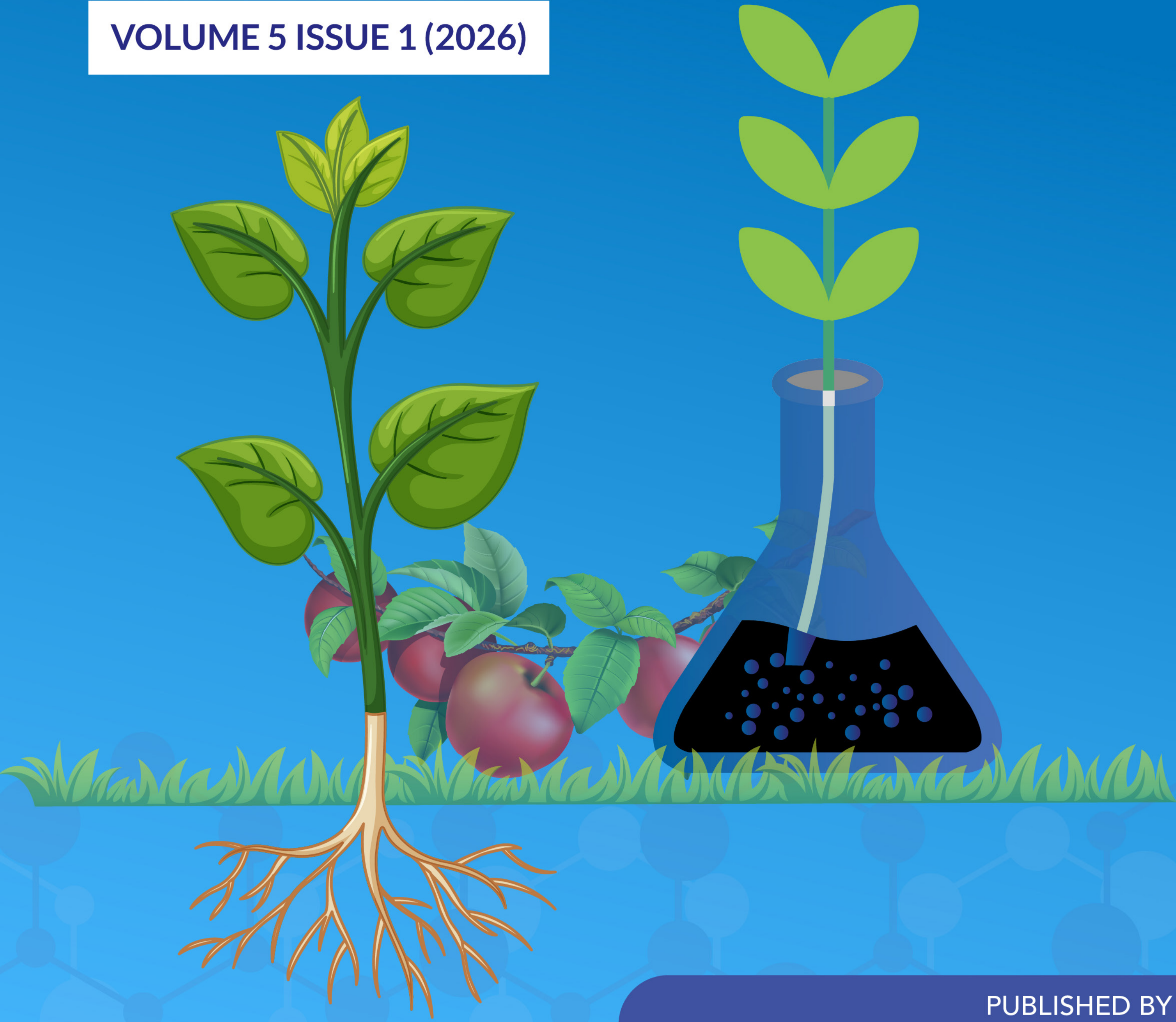
American Journal of Food Science and Technology (AJFST)

ISSN: 2834-0086 (ONLINE)

VOLUME 5 ISSUE 1 (2026)



PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Food Science and Technology (AJFST)

Volume 5 Issue 1, Year 2026
ISSN: 2834-0086 (Online)
DOI: https://doi.org/10.54536/ajfst.v5i1.6592
https://journals.e-palli.com/home/index.php/ajfst

Fortifying Egg Noodles with Alugbati Powder to Combat Vitamin A and Iron Deficiencies among Filipino Children and Adolescents

Junrey S. Cagatan[1], Dyssa T. Tagurmacon[1], Frecious J. Sumalpong[1], Melvin H. Madroñal[1*], Charmagne Kris C. Gardose[1], Maylyn E. Gastardo[2]

