



Functional dried noodles with snakehead fish and yellow sweet potato flour to support stunting prevention

Mie kering fungsional dengan tepung ikan gabus dan ubi jalar kuning untuk mendukung pencegahan stunting

Permana Agung^{1*}, Hijrah Asikin², Thresia Dewi Kartini B³, Sirajuddin⁴, Mustamin⁵, Kurnia Taqwa⁶

¹ Nutrition and Dietetics Study Program Applied Bachelor Program, Nutrition Major, Polytechnic of Health of Ministry of Health Makassar, South Sulawesi, Indonesia.

E-mail: pagung171717@gmail.com

² Nutrition Major, Polytechnic of Health of Ministry of Health Makassar, South Sulawesi, Indonesia.

E-mail: hijrashasikin@poltekkes-mks.ac.id

³ Nutrition Major, Polytechnic of Health of Ministry of Health Makassar, South Sulawesi, Indonesia.

E-mail: thresiadewikartini@poltekkes-mks.ac.id

⁴ Nutrition Major, Polytechnic of Health of Ministry of Health Makassar, South Sulawesi, Indonesia.

E-mail: sirajuddin@poltekkes-mks.ac.id

⁵ Nutrition Major, Polytechnic of Ministry of Health Makassar, South Sulawesi, Indonesia.

E-mail: mustamin@poltekkes-mks.ac.id

⁶ Nutrition and Dietetics Study Program Applied Bachelor Program, Nutrition Major, Polytechnic of Health of Ministry of Health Makassar, South Sulawesi, Indonesia.

E-mail: kurniataqwa18@gmail.com

*Correspondence Author:

Nutrition Major, Polytechnic of Ministry of Health Makassar. Jalan Paccerrakkang KM.14, Kecamatan Biringkanaya, Makassar, Sulawesi Selatan, Indonesia.

E-mail: hijrashasikin@poltekkes-mks.ac.id

Article History:

Received: July 02, 2025; Revised: July 25, 2025; Accepted: August 12, 2025; Published: December 13, 2025.

Publisher:



Politeknik Kesehatan Aceh
Kementerian Kesehatan RI

© The Author(s). 2025 **Open Access**

This article has been distributed under the terms of the *License Internasional Creative Commons Attribution 4.0*



Abstract

Stunting is a chronic nutritional problem caused by a prolonged inadequate intake of nutrients, particularly protein and iron. Its management requires local food innovations that are nutrient-dense, acceptable, and affordable. Dried noodles substituted with snakehead fish flour and yellow sweet potato flour have the potential to increase energy density and essential nutrient content, making them a viable alternative for local supplementary feeding (PMT) in children at risk of stunting. This study aimed to determine the chemical characteristics and organoleptic properties of dried noodles. A pre-experimental design was used, with one control formula and three treatment formulas, conducted at the Food Technology and Organoleptic Laboratory, Poltekkes Kemenkes Makassar, and the Feed Chemistry Laboratory, Hasanuddin University (June 2023–March 2024). The energy, protein, carbohydrate, iron, zinc, and vitamin C contents were analyzed in duplicate, and organoleptic testing was performed by 50 semi-trained panelists. Significant differences were observed in protein, iron, carbohydrate, color, and taste ($p < 0.05$), but not in energy, zinc, vitamin C, or texture ($p > 0.05$). In conclusion, formula F3 was the best, containing 340.30 kcal/100 g energy, 21.92% protein, 65.67 g/100 g carbohydrate, 4.10 mg/100 g iron, 3.17 mg/100 g zinc, and 49.24 mg/100 g vitamin C.

Keywords: Snakehead Fish Flour, Yellow Sweet Potato Flour, Dried Noodle, Stunting, Functional Food

Abstrak

Stunting adalah masalah gizi kronis akibat kekurangan asupan zat gizi, terutama protein dan zat besi, dalam jangka panjang. Penanganannya memerlukan inovasi pangan lokal yang padat gizi, mudah diterima, dan terjangkau. Mie kering dengan substitusi tepung ikan gabus dan tepung ubi jalar kuning berpotensi meningkatkan kerapatan energi serta kandungan zat gizi esensial, sehingga dapat menjadi alternatif Pemberian Makanan Tambahan (PMT) lokal bagi anak berisiko stunting. Tujuan penelitian ini untuk mengetahui karakteristik kimia dan sifat organoleptik mie kering dengan substitusi tepung ikan gabus dan tepung ubi jalar kuning. Penelitian pra-eksperimen ini menggunakan satu formula kontrol dan tiga formula perlakuan, dilakukan di Laboratorium Teknologi Pangan dan Organoleptik Poltekkes Kemenkes Makassar serta Laboratorium Kimia Pakan Universitas Hasanuddin (Juni 2023–Maret 2024). Analisis kandungan energi, protein, karbohidrat, zat besi, seng, dan vitamin C dilakukan dua kali pengulangan, serta uji organoleptik melibatkan 50 panelis agak terlatih. Hasil menunjukkan perbedaan signifikan pada protein, zat besi, karbohidrat, warna, dan rasa ($p < 0,05$), namun tidak pada energi, seng, vitamin C, dan tekstur ($p > 0,05$).

Kesimpulan, formula F3 menjadi terbaik dengan energi 340,30 kkal/100 g, protein 21,92%, karbohidrat 65,67 g/100 g, zat besi 4,10 mg/100 g, seng 3,17 mg/100 g, dan vitamin C 49,24 mg/100 g.

Kata Kunci: Tepung Ikan Gabus, Tepung Ubi Jalar Kuning, Mi Kering, Stunting, Makanan Fungsional

Introduction

Advancements in fortified food products, food ingredient substitutions using local nutrient-dense foods, supplementary feeding programs, and food processing technologies have not necessarily resulted in a significant reduction in the prevalence of stunting in Indonesia. One persistent nutritional problem is stunting, defined as a child's length or height-for-age being below the standard for a given age (Kemenkes RI, 2020a). Stunting increases the risk of chronic diseases in adulthood and negatively affects productivity (Bappenas, 2018).

The World Health Organization (WHO) reported that in 2022, 22.3% of children under five years of age worldwide were stunted (WHO, 2023). In Indonesia, the 2024 Indonesian Nutrition Status Survey showed a prevalence of 19.6%, with South Sulawesi reaching 23.2% (Kemenkes RI, 2025), both exceeding the national target of 14% set in the National Medium-Term Development Plan (Bappenas, 2020). The persistence of stunting suggests that existing interventions have been suboptimal, partly because of the low acceptability of supplementary foods, economic constraints, and underutilization of local food resources. South Sulawesi is a priority region for stunting mitigation not only because of its high prevalence but also because of its abundant nutrient-rich local commodities, notably *Channa striata* (snakehead fish) and *Ipomoea batatas L.* (yellow sweet potato), which can be exploited as raw materials for functional food products.

