highest overall acceptance from the panelists.

a. Color

Color is a crucial element in product appeal and can significantly influence consumer perceptions of quality and freshness (Dewi et al., 2020). The organoleptic results showed that P2 and P3 were the most preferred in terms of color, attributed to their visually appealing golden-brown appearance. This color was influenced by the frying process, flame intensity, and the use of breadcrumbs as an outer coating (Johan, 2014).

The Kruskal-Wallis test indicated a significant difference in color preference among the treatments with p-value = 0,000 ($p < 0.05$). The Mann-Whitney post-hoc test showed no significant differences ($p > 0.05$) between P0 and P2 or between P2 and P3.

However, significant differences ($p < 0.05$) were found between P1 and the other treatments, indicating that panelists preferred the golden-brown hues in P2 and P3, enhanced by red bean flour substitution (Reddy et al., 2013).

b. Aroma

Aroma plays a vital role in food acceptance by stimulating the sense of smell (Arzaqina et al., 2021). P3 received the highest aroma ratings, likely due to the higher catfish proportion and the use of spices such as garlic and pepper, which masked any fishy odors.

The Kruskal-Wallis test showed significant differences in aroma ($p = 0.011$). Mann-Whitney tests revealed significant differences between P3 and P1 and P2, but no significant differences among P0, P1, and P2. The spices effectively enhanced the aroma, supporting findings by Afrisanti (2010) that aroma is influenced by the main ingredients, additives, and spices used in food products.

c. Texture

Texture is a key factor in food acceptance, influencing how a food product feels when handled or eaten (Winarno in Thalib, 2011). The soft and cohesive texture of P3 was the most favored among the panelists.

The Kruskal-Wallis test showed significant differences in texture ($p = 0.004$), with post-hoc Mann-Whitney analysis confirming significant differences between P0, P1, and P3. Higher red bean flour content in P1 and P2 contributed to a firmer texture due to starch gelatinization and dehydration during frying, forming a more rigid gel structure (Pangastuti et al., 2013).

d. Taste

Taste is the most critical factor in determining food acceptance (Saputra et al., 2015). P3, with the highest catfish proportion, was the most liked by the panelists for its savory flavor. Frying enhances taste by creating desirable flavors and textures (Jonshon et al., 2016; Mansyur, 2022).

The Kruskal-Wallis test showed significant differences in taste ($p = 0.001$). Mann-Whitney tests indicated that P3 did not differ significantly from P0, highlighting the similarity in their taste appeal. The addition of catfish and balanced seasoning contributed to P3's preferred taste profile.

Best Treatment Analysis

The determination of the best treatment was carried out by considering the role of key variables that influence the quality of catfish and red bean nugget products as Supplementary Food for wasted children. This assessment was conducted by semi-trained panelists who assigned weights to each variable. Based on the evaluation, the taste variable ranked first as the most important factor in determining product quality. The second rank was occupied by the protein content variable, while the texture of the nuggets ranked third. The ranking of the other variables can be found in the appendix.

The determination of the best treatment for the catfish and red bean nugget product was conducted through an effectiveness index calculation. This process involved determining the best and worst values for each variable in each treatment, resulting in one product identified as the best treatment. The calculated values for each treatment can be seen in Table 4

Table 4. Best Treatment for Catfish and Red Bean Nugget Formulation

Treatment	OV Total	Rank
P0	0,449	III
P1	0,247	IV
P2	0,480	II
P3	0,884	I

The treatment with the highest overcome value was considered the best, as it included evaluations from various variables affecting product quality. These variables include nutrients such as energy, protein, fat, and carbohydrates, as well as sensory aspects such as color, aroma, texture, and taste. Based on the data in the table, the treatment with the highest overcome value (OV) was P3, consisting of 41% catfish, 32% chicken, and 27% red beans, with OV of 0.884.

Table 5. Characteristics of Catfish and Red Bean Nuggets in Treatment P3

Characteristics	Results	Standard	Description
Energy (kcal)	359,94	300-450	Meets standard
Protein (g)	15,67	6-18	Meets standard
Fat (g)	20,94	7,5-29,3	Meets standard
Carbohydrate (g)	27,17	21,5-32,25	Meets standard
Vitamin A(μg)	72,03	40	Exceeds standard
Iron (mg)	2,64	0,7	Exceeds standard
Calcium (mg)	207,78	46	Exceeds standard
Phosphorus (mg)	100,51	65	Exceeds standard
Taste	Savory	-	Highly preferred
Texture	Chewy	-	Highly preferred
Aroma	Non-fishy	-	Highly preferred
Color	Golden brown	-	Highly preferred

Note: Food Composition Standards based on the Technical Guidelines for Providing Local Complementary Foods for Toddlers and Pregnant Women (2023) and AKG 2019.

In this study treatment P3 stands out in terms of acceptance for taste and texture. The dominant savory taste and chewy texture in this treatment are due to the high content of catfish in its composition. Compared to other treatments, P3 has the most favorable taste and texture profile according to the panelists.

Nutritionally, P3 also shows advantages. The energy quality of this treatment is 359.94 kcal, with 15.67 grams of protein, 20.94 grams of fat, and 27.17 grams of carbohydrates. This nutritional composition is very close to the median standard for Complementary Foods (PMT) for toddlers aged 24-59 months. This means that treatment P3 is not only superior organoleptically but also in meeting the essential nutritional requirements for toddler growth and development.

Notably, Treatment P3 exceeds the standard for micronutrients such as vitamin A, iron, calcium, and phosphorus. Vitamin A content is 72.03 μg, surpassing the required 40 μg. Iron (2.64 mg) exceeds the 0.7 mg requirement, contributing to improved iron stores and preventing iron deficiency, which is a common issue in toddlers (Bhutta et al., 2008). Similarly, calcium (207.78 mg) and phosphorus (100,51 mg) levels are well above their respective standards, supporting bone health and overall growth (Imdad & Bhutta, 2012).

This finding is in line with the research conducted by Sappu et al. (2014), which stated that ranking assessments are influenced by consumer acceptance levels. The ranking values tend to decrease as the amount of flour substitution increases. This decline is due to the additional substitute flour, which can reduce consumer acceptance of the intensity of the evaluated properties such as color, taste, aroma, and texture.

CONCLUSIONS

In this study, the formulation of nuggets with modified proportions of catfish and red beans showed significant differences in all organoleptic parameters, including taste, texture, aroma, and color.

The modification of treatment P3 (41% catfish : 32% chicken meat : 27% red beans) was the best treatment, with a overcome value of 0.884 and nutrient content per 100 grams, which included 359.94 kcal of energy, 15.67 grams of

protein, 20.94 grams of fat, and 27.17 grams of carbohydrates. Based on statistical tests, the control treatment (P0) and treatment P3 received the highest acceptance from the panelists, with no significant difference between P0 and P3.

For future researchers, it is recommended to pay attention to the use of cooking oil during the frying process and the precise frying time, in order to improve the appearance and color of the catfish and red bean nuggets after frying.

Contains things that state the relationship between the variables studied and suggestions. Made in one paragraph, not in bullet points.

ACKNOWLEDGEMENTS

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