Article Information

Received: October 19, 2025

Accepted: December 30, 2025

Published: January 19, 2026

Keywords

Alugbati (Basella Alba), Egg Noodle, Fortification, Sensory Evaluation

ABSTRACT

Vitamin A and iron deficiencies remain major nutritional issues in Filipino children and adolescents. To address this, fortified egg noodles were developed using alugbati (Basella alba) stem and leaf powders. The combined use of these two methods remains unexplored in the Philippines as a sustainable fortification method. This study used a mixed-methods approach that integrated quantitative nutrient profiling with qualitative sensory evaluation. Laboratory analyses were conducted at the Department of Science and Technology – Region X and the First Analytical Services and Technical Cooperative Laboratories. The results of the proximate analysis showed 63.55 g of moisture, 7.98 g of protein, 1.91 g of total fat, and 2.31 g of ash per 100 g of sample. Micronutrient analysis revealed 14.8 mg/kg iron and 2 IU/100 g vitamin A, indicating minimal vitamin A but meaningful iron content in the noodles. This study adds to the knowledge of Philippine food science, as the iron content of these products was previously unreported. Forty panelists (thirty Grade 11 students and ten teachers) participated in sensory evaluation comparing fortified egg noodles (A) with plain noodles (B). Twenty-eight out of forty panelists or 70% preferred the fortified noodles because of their pleasant aroma, chewy texture and nutritious taste while twelve or 30% favored the plain noodles because of their familiar flavor. The exact binomial sign test showed a significant difference at $p<0.05$. This analysis may serve as a baseline for Alugbati-based fortification as an inexpensive method to improve the nutritional quality of staple foods in the Philippines.

INTRODUCTION

Micronutrient deficiencies, primarily referring to vitamins and minerals, remain a major public health problem in Southeast Asian countries, such as Indonesia, Malaysia, Thailand, Vietnam, and the Philippines (Tan *et al.*, 2024; Molani-Gol *et al.*, 2023; Mir *et al.*, 2021). However, in the Philippines Vitamin A, Iron and Zinc deficiencies among children and adolescents persist, together with high rates of stunting, wasting, and underweight, which reflect long-standing malnutrition. This has resulted in serious health consequences, such as impaired vision, a weakened immune system, and increased susceptibility to infectious diseases (Smith *et al.*, 2024; Calayo-Garvilles *et al.*, 2025; Huey et, al.,2022; Ramoso *et al.*, 2024). Iron deficiency is also alarming among adolescent females, where the prevalence rate of Iron Deficiency Anemia (IDA) is increasing.

This condition occurs because low iron reserves result in the incomplete production of functional red blood cells and block oxygen transport to body tissues, most often associated with inadequate dietary iron absorption (Molani-Gol *et al.*, 2023). Adding weight to this concern is the most recent National Nutrition Survey conducted by the Department of Science and Technology–Food and Nutrition Research Institute (DOST-FNRI, 2023), which reported high rates of anemia among pregnant women (21.8%), lactating mothers (11.2%), young children below five years old (11.4%), and elderly people (20%). To address this issue, food fortification has been proven to be effective at a very low cost in providing a solution to micronutrient deficiencies and is thus widely used. The World Health Organization (WHO) definition of food fortification, as quoted by Yakum *et al.* (2024), is as follows: "The deliberate addition to foods or condiments of one or more micronutrients vitamins and minerals to improve the nutritional quality of the food supply with public health benefit and minimal risk to health" (Regulations, 2021).

This intervention is highly rated for ease of application, improved nutrient intake among various demographic groups over widespread micronutrient inadequacies, and reduced inadequacy effectiveness with all these factors considered (Rohner *et al.*, 2023; Ofori *et al.*, 2022). The most added nutrients are iron, vitamin A, iodine, folic acid, and ascorbic acid, which play major roles in preventing nutrition-related disorders and ensuring general public health (Ashraf,2025; Olson *et al.*, 2021). Republic Act 8976, popularly known as The Philippine Food Fortification Law of 2000, contains provisions on food fortification in the Philippines. The law mandates the addition of essential nutrients to the staple food crops of the country to meet the recommended nutrient

[1] Department of Education- Misamis Oriental Division, Opol National Secondary Technical School, Taboc, Opol, Misamis Oriental, Northern Mindanao, Philippines
[2] Department of Food Science and Technology-Northern Mindanao Food Innovation Center University of Science and Technology of Southern Philippines, Claro M. Recto Avenue, Lapasan Cagayan de Oro City, Philippines
[*] Corresponding author's e-mail: melvin_madronal15@yahoo.com

intake and national technical standards (Candelario, 2023). Furthermore, noodles have cultural significance in Southeast Asia, particularly in the Philippines, where they are associated with longevity and communal feasting. Pancit (also pansit), brought by Chinese traders in pre-Hispanic times, has been well integrated into Filipino cuisine. Distinct versions of pancit, defined by local resources, flavors preferred by the people, and cultural practices, can be found throughout the archipelago. In all these variations, however, a general description would suffice: noodles bihon, canton, or miki with vegetables, mixed with either meat or seafood, and all forms of seasoning expressing regional identities (Mercado and Andalecio 2020; Mercado 2021).