Stunting primarily results from chronic, inadequate nutrient intake (Sumartini, 2022). Stunting primarily results from chronic inadequate nutrient intake (Sumartini, 2022). Prevention and treatment require sufficient macronutrients (carbohydrates, proteins, and fats) and micronutrients such as iron (Fe) and zinc (Zn). Energy intake is critical for growth, metabolism, physical activity and thermoregulation (Fonnie et al., 2023). Inadequate energy intake over time leads to chronic energy deficiency, which impairs growth (Diniyah & Nindya, 2017).

Iron plays a pivotal role in cognitive development (Aurora, 2021), whereas zinc is essential for growth hormone activation, immune function, and antioxidant defense (Hidayati et al., 2019). However, stunted children often experience iron and zinc deficiency. This is due to the inhibition of iron and zinc absorption. Therefore, nutrients are required to facilitate the absorption of Fe and Zn (Maares & Haase, 2020; Piskin et al., 2022).

Government strategies to address stunting include supplementary feeding for children aged 6–24 months (Kemenkes RI, 2023a). The integration of culturally acceptable, nutrient-rich foods can enhance the program's impact. Noodles are a viable vehicle, as 21.3% of Indonesian children aged 0–59 months consume them (Balitbangkes, 2014). Substituting wheat flour with snakehead fish and yellow sweet potato flour can increase the nutritional value of the product.

Snakehead fish are abundant in South Sulawesi, with a production volume of 2,382.5 tons in 2020 (Dinas Kelautan & Perikanan Sulsel, 2021). Flour processing extends its shelf life and facilitates its incorporation into food products. Snakehead fish flour is rich in Fe (0.9%) and Zn (0.42%) (Nadimin & Lestari, 2019). Yellow sweet potatoes are also widely available, with 49,535 tons produced in 2021 (Kementerian Pertanian RI, 2022). Yellow sweet potatoes are generally known as a source of carbohydrates and contain carotenoids, it turns out that yellow sweet potatoes also contain vitamin C. The vitamin C content of yellow sweet potatoes is 21 mg per 100 g (Kemenkes RI, 2020b).

Vitamin C is a water-soluble vitamin that aids iron absorption (Kamaruddin et al., 2023). Vitamin C reduces ferrous iron to ferrous ions in the small intestine, allowing easy absorption (Hardinsyah et al., 2016). Umasangaji et al. (2023) showed that adding yellow sweet potatoes to nugget formulas increased vitamin C content.

Yulianti (2018) formulated dried noodles with 10% wheat flour, 70% sweet potato flour, and 20% skipjack fish meal, which had the

highest sensory preference. However, its limitations include a strong fish aroma and altered texture due to the high sweet potato content, potentially reducing its acceptability among children. These findings highlight the necessity of optimizing formulations to balance nutritional enhancement and sensory quality. The results of this study motivate researchers to conduct dry noodle research with the substitution of yellow sweet potato flour at 30%, 25%, and 20%, and snakehead fish meal at 5%, 10%, and 15%.

The sustained high prevalence of stunting in South Sulawesi, despite ongoing interventions, reflects the inadequacies of current approaches to address macro- and micronutrient deficiencies, particularly in energy, iron, and zinc. Given the widespread consumption of noodles and the availability of nutrient-rich local raw materials, the development of enriched dried noodles represents a feasible and culturally compatible intervention. This study aimed to evaluate the chemical composition and organoleptic properties of dried noodles formulated with snakehead fish flour and yellow sweet potato flour, with the objective of producing a functional food product that could contribute to reducing efforts in Indonesia.

Methods

This pre-experimental study had a one-shot study case design consisting of a standard

formula and three treatment formulas with varying wheat flour concentrations of snakehead fish flour: yellow sweet potato flour F1 (65%:5%:30%), F2 (65%:10%:25%), and F3 (65%:15%:20%). The concentration ranges (5–15% fish meal and 20–30% sweet potato flour) were selected based on prior studies and preliminary trials aimed at balancing sensory acceptability and nutritional enhancement of the feed. All formulas were analyzed for energy (bomb calorimeter), protein (micro Kjeldahl), carbohydrate (Luff method), iron and zinc (Atomic Absorption Spectrophotometry), and vitamin C (iodometric titration). Organoleptic testing was conducted with 50 moderately trained panelists using a 5-point hedonic scale and a blind testing protocol. A blind testing protocol was applied to minimize bias, and the instrument used for sensory assessment was validated through expert review and Confirmatory Factor Analysis (CFA), confirming model fit ($p > 0.05$), in line with (Sugiyono, Mardapi, and Suryadarma, 2017). The internal consistency was strong (Cronbach's $\alpha = 0.83$), indicating the reliability and suitability of the tool for evaluating sensory acceptability of the food. The research was conducted from June 2023-March to 2024 at the Department of Nutrition of the Polytechnic of Health of the Ministry of Health Makassar and the Laboratory of Animal Food Chemistry of the Department of Nutrition and Animal Feed, Faculty of Animal Husbandry, Hasanuddin University.

Tools and Materials

Table 1. List of materials of Dried Noodles with Snakehead fish Flour and Yellow Sweet Potato Flours Substitution

Materials	Material Weight			
	F ₀	F ₁	F ₂	F ₃
Wheat flour for dough (g)	475	300	300	300
Wheat flour for a sprinkle of noodle strands (g)	25	25	25	25
Yellow sweet potato flour (g)	0	150	125	100
Snakehead fish flour (g)	0	25	50	75
Water for dough (ml)	200	200	200	200
Garlic (g)	25	25	25	25
Egg (g)	100	100	100	100
Oil (g)	5	5	5	5
Baking soda (g)	5	5	5	5
Salt (g)	5	5	5	5

Modification : (Yulianti, 2018)

The tools used included scales, basins, glasses, bowls, graters, tablespoon knives, stoves, steamers, flour sieves, aluminum foil,

brushes, roll presses, cabinet dryers, pens, and organoleptic questionnaires.

Making Snakehead Fish Flour

A total of 5500 g of snakehead fish was cleaned by removing the head and entrails, cut into pieces, and washed with clean water, which was repeated three times. The snakehead fish were marinated for 2 h using 125 ml of lime juice and 187 g of ginger, which had been mashed with 250 ml of water. The mixture was then washed to remove the attached ginger fibers. The fish was then steamed for 30 min with steaming water using 500 g of lemongrass and 125 g of galangal that had been mashed with 500 mL of water, and 2 liters of water was added. Once cooked, the flesh of the snakehead fish is separated from the bones, fins, and skin. The fish was then squeezed to remove the remaining water. The snakehead fish meat was dried at 60°C for 8 h using a cabinet dryer (every two hours, the pan was rotated horizontally 180°, and the arrangement of the pan was exchanged every two hours to dry evenly). Dried snakehead fish (535 g) were ground using a grinder and sieved (80 mesh) to obtain 511 g of flour.