However, similar to most flour-based noodles in Asia, their nutritional content remains limited. They are high in carbohydrates and calories (Park & Liu, 2023; Laenggeng, Tangge, & Rafiqa, 2025). Conversely, they contain significantly lower amounts of protein, fiber, vitamins, and minerals (Olorunsogo *et al.*, 2023). This is true for fresh noodles sold in the markets of Opol, Misamis Oriental, both public and private markets of Cagayan de Oro City in Northern Mindanao, Philippines, wherein the products are energy-dense but nutrient-poor. Such nutritional imbalance may pose health risks, including malnutrition and metabolic disorders, if noodles are constantly consumed for a long period (Park & Liu, 2023). The increasing public awareness of the importance of a nutritious diet has inspired the improvement of better-quality noodles, particularly through nutrition enhancement and fortification (Ayustaningwarno, Suryaputra, & Anjani, 2025).

Alugbati (Basella alba) is an indigenous vegetable widely consumed in the Philippines. It is a potential source of essential micronutrients, principally vitamin A and iron, making it suitable for food fortification programs (Felicilda, 2025; Olayinka & Odeniran 2025). According to the University of the Philippines Mindanao Campus (UP Mindanao), alugbati leaf powder can considerably increase the vitamin A content of food products. Egg noodles with 15 percent alugbati powder had a total carotenoid content of 1550 μg/g compared to 610 μg/g in the control samples. Consuming only 5–10 g of these fortified noodles could supply 400–800 μg retinol equivalents, corresponding to the daily vitamin A requirement (Soriano *et al.* 2020).

This innovation is a response to the Department of Science and Technology (DOST, 2022-2028, pp. 24-27). Harmonized National Research and Development Agenda (HNRDA 2023-2028), which promotes the creation of functional foods from nutrient-dense, underutilized crops. Integrating indigenous vegetables into staple foods can help achieve the national objectives of improved public health, nutritional security, and an environmentally sustainable food system in the Philippines. The incorporation of indigenous vegetables, such as alugbati, into staple food products supports various national goals in the Philippines, including improved public health, food and nutrition security, and sustainable food systems. Thus, this study aimed to develop and evaluate egg noodles fortified with Basella alba leaf and stem powder as a food-based, sustainable approach to enhance nutrition. Specifically, this study assessed the proximate composition and micronutrient content (vitamin A and iron) of the developed noodles, their consumer acceptability compared to that of the control samples, and the formulation that optimally balances the nutritional and sensory characteristics.

LITERATURE REVIEW

Food fortification is one of the most successful nutritional interventions for overcoming micronutrient deficiencies in low- and middle-income countries (LMICs). The national nutrition program has embraced the introduction of low-dose vitamin A in breakthrough health and nutrition, garnering strong evidence of population-wide benefits of vitamin A. Specifically, an important benefit is the improvement in nutrient intake among vulnerable groups (Kancherla *et al.*, 2021; Ulep *et al.*, 2025). Likewise, their proven practical benefits include low cost, availability, and compatibility with current dietary habits. According to Friesen *et al.*,2023 and Candelario (2023), the enactment of Republic Act 8976 in the Philippines provided the basis for national fortification programs to correct micronutrient deficiencies through fortified staple foods.

Indigenous vegetables have emerged as appealing fortification ingredients because of their high nutrient content, low cost, and social acceptability. Among these vegetables, Basella alba (alugbati) is particularly promising in the Philippines and India (Felicilda, 2025). Previous studies have reported high levels of vitamin A, iron, and phytochemicals in alugbati leaves, which exhibit antioxidant, anti-inflammatory, and functional properties (Nurfarahin *et al.*, 2018). Studies have further assessed the functional properties of flour developed from Basella rubra. The flour reportedly has superior fat and water absorption, swelling, and gelation capacities compared with wheat flour (Borja *et al.*, 2013). The flour combinations of wheat and alugbati have enhanced functional characteristics, making them suitable for processed-food applications.