Making Yellow Sweet Potato Flour

The yellow sweet potatoes were weighed, washed thoroughly with three changes of water, drained, and then grated to a thickness of ± 1 mm. The grated yellow sweet potato was soaked in water for 30 min, blanched for 10 min, and then drained for 5 min. Subsequently, the baking sheet was sprinkled evenly with 500 g per 1 baking sheet and dried using a cabinet dryer at a temperature of 60°C for 10 h. The dried yellow sweet potato was left for 15 min and then ground or pulverized using a grinder and sifted (80 mesh) until it became flour.

Making Dried Noodles

Dry noodles were prepared by substituting snakehead fish and yellow sweet potato flour with wheat flour, yellow sweet potato flour, snakehead fish flour, salt, grated garlic, and beaten eggs, which were mixed and stirred well. The baking soda solution was gradually added while the mixture was kneaded. Subsequently, the dough was allowed to rest for 30 min and was kneaded again. The dough was thinned using a roll press and molded with a noodle maker to form noodle strands. The strands of noodles were sprinkled with flour to prevent them from sticking together and then printed into a box-shaped aluminum foil. The noodles

were steamed for 10 min in an oiled saucepan. The noodles were allowed to stand at room temperature for 10 min before weighing. The noodles were dried using a cabinet dryer at 60°C for 10 h.

Data Processing and Analysis

The data on energy, protein, carbohydrate, iron, zinc, and vitamin C levels obtained from laboratory analysis were processed by dividing each analysis data by 10 to produce the energy, protein, carbohydrate, iron, zinc, and vitamin C levels of dried noodles in 100 g. The data were then processed manually using a computer with Microsoft Excel 2019 and IBM Statistical Product and Service Solutions (SPSS) version 26 for Windows. Energy, protein, carbohydrate, iron, zinc, and vitamin C content data were first tested for normality using the Shapiro-Wilk test. The data were normally distributed, and a parametric test, namely, one-way ANOVA, was used. If there was a significant difference, a further test was carried out, namely, the Duncan test. Data from organoleptic tests on acceptability were tabulated in tabular form, and normality tests were performed. Data on the acceptability of color, texture, and taste were not normally distributed; therefore, the Kruskal-Wallis nonparametric test was conducted. The results of the Kruskal-Wallis test in terms of color and taste showed a significant difference; therefore, the Mann-Whitney test was continued.

Result and Discussion

The data in this study were obtained from chemical and organoleptic analyses. Chemical analysis included measurements of energy, protein, carbohydrates, iron, zinc, and vitamin C, which are essential macronutrients and micronutrients that support optimal growth and development of the children. Organoleptic analysis assesses consumer acceptance based on color, texture, and taste, which are critical factors for ensuring compliance with product consumption. The integration of these parameters is particularly relevant in the context of stunting prevention because adequate nutritional content must be accompanied by acceptable sensory characteristics to promote a consistent dietary intake. By evaluating both nutritional quality and sensory acceptance, this

study provides evidence-based insights into the development of fortified dried noodle products that can serve as locally accessible and culturally acceptable complementary foods in stunting-reduction programs.

Chemical Analysis

Energy

The results of the analysis of the energy content of dry noodles obtained from the Kruskal-Wallis test with p value $0.104 > 0.05$, indicate that H_0 is accepted, so there is no significant difference between treatments F0, F1, F2, and F3. A descriptive test showed that the energy content increased significantly with the use of decreased concentrations of yellow sweet potato flour and increased concentrations of snakehead fish. The energy content of F0 with flour concentrations of 65%, 30%, and 5% (500 g wheat flour, 0 g snakehead fish flour, and 0 g yellow sweet potato flour) decreased by 14.85% compared to that of F1. The energy content of F1 with flour concentrations of 65%, 30%, and 5% (325 g wheat flour, 25 g snakehead fish flour meal, and 150 g yellow sweet potato flour) increased by 0.6% compared to F2 and increased by 1.95% from F2 to F3 with a flour concentration of 65%: 20%: 15% (325 g wheat flour, 75 g snakehead fish flour, and 100 g yellow sweet potato flour).

Analysis of the energy content of the dried noodles showed that F3 dried noodles had the highest energy content, with an average value of 340.3 kcal per 100 g, and F1 had the lowest energy content, with an average value of 337.75

kcal per 100 g. This was due to the higher concentration of wheat flour compared to snakehead fish and yellow sweet potato flours. This is because the concentration of wheat flour was higher than that of the snakehead fish and yellow sweet potato flours. Wheat flour contributed an energy content of 333 kcal per 100 g, whereas the energy content of yellow sweet potato was only 119 kcal per 100 g.

In addition to wheat flour and yellow sweet potato flour, snakehead fish also contributed to the energy content of the F3 dry noodles, which was 80 calories per 100 g. This study is consistent with that of Alif et al. (2019), who found that substituting yellow sweet potato flour and soybean sprout flour did not significantly affect the energy content of donuts.

The 2019 Recommended Dietary Allowance (RDA) (Kemenkes RI, 2019) states that the daily energy requirement for the 1-3 years age group is 1350 kcal. The portion of the main meal is 25%; therefore, the total requirement for children aged 1-3 years is 337.5 kcal. One serving of dried noodles, as recommended by Kemenkes RI (2023b), was 50 g, but dried noodles with substitutions of snakehead fish flour and yellow sweet potato flour in F3 produced 45 g servings. The energy contribution of dried noodles with the substitution of snakehead fish flour and yellow sweet potato flour at concentration F3 (the best concentration) was 153.13 kcal. To fulfill the energy requirement of 337.5 kcal per main meal, 99.18 g of dried noodles must be consumed.