Investigations into the vitamin A content of egg noodles augmented with alugbati leaf powder revealed significant enrichment (Soriano *et al.*, 2020). However, most previous studies have focused on the nutritional and functional properties of alugbati leaves alone. The stem, which is always considered waste and discarded, has not received much scientific attention. Research findings from India have shown that the stems of Basella alba possess cytotoxic and anti-angiogenic properties and contain bioactive compounds such as gallic acid, ferulic acid, lutein, zeaxanthin, and β-carotene (Kumar *et al.*, 2018; Kumar *et al.*, 2022). Although these substances are present, the proximate and micronutrient compositions of alugbati stems have been characterized in only a few studies, as has their use as functional food ingredients.

Moreover, proximate analysis is important for determining the moisture, ash, protein, fat, fiber, and carbohydrate contents of food products (Cortés-Herrera *et al.*, 2021; Ismail, 2024; Kari, Ahmad & Ayub, 2022; Ihotu & Etim, 2024). Measuring micronutrients such as vitamin A and iron is also important, as deficiencies in these nutrients still affect Filipino children and adolescents, resulting in visual impairment, lower immunity, and anemia. The country needs food fortifiers as we have a long-standing nutritional gap in the Philippines and the absence of nutritional profiling of alugbati stems and leaves. Thus, further investigation is required.

MATERIALS AND METHODS

Research Design

This study utilized a mixed-methods research design combining quantitative nutrient profiling and qualitative sensory preference testing in alignment with the predominant methodological frameworks in food fortification research (Akusu, Otegbayo, & Osidipe, 2022; Suri, Kumar, Singh, & Singh, 2020).

Participants

The 40 untrained panelists were composed of 30 senior high school students aged 16-17 years old and ten teaching staff of Opol National Secondary Technical School, Taboc, Opol, Misamis Oriental, Northern Mindanao. All participants voluntarily signed informed consent forms before the activity, with strict compliance with the Data Privacy Act of 2012 on confidentiality and ethical handling of participant information.

Procedure

Drying and Grinding Alugbati Leaves and Stem

Fresh Alugbati (*Basella alba L.*) leaves and stems were purchased from the Taboc Market in Opol, Misamis Oriental, Northern Mindanao, Philippines. The plant material was transferred to a Senior High School Chemistry Laboratory. The leaves and stems were washed to eliminate dirt and other surface contaminants from the samples. The leaves and stems were subsequently dried in a hot air food roaster set to 55–60 °C for 8–12 h. The selected moisture removal temperature adhered to recommendations from prior studies, which stated that 55–60 °C is the most suitable temperature for moisture removal without degrading essential micronutrients such as beta-carotene and iron, both of which are heat degradable (Soriano *et al.*, 2020; ElGamal *et al.*, 2023). The dried stems and leaves were ground in a blender and using a mortar and pestle, sieved through 60 mesh screens, and stored in opaque airtight containers to prevent oxidative destruction.

Formulations of Fortified Egg Noodles with Alugbati Leaves and Stem Powders

Fortified egg noodles were prepared using the leaf and stem powder of Basella alba (*Alugbati*) incorporated into a standardized 200 g dry mix formulation. The preparation method was adapted from Alemayehu *et al.* (2016) and Soriano *et al.* (2020), University of the Philippines Mindanao, with certain modifications to fit the laboratory testing requirements and to optimize the structure and handling properties of the noodles. To achieve 200 g of the total dry mix, all the ingredients were scaled proportionally, thus ensuring that 100% of the formulation was obtained. The main flour used in this composition was all-purpose flour, which consisted of 105.72 g (52.86% of total flour). To improve the nutritional status, 48.46 g (24.23%) of alugbati leaf powder and 35.24 g (17.62%) of stem powder were incorporated to provide substances such as β-carotene, non-heme iron, dietary fiber, and other micronutrients. The addition of dried whole eggs at 8.81 g (4.41%) improved the protein content, elasticity, and texture of the dough, whereas salt at 1.76 g (0.88%) acted as a flavor enhancer.

All dry ingredients, such as flour, alugbati leaf and stem powder, dried whole egg, and salt, were carefully weighed on a digital analytical balance to ensure reproducibility. The ingredients were sifted and homogenized in a mixing bowl prior to use. A cavity was created in the dry blend. Two egg yolks and approximately 40-50 mL of distilled water were added to the cavity. The dough was prepared by kneading the mixture until smooth and firm. The dough was allowed to rest at room temperature for one hour for gluten relaxation and moisture equilibration. After the resting period, the dough was rolled into thin layers, and strips of approximately 2 mm were cut using a manual noodle cutter. To prevent sticky lumps from forming in the noodles, a light dusting of flour was added, and the air was set at room temperature for one hour to improve the firmness of the noodles. The cooking method used was boiling the food. The noodles were boiled for 60 s and rinsed with cold water afterward. This is done to prevent over-gelatinization and lower the surface starch. Prior to assessing the sensory characteristics of the noodles, the high-density ziplock bags containing the cooked noodles were placed inside a 2-3 °C refrigerator.

Proximate and Mineral Analysis of Fortified Noodles

For a more detailed examination of the formulations, the mixture was scaled to produce 405 g of noodles that met the laboratory requirements for one complete submission. A 55 g sample was submitted to the Department of Science and Technology – Regional Standards and Testing Laboratory (DOST-RSTL) in Carmen, Cagayan de Oro City for proximate analysis. As specified in the contract, the laboratory used the Association of Official Analytical Collaboration (AOAC) International (2000) methods were used to determine the moisture, crude protein, total fat, and ash content. For micronutrient workup, 80 g of the sample was submitted at the (Food, Analytical Services, and Testing Laboratory) while 65 g of the sample was reserved for vitamin A analysis. A 80 g portion was used for iron content determination. The FAST Laboratory is an ISO/IEC17025:2017-accredited laboratory by the Philippine Accreditation Bureau, Department of Health & Food Drug Administration, which ensures accuracy and reliability of all analytical results. To maintain heat- and light-sensitive nutrients, such as vitamin A, fresh noodle samples were transported in aluminum foil and ice-filled Styrofoam containers. This method is supported by best practice recommendations, as lower temperatures and minimal light exposure result in less degradation of the vitamin (Hemery *et al.*, 2018; Yan *et al.*, 2022; Delompré *et al.*, 2019). Owing to budget constraints, a control noodle sample was excluded from the laboratory analysis. Instead of a control sample, the proximate and micronutrient values were obtained from peer-reviewed studies as reference controls for wheat-based noodles (Orisa & Udofia, 2019; Zula *et al.*, 2021; Prayitno *et al.*, 2022; Mpalanzi *et al.*, 2023).

Preference Ranking Test

The control (plain egg noodles) and fortified noodles were stir-fried following the procedure and conditions described by Soriano *et al.* (2020) at the University of the Philippines Mindanao. Minced garlic (7 g) and chopped onion (14 g) were sautéed together. Next, 64 g of julienned carrots, 128 g of sliced cabbage, 4 g of diced red bell pepper, and 100 g of diced chicken breast were added to the mixture. The mixture was brought to a boil after chicken broth (238 mL) was added, followed by the addition of 250 g of prepared egg noodles. A mixture comprising 5 mL sesame oil, soy sauce, and oyster sauce was added, and the noodles were cooked for 3–5 min, adding salt to taste. To minimize potential bias, the samples were blindly coded with random three-digit numbers. Moreover, the samples were served under identical conditions, such as equal portion size, serving temperature, and preparation time. Blind coding is an accepted procedure that hampers expectation bias and ensures that evaluations are purely based on the sensory level (Sinkinson, 2017). The sequence of the samples was counterbalanced, with half of the panelists receiving Sample A first and the other half receiving Sample B first, to reduce possible order effects. The sensory evaluation comprised 40 untrained panelists. Thirty of them were senior high school students aged 16-17 years, while 10 were teachers. The panelists also provided their consent. Panelist were to give one answer "Prefer A" or "Prefer B." The participants were also allowed to opt for "No preference." Drake *et al.* (2023) recommend use of this forced-choice method for consumer acceptability testing of a new product versus control. The instrument included a qualitative comments section to rehearse the descriptions of the color, fragrance, texture, and flavor of the products. These comments were helpful in illustrating which sensory features of the products were responsible for an individual's choice. The open-ended questionnaires were adapted from the study by Soriano *et al.* (2020) on fortified noodle products.

Data Analysis

The moisture, crude protein, fat, ash, vitamin A (as retinol activity equivalents, RAE), and total iron contents of the fortified noodles were described alongside the approximate and micronutrient profiles. For the calculations, values were presented per 100 g, per 55 g standard serving, as well as portions of the Recommended Energy and Nutrient Intake (RENI) for the adolescents. Given the financial constraints of the study, only one analytical replicate was completed (n=1), and the results were used as provisional baseline values for subsequent validation. For the sensory analysis of the fortified noodles, consumer preference was compared using the exact binomial sign test, which was valid for two-sample forced-choice analytical scenarios (Marques et a1., 2022, Bi & Kuesten, 2015). Responses with no preference were excluded. The results, which included the exact p-value and a measure of effect size (the proportion of difference, 95% confidence bounds), were referenced to the number and proportion of panelists that preferred either of the samples. To supplement the quantitative results, the participants' qualitative feedback with respect to color, aroma, texture, and taste was combined.