Table 2. Results of Chemical Characteristics of Dried Noodles with Substitution of Snakehead fish Flour and Yellow Sweet Potato Flour

Chemical Characteristics	Treatment				p-value
	F0 (Mean \pm SD)	F1 (Mean \pm SD)	F2 (Mean \pm SD)	F3 (Mean \pm SD)	
Energy (kcal/100 g)	352.60 \pm 1.41 ^a	337.75 \pm 0.21 ^a	338.35 \pm 0.91 ^a	340.30 \pm 0.70 ^a	0.104
Protein (%)	12.58 \pm 0.26 ^a	13.47 \pm 0.02 ^b	18.39 \pm 0.13 ^c	21.92 \pm 0.18 ^d	0.000
Carbohydrate (g/100 g)	76.47 \pm 0.07 ^a	73.69 \pm 0.98 ^b	68.89 \pm 0.04 ^c	65.67 \pm 0.32 ^d	0.000
Iron (mg/100 g)	1.90 \pm 0.13 ^a	2.16 \pm 0.10 ^a	3.42 \pm 0.22 ^b	4.10 \pm 0.14 ^c	0.000
Zinc (mg/100 g)	3.02 \pm 0.12 ^a	3.05 \pm 0.12 ^a	3.15 \pm 0.16 ^a	3.17 \pm 0.07 ^a	0.560
Vitamin C (mg/100 g)	50.28 \pm 0.56 ^a	52.52 \pm 1.23 ^a	46.55 \pm 2.61 ^a	49.24 \pm 0.81 ^a	0.071

Note: Numbers with the same notation in the same row were not significantly different ($p > 0.05$)

F0: standard formula, F1 (65% wheat flour, 5% snakehead fish flour, 30% yellow sweet potato flour), F2 (65% wheat flour:10% snakehead fish flour:20% yellow sweet potato flour), and F3 (65% wheat flour:15% snakehead fish flour:20% yellow sweet potato flour).

Protein

The results of the analysis of the protein content of dry noodles with substitutions of snakehead

fish flour and yellow sweet potato flour showed that F3 dry noodles had the highest protein content, with an average value of 21.92 g per

100 g, and F0 dry noodles had the lowest protein content, with an average value of 12.58 g per 100 g. These values met the SNI standard $\geq 10\%$ (SNI 8217:2015). This value met the SNI standard of $\geq 10\%$ (SNI 8217:2015). This study is consistent with that of Damayati et al. (2018), who stated that the lower the addition of yellow sweet potato flour, the higher the protein content of muffins. The protein source is mostly from snakehead fish flour, which has a high-quality protein content of 73.81 g (Nadimin & Lestari, 2019).

The ANOVA test result of $0.000 < 0.05$ means that H_0 is rejected, so there is a significant difference in treatment (F0, F1, F2, and F3) in the protein content of dried noodles with the substitution of snakehead fish flour and yellow sweet potato flour. Duncan's test was conducted to further explore which group was significant. Duncan's test results showed that the protein content of F0 was significantly different from those of F1, F2, and F3. The protein content of F1 was significantly different from that of F0, F2, and F3. The protein content of F2 was significantly different from that of F0, F1, and F3. The protein content of F3 was significantly different from that of F0, F1, and F2.

The 2019 Recommended Dietary Allowance (RDA) (Kemenkes RI, 2019) states that the daily protein requirement for the 1-3 year old age group is 20 g. The portion of the main meal is approximately 25% per meal, so the total protein requirement for children aged 1-3 years is 5 g per meal. One serving of dried noodles recommended by Kemenkes RI (2023b) was 50 g, but dried noodles with substitutions of snakehead fish flour and yellow sweet potato flour in F3 produced 45 g per serving. The protein contribution of dried noodles with the substitution of snakehead fish flour and yellow sweet potato flour at an F3 concentration of 9.86 g. To fulfill the protein requirement of 5 g per serving. To fulfill the protein requirement of 5 g per main meal, 22.81 g of dried noodles must be consumed.

Carbohydrate

The ANOVA test result of $0.000 < 0.05$ means that H_0 is rejected, so there is a significant difference in treatment (F0, F1, F2, and F3) on the carbohydrate content of dried noodles with substitution of snakehead fish flour and yellow sweet potato flour. Duncan's test was conducted

to further explore which group was significant. Duncan's test results showed that the carbohydrate content of F0 was significantly different from those of F1, F2, and F3. The carbohydrate content of F1 was significantly different from those of F0, F2, and F3 groups. The carbohydrate content of F2 was significantly different from those of F0, F1, and F3. The carbohydrate content of F3 was significantly different from those of F0, F1, and F2.

The results of the analysis of the carbohydrate content of dry noodles with the substitution of snakehead fish flour and yellow sweet potato flour showed that F0 dry noodles had the highest carbohydrate content, with an average value of 76.47 g per 100 g, and F3 dry noodles had the lowest carbohydrate content, with an average value of 65.68 g per 100 g. This study is consistent with that of Milanti et al. This study is in line with that of Milanti et al. (2022), who stated that the addition of yellow sweet potato flour increases the carbohydrate content of biscuits. This study is also in line with the research conducted by Efendi et al. (2022), who found that the carbohydrate content increased with an increase in the concentration of wheat flour used in the manufacture of wet noodles formulated with yellow sweet potato flour and carrot filtrate. The increase in carbohydrates was influenced by the higher concentration of wheat flour, which contributes the most carbohydrates. The carbohydrate content of wheat flour is 77.2 g per 100 g (Kemenkes RI, 2020b). Apart from wheat flour, snakehead fish flour and yellow sweet potato flour also contributed carbohydrates to dry noodles with substitutions of snakehead fish flour and yellow sweet potato flour, namely 2.6 g per 100 g and 25.1 g per 100 g, respectively (Kemenkes RI, 2020b).

The 2019 Recommended Dietary Allowance (RDA) (Kemenkes RI, 2019) states that the daily carbohydrate requirement for the 1-3 years age group is 215 g. The portion of the main meal is approximately 25% per meal, so the total carbohydrate requirement for children aged 1-3 years is 53.75 g per meal. One serving of dried noodles recommended by Kemenkes RI (2023b) was 50 g, but dried noodles with substitutions of snakehead fish flour and yellow sweet potato flour in F3 produced 45 g per serving. The carbohydrate contribution of dry noodles with the substitution of snakehead fish

flour and yellow sweet potato flour at concentration F3 (the best concentration) was 29.56 g. To fulfill the carbohydrate requirement of 53.75 g per main meal, the amount of dried noodles that must be consumed is 81.83 g.

Iron

The results showed significant differences in the iron content of the dried noodles (F0, F1, F2, and F3) ($p = 0.000$). Next, to further investigate which groups had significant differences, a follow-up test was conducted using Duncan's test. Duncan's test showed that the iron content of F0 was significantly different from that of F2 and F3, but not significantly different from that of F1. The iron content of F1 was significantly different from that of F2 and F3 but not significantly different from that of F0. The iron content of F2 was significantly different from that of F0, F1, and F3 samples. The iron content of F3 was significantly different from that of F0, F1, and F2.