RESULTS AND DISCUSSION

Proximate analysis (Table 1) revealed certain nutritional strengths in alugbati-fortified egg noodles. Its moisture content (63.55 g/100 g, DOST-X) classifies the product as wet noodles and is significantly higher than the normal dry noodle moisture content levels (8-11%). This high moisture level improves softness and elasticity, as well as cooking quality, which is highly dependent on consumer acceptability. The ash content (2.31 g/100 g, DOST-X) was higher than that of the control noodles (0.99-1.84%), indicating an enhanced mineral content due to the inclusion of alugbati leaf and stem powders. Soriano *et al.*,2020 also reported increasing trend of ash content in alugbati fortified noodles.

Protein analysis revealed a protein content of 7.98 g/100 g in the fortified noodles, which was slightly lower than that of wheat-based dry noodles (9.8–11.7%)1 but higher than that of wet noodles (3.01%)2, thus indicating the substantial contribution of alugbati powders towards improving the protein profile of the product. Comparable results were reported by Shere *et al.* (2018), who found an increase in protein and ash content values for spinach-fortified noodles, thereby proving that enrichment with leafy vegetables has a positive effect on the nutritional quality of noodles. The fat content was within the permissible range reported for control noodle formulations (0.09–2.12%)7, balancing energy density and flavor without excessive levels. The F.A.S.T. Laboratory results showed that iron content can significantly help address micronutrient deficiency, particularly anemia or iron-deficiency anemia, which remains a problem among Filipino adolescents (14.8 mg/kg). This is lower compared to fortified noodles reported by Prayitno *et al.* (2022) at 41.26 mg/kg, and also lower than values of Moringa- and sardine-fortified noodles found by Mpalanzi *et al.*(2023)32.6–65 .5 mg/100 g but this level still proves the functional potential of dietary mineral intake enhancement through Alugbati enrichment in food science in the Philippines, as no previous local studies have reported on the iron content of Alugbati-fortified noodle products, hence providing a valuable addition to the national literature despite its relatively low concentration. Vitamin A was found to be very low (<2 IU/100 g), but it serves as a good baseline for future studies on increasing carotene retention in wet noodle formulations.

Table 2 shows that most of the Grade 11 student panelists opted for fortified noodles containing alugbati powder. Twenty out of thirty students (67%) picked the fortified noodles and related their dark-light green color to vegetables, nutrition, and health. Shere *et al.* (2018) reported that consumers associated a green color with spinach-fortified noodles as highly nutritious. Susanti *et al.*, (2021) found out that noodle products which were vegetable-fortified and had green hues received favorable sensory acceptance in terms of aroma and texture. Aroma is another distinguishing factor. Most students said the fortified noodles smelled good, a little strong but fresh with some vegetable scent, while the plain noodles were just mild and familiar. Ramu *et al.*, (2018) also found that there was a more inviting aroma from particulates of vegetables in fortified noodles which enhanced greater consumer appeal. Both types of noodles were described using words such as soft and chewy. Interesting comments were made about the fortified noodles, which were smooth with a slight stickiness. Shere *et al.* (2018) also found this type of structural integrity in vegetable-fortified noodles, calling it superior; interestingly, because consumers normally associate high levels or degrees (in this case) of "structural integrity" with chewiness rather than smoothness. The two products' tastes set them apart further down the tasters' lists: they got to the fortified noodle, which is flavorful, nutritious, and enjoyable-consistent with Susanti *et al.*, 2021, who found higher taste scores on formulations containing vegetables. Teacher panelists demonstrated similar sensory preferences. As shown in Table 3, eight out of ten teachers (80%) preferred the fortified noodles and described them as tasty, healthy, and attractive. The other two teachers (20%) preferred plain noodles because of their traditional color and familiar taste profile. Vegetable fortification has been previously reported to improve the sensory attributes of noodles with uncompromised acceptability (Ramu *et al.*, 2018; Shere *et al.*, 2018; Susanti *et al.*, 2021), hence this result slightly supports that finding.

Table 1: Proximate and Micronutrient Composition of Alugbati-Fortified Egg Noodles Compared with Control Noodles (per 100 g)

Nutrient	Fortified Noodles (DOST-X & F.A.S.T. Laboratory)	Control Noodles (2019–2023)	Comparison
Moisture	63.55 g/100 g	8.04–10.83 % (dry/wet)	↑ Much higher (wet form)
Ash	2.31 g/100 g	0.99–1.84 %	↑ Higher
Crude Protein	7.98 g/100 g	3.01–11.67 %/g	~ Comparable
Total Fat	1.91 g/100 g	0.09–2.12 %/g	~ Comparable
Vitamin A	< 2 IU/100 g	Not reported	– (no basis for comparison)
Iron (Fe)	14.8 mg/kg	41.26 mg/kg (Prayitno et al., 2022)	↓ Lower

Table 2: Grouped Sensory Evaluation of Fortified (A) and Plain (B, Control) Egg Noodles (n = 30 Grade 11 Students)

Preference Group	No. of Students	Color	Aroma (Themes)	Texture (Themes)	Taste (Themes)
Fortified Noodles (A)	20	Dark to light green	Smells good; mild to strong; pleasant, vegetable-like	Smooth, chewy, soft; enjoyable mouthfeel	Tasty, flavorful, pleasant, good taste
Plain Noodles (B, Control)	10	Cream	Smells good; familiar; sweet; mild but pleasant	Smooth, chewy, soft; familiar texture	Delicious, mild but tasty, pleasant

The combined responses clearly indicated the better sensory perception of the fortified formulation. Twenty-eight out of forty panelists (70%) preferred the fortified noodles to the non-fortified ones. The nutritional findings strongly support this preference: 7.98 g protein/100 g, 1.91 g fat/100 g, 2.31 g ash/100 g, and 14.8 mg/kg iron content (DOST-X; F.A.S.T. Laboratory) in the fortified noodles, enhanced mineral density, and improved

Table 3: Grouped Sensory Evaluation of Fortified (A) and Plain (B, Control) Egg Noodles by Teachers (n = 10)

Preference Group	No. of Teachers	Color	Aroma (Themes)	Texture (Themes)	Taste (Themes)
Fortified Noodles (A)	8	Dark to light green	Pleasant, fresh, vegetable-like	Smooth, chewy, soft, slightly sticky	Flavorful, tasty, enjoyable, nutritious, tastes good
Plain Noodles (B, Control)	2	Cream	Familiar, mild	Smooth, soft	Mild but good, acceptable, tastes good

macronutrient retention relative to control(non-fortified) noodles. The results obtained support the findings of previous studies (Soriano *et al.*, 2020; Shere *et al.*, 2018; Susanti *et al.*, 2021; Ramu *et al.*, 2018; Prayitno *et al.*, 2022; Mpalanzi *et al.*, 2023) that noodles can be a nutritionally enhanced acceptable alternative both by sensory evaluation and eventually by consumers. Hence, Formulation A considered an optimal product with the best combination of nutrition and positive sensory attributes.

CONCLUSIONS

Alugbati powder was effective in improving the nutritional and sensory qualities of egg noodles. Laboratory analysis showed adequate protein and fat content, high ash content, significant iron enrichment, and desirable characteristics of softness, elasticity, and good quality in cooked wet noodles. This is new evidence added to the Philippine literature on food science, as no local study has yet reported the iron content (14.8 mg/kg) detected in Alugbati-fortified noodles. The formulation has comparative advantages over the control noodle values reported in recent research, despite its minimal vitamin A content. The sensory evaluation test revealed that 70% of the student-teacher panelists preferred fortified fresh vegetable-like aromatic dark-to-light green smooth chewy nutritious tasting egg noodles. While plain noodles remained within the boundaries of acceptability due to their familiarity, the fortified version was preferred both nutritionally and organoleptically. In general, the results show that Alugbati-based fortification is a feasible, low-cost, sustainable approach to improving staple food quality and addressing micronutrient issues among Filipino consumers. However, this study had limitations because only one laboratory replicate performed proximate and micronutrient analyses, which made the nutrient values only estimates. A preference test was conducted for sensory evaluation and preliminary screening. Follow-up studies should be conducted with multiple replicates. A 9-point hedonic scale was used to obtain detailed attribute scores. This will enhance the accuracy, comparison, and generalizability of the results. This will also provide more insights into consumer acceptability.

REFERENCES

Akusu, O. M., Otegbayo, B. O., & Osidipe, O. O. (2022). Proximate composition and consumer acceptability of wheat cassava noodles fortified with moringa (Moringa oleifera) leaf powder. *Food Science & Nutrition, 10*(5), 1472–1482. https://doi.org/10.1002/fsn3.2737

Alemayehu, D., Belachew, B., & Alemayehu, G. (2016). Effect of Drying Temperature on the Nutritional Quality of Noodles Enriched with Vegetables. *African Journal of Food Science, 10*(8), 112–120.

AOAC International. (2019). *Official methods of analysis of AOAC International* (21st edition). AOAC International.

Ashraf, S. A. (2025). Food fortification as a sustainable global strategy to mitigate micronutrient deficiencies and improve public health. *Discover Food, 5*(1), 201.

Ayustaningwarno, F., Suryaputra, A., & Anjani, G. (2025). A review of enhancing noodle quality: Fortification with micronutrients and substitution with nutrient-dense alternative. *Journal of Food Science, 90*(1), e17677.

Bamidele, O., Akinnuga, A. M. and Olorunfemi, J. O. Odetola, O. A., Oparaji, C. K., & Ezeigbo, N. (2010). Effects of aqueous extract of Basella alba leaves on haematological and biochemical parameters in albino rats. *African Journal of Biotechnology, 9*(41), 6952–6955.