F0 dry noodles had the lowest iron content, with an average value of 1.9 mg/100 g, whereas F3 dry noodles had the highest iron content, with an average value of 4.10 mg/100 g. This is due to the iron content of fishmeal. This is due to the iron content of snakehead fish flour, which is 9 mg/100 g (Nadimin & Lestari, 2019) This is because the iron content of cork fish flour, which is 9 mg/100 g and yellow sweet potato flour, which is 9.7 mg/100 g (Rahmawati et al., 2015) is higher than wheat flour, which is 1.3 mg/100 g (Kemenkes RI, 2020b).

The results of this study also showed an increase in iron levels at each concentration of dried noodles, with a percentage increase between F0 and F1, 13.87% between F1 and F2 by 58.01%, and 19.96% between F2 and F3. This is in line with research conducted by Nadimin and Lestari (2019), who found that the addition of snakehead fish flour, especially iron, can increase the nutritional value of local snacks and meet the Recommended Dietary Allowance (RDA) of children under five.

This study is not in line with the research conducted by Lusiana et al. (2023) showed that the iron content of the three snack bar formulations of snakehead fish flour with the addition of peanuts was not significantly different. The highest iron content was in snack bar F3 with a ratio of snakehead fish (40): peanut (60), which was 0.94 g / 100 g and the lowest in snack bar F2 with a ratio of snakehead

fish (60): peanut (40). This research is also not in line with the research conducted by Damayati et al. (2018), who found that the iron content in all yellow sweet potato muffin formulations decreased the iron content. The highest iron content was in the control muffin (100:0) (wheat flour 100: yellow sweet potato 0), which was 1.13 $\mu\text{g/g}$, and the lowest was in the muffin formulation 60:40 (wheat flour 60: yellow sweet potato 40), which was 0.56 $\mu\text{g/g}$.

The 2019 Recommended Dietary Allowance (RDA) (Kemenkes RI, 2019) states that the daily iron requirement for the 1-3 years age group is 7 mg/day. The portion of the main food is approximately 25%; therefore, the total iron requirement for the 1-3 year age group is 1.75 mg/meal. Iron intake of 25 % for children aged 1-3 years for the main meal will be met if children consume 42.673 g of dry noodles with 15% cork fish meal substitution and 20% yellow sweet potato flour. One serving of dried noodles was 50 g (Kemenkes RI, 2023b); however, in this study, dried noodles at concentration F3, which was the best concentration organoleptically, produced 45 g per serving. The iron contribution of 45 g of dried noodles at concentration F3 is 1.845 mg; therefore, it can fulfill the iron requirement for the main food portion per meal (25% of the daily requirement) with a sufficiency of 105.43%.

Zinc

The results of this study showed that there was no significant difference between the treatments (F0, F1, F2, and F3) in the zinc content of the dried noodles ($p = 0.560 > 0.05$ at a significance level of 5%). The substitution of snakehead fish flour and yellow sweet potato flour had no effect on the zinc content of dried noodles because the zinc content in wheat flour is higher (2.8 mg/100 g) (Kemenkes RI, 2020b) than that in yellow sweet potato flour (0.614 mg/100 g) (Rahmawati et al., 2015) but lower than that in cork fish flour (4.2 mg/100 g) (Nadimin & Lestari, 2019).

The results of this study also showed that there was an increase in zinc levels at each concentration of dried noodles, with a percentage increase between F0 and F1, 0.91% between F1 and F2 of 3.46%, and 0.67% between F2 and F3. This study is in line with the research conducted by (Fitriani et al. (2022), who found that there was no significant difference in the zinc mineral content of

snakehead fish meatballs, but there was still an increase in zinc levels in snakehead fish meatballs. The highest zinc content in snakehead fish meatballs was in treatment F0 with a proportion of 100% snakehead fish and 10% tapioca flour, which amounted to 3.12 mg/100 g, while the lowest was in treatment F3 with a proportion of 40% snakehead fish and 60% tapioca flour, which amounted to 1.50 mg/100 g.

This study is not consistent with the research conducted by Noer et al. (2017) that there are differences in zinc levels between instant porridge formulas of complementary food substitutions of snakehead fish flour and pumpkin flour. The higher the substitution of snakehead fish meal and pumpkin flour, the higher the zinc content of the complementary feeding instant porridge.

The 2019 Recommended Dietary Allowance (RDA) (Kemenkes RI, 2019) states that the daily zinc requirement for the 1-3 years age group is 3 mg/day. The portion of the main food is approximately 25%; therefore, the total zinc requirement for the 1-3 year old group is 0.75 mg/meal. Zinc intake of 25 % for children aged 1-3 years for the main meal will be met if children consume as much as 23.622 g of dry noodles with a substitution of 15% snakehead fish flour and 20% yellow sweet potato flour. One serving of dried noodles was 50 g (Kemenkes RI, 2023b); however, in this study, dried noodles at concentration F3, as the best concentration organoleptically, produced 45 g/fruit. The zinc contribution of 45 g of dried noodles at concentration F3 is 1,429 mg, which can exceed the zinc requirement for the main food portion per meal (25% of the daily requirement), with a sufficiency percentage of 190.53%.

Vitamin C

The results of this study indicate that there was no significant difference between the treatments (F0, F1, F2, and F3) in the vitamin C content of the dried noodles ($p = 0.071 > 0.05$, significance level of 5%). Dried noodles F2 had the lowest vitamin C content, with an average value of 46.555 mg/100 g, whereas dried noodles F1 had the highest vitamin C content, with an average value of 52.527 mg/100 g.

The results of this study also showed insignificant increases and decreases in the vitamin C content at each concentration of dried

noodles, with an increase of 4.46% between F0 and F1, a decrease of 11.37% between F1 and F2, and an increase of 5.77% between F2 and F3. This is because of the substitution of yellow sweet potato flour, where the vitamin C content of yellow sweet potato is 21 mg/100 g (Kemenkes, 2020).

However, vitamin C is a water-soluble vitamin that is not heat-resistant; therefore, the substitution of snakehead fish flour and yellow sweet potato flour in these dried noodles did not significantly affect the vitamin C content. This aligns with the research conducted by Yudhistira et al. (2019), who found that the baking process is one of the factors causing unstable vitamin C levels, leading to a reduction in vitamin C content in cookies.

This study is not in line with the research conducted by Syarfaini et al. (2019), who reported a significant increase in the vitamin C content of purple sweet potato biscuits. The vitamin C content of formulation 1:0 (100 g wheat flour and 0 g purple sweet potato flour) was 34.48% lower than that of formulation 1:3 (25 g wheat flour and 75 g purple sweet potato flour), which had a vitamin C content of 66.89%.

The 2019 Recommended Dietary Allowance (RDA) (Kemenkes RI, 2019) states that the daily vitamin C requirement for the 1-3-year-old age group is 40 mg/day. The portion of the main meal is approximately 25%; therefore, the vitamin C requirement for the 1-3-year-old age group is 10 mg per meal. The vitamin C intake for children aged 1-3 years from the main meal (25%) will be met if the child consumes 20.307 g of dry noodles with 15% catfish flour and 20% yellow sweet potato flour. One serving of dried noodles was 50 g (Kemenkes RI, 2023b); however, in this study, dried noodles at concentration F3, which was the best concentration organoleptically, were produced at 45 g per piece. The vitamin C contribution of 45 g of dry noodles at concentration F3 was 22.159 mg, which exceeded the vitamin C requirement for a main meal per serving (25% of the daily requirement), with a sufficiency percentage of 221.59%.

Organoleptic Analysis

Color

The results of the color analysis showed that the most preferred formula had an average score of 3.82. The results of the Kruskal-Wallis test for

color parameters showed a p-value of 0.000, which means that H₀ was rejected, indicating that there was a significant difference between the treatments (F1, F2, and F3) on dried meat with substitution of snakehead fish flour and yellow sweet potato flour.

The Mann-Whitney U test was performed to determine the differences between groups. The Mann-Whitney test results showed no significant difference in the preference levels for dried noodles with catfish flour and yellow sweet potato flour substitutions (0.866 for F1 and F2). The test results showed a significant difference at 0.000 for F1 and F3, as well as at 0.000 for F2 and F3 in the level of preference for dried noodles with catfish flour and yellow sweet potato flour substitutions.

The results showed that the most preferred dry noodle color was F3 with 65 a flour concentration: 20%: 15% (325 g wheat flour, 75 g cork fish flour, and 100 g yellow sweet potato flour). The color of the dried noodles was brown to light brown because they

were a substitute for cork fish flour and yellow sweet potato flour. The color of the dried noodles was influenced by the beta-carotene content of yellow sweet potato. Color plays an important role as one of the aspects that influence consumers' perceptions of food, in addition to texture and taste parameters. Consumers' food choices are often influenced by the external appearance of food products. Bright colors are more attractive to consumers (Tutuhaturunewa, 2020). This aligns with the results of Situngkir et al. (2019), who stated that bright colors on dried noodles are increasingly preferred by consumers.

The brown color of the dried noodles was due to the drying process of the dried noodles, snakehead fish flour, and yellow sweet potato flour at 60°C, which increased the Maillard reaction. The Maillard reaction occurs because of the presence of reducing sugars that react with amino acids, causing the browning of food ingredients (Yulianti, 2018).

Table 3. Results of Organoleptic Analysis of Dried Noodles with Substitution of Snakehead fish Flour and Yellow Sweet Potato Flour

Organoleptic Analysis	Treatment			p-value
	F1 (Mean ± SD)	F2 (Mean ± SD)	F3 (Mean ± SD)	
Color	2.98 ± 0.82 ^a	3.02 ± 1.00 ^a	3.82 ± 0.77 ^b	0.000
Texture	3.10 ± 0.86 ^a	3.00 ± 0.99 ^a	3.36 ± 0.94 ^a	0.073
Taste	3.04 ± 0.07 ^a	2.84 ± 0.98 ^a	2.52 ± 0.04 ^a	0.010

Numbers with the same notation in the same row were not significantly different ($p > 0,05$)

F₀: standard formula, F₁ (65% wheat flour, 5% snakehead fish flour, 30% yellow sweet potato flour), F₂ (65% wheat flour:10% snakehead fish flour:20% yellow sweet potato flour), and F₃ (65% wheat flour:15% snakehead fish flour:20% yellow sweet potato flour).

Texture

The texture analysis results showed that the most preferred formula had an average score of 3.36. The results of the Kruskal-Wallis test for texture parameters showed a value of 0.073 > 0.05, which means that H₀ was accepted; therefore, there was no significant difference between treatments (F1, F2, and F3) on dried noodles with substitutions of snakehead fish flour and yellow sweet potato flour.

The results of the study indicate that the panelists' preference for the most preferred texture aspect is F3 with a flour concentration of 65%: 20%: 15% (325 g wheat flour, 75 g snakehead fish flour, and 100 g yellow sweet potato flour). The organoleptic test results showed no difference in texture among the dry noodle formulations. This is because all

treatments used the same amount of ingredients; therefore, the texture of the dry noodles at all concentrations was not significantly different. The texture and concentration of an ingredient can influence the flavor it produces because they can affect the speed at which stimuli are transmitted to olfactory receptor cells and salivary glands (Dahliansyah et.al., 2022)

Fitriani (2019) stated that the proteins myosin and actinomyosin found in fish play an important role in increasing texture hardness because they are crucial in coagulation and gel formation; therefore, when fish are processed into noodles, they produce a dense structure.

The results of this study are consistent with those of Canti et al. (2020) stated that adding tuna fish flour to dried noodles does not

affect the panelists' preferences for the texture attributes of dried noodles. Debbarma et al. (2017) found no significant differences in noodle texture with the addition of catfish and egg white flours. Dry noodles with 70% sweet potato flour substitution and 20% skipjack tuna flour addition are preferred by panelists in terms of color, aroma, taste, and texture (Yulianti, 2018)

Taste

Taste analysis results showed that the most preferred formula had an average score of 3.04. The results of the Kruskal-Wallis test for taste parameters showed a p-value of 0.010, which means that H_0 was rejected, indicating a significant difference between the treatments (F1, F2, and F3) for dry noodles with substitutions of *Channa micropeltes* flour and yellow sweet potato flour. The Mann-Whitney test results showed that the preference levels for dried noodles with snakehead fish flour and yellow sweet potato flour substitutions were not significantly different, with values of 0.274 for F1 and F2 and 0.064 for F2 and F3. The test results showed a significant difference of 0.002 between F1 and F3 in the level of preference for dried noodles with snakehead fish flour and yellow sweet potato flour.

The results indicated that the most preferred dry noodle flavor was F1, with a flour concentration of 65%: 30%: 5% (325 g wheat flour, 25 g snakehead fish flour, and 150 g yellow sweet potato flour). The organoleptic test results showed differences in flavor among the dry noodle formulas. This is due to the presence of an aftertaste characterized by fishy odor in dry noodles. The aftertaste is caused by amino acid hydrolysis during the Maillard reaction, both during flour production and the dry noodle drying process. The more snakehead fish flour used, the lower the panelists' preference for dry noodles, as the snakehead fish flavor and fishy odor became more pronounced.

This study aligns with the research by Canti et al. (2020), who found that the lower the concentration of tuna fish flour, the more preferred were the dry noodles with substitutions of yellow squash flour and tuna fish flour. This study is also consistent with the research conducted by Alkhamdan and Husain (2022), who showed that panelists prefer crackers with a mild fish flavor, meaning that the lower the concentration of catfish flour used, the more preferred the fish crackers.

This study showed that increasing the proportion of snakehead fish meal consistently increased the protein and iron content of dried noodles. Formulation F3 resulted in a 74.2% increase in protein content compared to F0, as well as an increase in iron content of up to 115.8%. However, this increase in nutritional value was accompanied by a decrease in taste acceptance by the panelists, from a score of 3.04 in F1 to 2.52 in F3. This phenomenon indicates a trade-off between achieving optimal nutritional value and organoleptic acceptance. This aligns with the findings of Canti et al. (2020), who reported that the use of animal-based food ingredients with distinctive aromas, such as fish meal, at high concentrations tended to reduce taste acceptance. Therefore, the development of functional food products requires formulation strategies that consider the balance between enhancing nutritional content and sensory acceptability, such as the application of flavor-masking techniques, process modifications, or the combination of raw materials that can reduce the intensity of the distinctive fishy aroma.

This study has several limitations that should be considered when interpreting its results. First, the relatively limited number of panelists and their origin in a single geographical region limit the generalizability of the findings. Second, organoleptic testing was conducted under controlled laboratory conditions; therefore, it does not fully represent consumer preferences under actual consumption. Third, the drying process may degrade heat-sensitive nutrients, such as vitamin C and unsaturated fatty acids, which were not specifically analyzed in this study.

Considering these limitations, further research should include shelf-life testing, consumer acceptance evaluation across various population segments, and economic feasibility analyses. This approach is expected to strengthen the potential of dried noodle formulations based on catfish and yellow sweet potato flours as functional foods applicable in Indonesia's stunting prevention programs.

Conclusion

Based on the results of this study, it can be concluded that the substitution of snakehead fish flour and yellow sweet potato flour affects

the organoleptic properties (color, texture, and taste) as well as the chemical properties of dried noodles, including energy content, protein, carbohydrates, iron, zinc, and vitamin C. F3 was the best formulation in terms of organoleptic properties and had the highest energy, protein, and iron content compared to the other formulations. Considering its nutrient profile, F3 is recommended for use in supplementary feeding programs, particularly for children at risk of stunting, for whom improved protein and iron intakes are crucial. This product has the potential to be developed into a locally produced supplemental food to prevent stunted growth. Further studies are needed to evaluate its economic feasibility and community acceptance to support broader-scale implementation.

References

- Alif, P. I., Puspita, T., & Suwita, I. K. (2019). Substitusi tepung ubi jalar kuning dan tepung kecambah kedelai terhadap nilai energi, kadar proksimat, mutu protein, dan mutu organoleptik donat sebagai PMT anak sekolah. *Jurnal Ilmiah*, 27(1), 10–22.
- Alkhamdan, T., & Husain, R. (2022). Pemanfaatan tepung ikan gabus (*Channa striata*) dalam pembuatan kerupuk ikan. *Jambura Fish Processing Journal*, 4(1), 25–36.
<https://doi.org/10.37905/jfpi.v4i1.11729>
- Aurora, W. I. D. (2021). Efek pemberian zat besi tambahan pada anak. *Jambi Medical Journal*, 9(2), 199–203.
<https://doi.org/10.22437/jmj.v9i1.13122>
- Balitbangkes. (2014). *Buku studi diet total: Survei konsumsi makanan individu*. Lembaga Penerbitan Badan Penelitian dan Pengembangan Kesehatan, Kementerian Kesehatan RI.
- Bappenas. (2018). *Pedoman pelaksanaan intervensi penurunan stunting terintegrasi di kabupaten/kota*. [data tidak tersedia].
- Bappenas. (2020). *Peraturan Presiden Republik Indonesia Nomor 18 Tahun 2020 tentang Rencana Pembangunan Jangka Menengah Nasional Tahun 2020–2024*. [data tidak tersedia].
- Canti, M., Fransiska, I., & Lestari, D. (2020). Karakteristik mi kering substitusi tepung terigu dengan tepung labu kuning dan tepung ikan tuna. *Jurnal Aplikasi Teknologi Pangan*, 9(4), 181–187.
<https://doi.org/10.17728/jatp.6801>
- Dahliansyah, D., Hariyadi, D., & Desi, D. (2022). Substitusi mie sumber zat gizi mikro bahan pangan lokal lahan gambut terhadap daya terima balita underweight umur 24–59 bulan. *Jurnal Surya Medika*, 8(3), 218–227.
<https://doi.org/10.33084/jsm.v8i3.4123>
- Damayati, D. S., Rusmin, M., & M, S. H. (2018). Analisa kandungan zat gizi muffin ubi jalar ungu putih dan kuning (*Ipomoea batatas* L.) sebagai alternatif peningkatan gizi. *Al-Sihah: Public Health Science Journal*, 10, 108–119.
- Debbarma, J., Viji, P., Rao, B. M., & Prasad, M. M. (2017). Nutritional and physical characteristics of noodles incorporated with green seaweed (*Ulva reticulata*) and fish (*Pangasianodon hypophthalmus*) mince. *Indian Journal of Fisheries*, 64(2), 90–95.
<https://doi.org/10.21077/ijf.2017.64.2.58918-14>
- Dinas Kelautan dan Perikanan Sulsel. (2021). *Laporan statistik perikanan Sulawesi Selatan 2020*. [data tidak tersedia].
- Diniyyah, S. R., & Nindya, T. S. (2017). Asupan energi, protein, dan lemak dengan kejadian gizi kurang pada balita usia 24–59 bulan di Desa Suci, Gresik. *Amerta Nutrition*, 1(4), 341.
<https://doi.org/10.20473/amnt.v1i4.7139>
- Efendi, S., Ansharullah, S., M. S., Wahyuni, S., & Rejeki, S. (2022). Pengaruh formulasi tepung ubi jalar kuning (*Ipomoea batatas* L.) dan filtrat wortel (*Daucus carota*) terhadap karakteristik organoleptik dan nilai gizi pada pembuatan mie basah. *Journal Sains dan Teknologi Pangan*, 7(5), 5521–5535.
- Fitriani, A., Hekmah, N., Fathullah, D. M., & Suryani, N. (2022). Perbedaan kandungan protein, zink, dan tingkat kesukaan bakso ikan gabus (*Channa striata*) sebagai makanan selingan balita. *Jurnal Gizi dan Kesehatan*, 14(2), 330–343.
- Fitriani, F. (2019). Pengaruh penambahan tiga jenis ikan terhadap tingkat kesukaan dan kadar protein mi kering. *Jurnal Proteksi Kesehatan*, 7(2), 79–86.

- <https://doi.org/10.36929/jpk.v7i2.138>
- Fonnie, E. H., Rachmawati, R., Setyawati, B., Ernita, Laiya, R., & Pujihastuti, A. (2023). *Metabolisme zat gizi*. PT Global Eksekutif Teknologi.
- Hardinsyah, Supariasa, I. D. N., Hizni, A., Adi, A. C., Wijayanti, A., Ahmad, A., ... Doloksaribu, B. (2016). *Ilmu gizi: Teori & aplikasi*. Penerbit Buku Kedokteran EGC.
- Hidayati, M. N., Perdani, R. R. W., & Karima, N. (2019). Peran zink terhadap pertumbuhan anak. *Majority*, 8, 168–171.
- Kamaruddin, I., Syah, J., Novaria, A. A., Faturahmah, E., Mardiana, Kamaruddin, M., ... Sari, N. W. (2023). *Kesehatan dan gizi*. PT Global Eksekutif Teknologi.
- Kemendes RI. (2019). *Angka kecukupan gizi masyarakat Indonesia (No. 65)*.
- Kemendes RI. (2020). *Tabel komposisi pangan Indonesia (TKPI)*.
- Kemendes RI. (2020b). *Tabel komposisi pangan Indonesia 2020*.
- Kemendes RI. (2020c). *Peraturan Menteri Kesehatan Nomor 2 Tahun 2020 tentang Standar Antropometri Anak*.
- Kemendes RI. (2023a). *3 upaya penting Kemendes dalam menurunkan stunting*. [data tidak tersedia].
- Kemendes RI. (2023b). *Petunjuk teknis pemberian makanan tambahan berbahan pangan lokal untuk balita dan ibu hamil*.
- Kemendes RI. (2025). *Survei Status Gizi Indonesia (SSGI)*.
- Kementerian Pertanian RI. (2022). *Statistik ketahanan pangan tahun 2022*. Pusat Data dan Sistem Informasi Pertanian.
- Lusiana, S. A., Sumule, M. U., Raya, M. K., & Sarpumpwain, A. (2023). Uji laboratorium kandungan zat gizi makro dan zat besi snack bar tepung ikan gabus dengan penambahan kacang tanah. *Health Information: Jurnal Penelitian*, 14(1), 78–87.
- Maares, M., & Haase, H. (2020). A guide to human zinc absorption: General overview and recent advances of in vitro studies. *Nutrients*, 12. <https://doi.org/10.3390/nu12030762>
- Milanti, S., Lasindrang, M., & Bait, Y. (2022). Formulasi biskuit bayi dengan penambahan tepung ubi jalar kuning termodifikasi yang difortifikasi tepung ikan gabus. *Jambura Journal of Food Technology*, 4, 198–212.
- Nadimin, & Lestari, R. S. (2019). Peningkatan nilai gizi mikro kudapan lokal melalui substitusi tepung ikan gabus untuk pencegahan stunting di Sulawesi Selatan. *Media Kesehatan Politeknik Kesehatan Makassar*, 14, 1–76. <https://doi.org/10.32382/medkes.v14i2.1021>
- Noer, E. R., Candra, A., & Panunggal, B. (2017). Nutrient content and acceptability of snakehead fish (*Ophiocephalus striatus*) and pumpkin (*Cucurbita moschata*) based complementary foods. *Journal of Physics: Conference Series*, 755(1). <https://doi.org/10.1088/1742-6596/755/1/011001>
- Piskin, E., Cianciosi, D., Gulec, S., Tomas, M., & Capanoglu, E. (2022). Iron absorption: Factors, limitations, and improvement methods. *ACS Omega*, 7, 20441–20456. <https://doi.org/10.1021/acsomega.2c01833>
- Rahmawati, A., Supartono, & Cahyono, E. (2015). Kandungan kimia dan potensi beberapa jenis tepung ubi jalar pada pembuatan roti. *Indonesian Journal of Chemical Science*, 4(1), 6–10.
- Situngkir, R. U., Sarungallo, Z. L., & Sarungallo, R. S. (2019). Sifat fisik dan organoleptik mie kering dengan penambahan tepung ubi jalar dan tepung kedelai. *Jurnal Teknologi Pangan*, 2(2), 78–86.
- Sugiyono, Mardapi, D., & Suryadarma, I. G. P. (2017). Developing assessment instruments for the sensory acceptability of food products. *Research and Evaluation in Education*, 1(2), 92–105. <https://doi.org/10.21831/reid.v3i1.13940>
- Sumartini, E. (2022). Studi literatur: Riwayat penyakit infeksi dan stunting pada balita. *Jurnal Kesehatan Mahardika*, 9(1), 55–62. <https://doi.org/10.54867/jkm.v9i1.101>
- Syarfaini, Damayati, D. S., Susilawaty, A., Alam, S., & Humaerah, A. M. (2019). Analisis kandungan zat gizi roti rumput laut lawilawi (*Caulerpa racemosa*) substitusi tempe sebagai alternatif perbaikan gizi masyarakat. *Public Health Science Journal*, 11(1), 94–106.

- Tutuhaturunewa, A. (2020). Analisis kualitas produk abon ikan dengan pendekatan logika fuzzy. *ALE Proceeding*, 3, 24-32. <https://doi.org/10.30598/ale.3.2020.24-32>
- Umasangaji, M. S., Puspita, T., & Fajar, I. (2023). Formula nugget tahu, ubi jalar kuning, brokoli untuk balita wasting. *Jurnal Nutriture*, 2(1), 19-26. <https://doi.org/10.31290/nj.v2i1.3668>
- WHO. (2023). *World health statistics 2023: Monitoring health for the SDGs*. [data tidak tersedia].
- Yudhistira, B., Sari, T. R., & Affandi, D. R. (2019). Karakteristik fisik, kimia, dan organoleptik cookies bayam hijau (*Amaranthus tricolor*) dengan penambahan tomat (*Solanum lycopersicum*) sebagai upaya pemenuhan defisiensi zat besi pada anak-anak. *Warta Industri Hasil Pertanian*, 36(2), 83. <https://doi.org/10.32765/wartaihp.v36i2.5286>
- Yulianti. (2018). Pengaruh penambahan tepung ikan cakalang pada mie kering yang bersubstitusi tepung ubi jalar. *Agriculture Technology Journal*, 1(2), 8-15. <https://doi.org/10.32662/gatj.v1i2.411>