Bi, J., & Kuesten, C. (2015). Global sensory preferences and hedonic scale usage. Woodhead Publishing. https://doi.org/10.1016/B978-1-78242-258-0.00006-5

Borja, J. C. S., Sedano, D. S., & Noel, M. G. (2013). *Functional properties of flours prepared from glucosinolate-rich vegetables: Alugbati (Basella rubra).* Manila: De La Salle University.

Calayo-Garvilles, G. V., Santos, N. L. C., Cadiao, S. B. A., Lim, A. H., Briones, D., Castilla, K. K. M., ... Y Palmer, A. C. (2025). Vitamin A intake and status of school-aged children in high-risk areas of the Philippines. Food and Nutrition Bulletin, 03795721251341976.

Candelario, C. M. C. (2023). Assessing the progress of the Philippine Plan of Action for Nutrition from 1974 to 2022: *A narrative review. Food and Nutrition Bulletin, 44*(3), 207-220.

Cortés-Herrera, C., Quirós-Fallas, S., Calderón-Calvo, E., Cordero-Madrigal, R., Jiménez, L., Granados-Chinchilla, F., & Artavia, G. (2021). Nitrogen/protein and one-step moisture and ash examination in foodstuffs: validation case analysis using automated combustion and thermogravimetry determination under ISO/IEC 17025 guidelines. *Current Research in Food Science, 4,* 900–909.

Delompré, T., Leclercq-Perlat, M. N., Riaublanc, A., & Viau, M. (2019). Degradation of vitamins A and E and thiamine in enteral formula as a function of storage temperature and duration. *International Journal of Food Sciences and Nutrition, 70*(2), 182–191. https://doi.org/10.1080/09637486.2018.1492523

Department of Science and Technology, Food and Nutrition Research Institute (2023). *Latest anemia status among Filipinos: 2023 National Nutrition Survey (NNS)* [Infographic]. https://fnri.dost.gov.ph

Department of Science and Technology. (2022, July 21). *Harmonized National R&D Agenda 2022–2028* (pp. 24–25). Retrieved July 21, 2025, from https://www.dost.gov.ph/knowledge-resources/downloads/file/5669-harmonized-national-r-d-agenda-2022-2028.html

Drake, M. A., Watson, M. E., & Liu, Y. (2023). Sensory analysis and consumer preference: *Best practices. Annual Review of Food Science and Technology, 14,* 145–166. https://doi.org/10.1146/annurev-food-071222-023943

Dwyer, J. T., Wiemer, K. L., Dary, O., Keen, C. L., King, J. C., Miller, K. B., ... & Bailey, R. L. (2015). Fortification and health: Challenges and opportunities. *Advances in nutrition, 6*(1), 124-131.

ElGamal, R., Song, C., Rayan, A. M., Liu, C., Al-Rejaie, S., & ElMasry, G. (2023). Thermal degradation of bioactive compounds during drying process of horticultural and agronomic products: A comprehensive overview. *Agronomy, 13*(6), 1580.

Felicilda, L. V. G. B. (2025). *Unlocking the potential of Alugbati (basella alba L.) Powder: Nutritional and Functional Food Ingredient.*

Friesen, V. M., Miller, J. C., Bitantes, R. B., Reario, M. F., Arnold, C. D., Mbuya, M. N., ... & Engle-Stone, R. (2023). Comparing two simplified questionnaire-based methods with 24-h recalls for estimating fortifiable wheat flour and oil consumption in Mandaluyong City, Philippines. *Maternal & Child Nutrition, 19*(3), e13486.

Gonzaga, Z. C., Dimabuyu, H. B., Sumalinog, R. R., & Capuno, O. B. (2014). Increasing productivity of Malabar spinach (Basella alba L. and Basella rubra L.) grown in the marginal upland area of Inopacan, Leyte, through different mulching materials. *Annals of Tropical Research 36*(Supplement), 166-178.

Halayal, R. Y., Bagewadi, Z. K., Khan, T. Y., & Shamsudeen, S. M. (2025). Investigating compounds from Basella alba for their antioxidant, anti-inflammatory, and anticancer properties using in vitro and network pharmacology and molecular simulation approaches. *Green Chemistry Letters and Reviews, 18*(1), 2481945

Hemery, Y. M., Laillou, A., Fontan, L., & Jallier, V. (2018). Storage conditions and packaging significantly impact the stability of fortified wheat flour, affecting vitamin A, iron, zinc, and oxidation. *Food Chemistry, 240*, 43–50. https://doi.org/10.1016/j.foodchem.2017.07.082

Huey, S. L., Krisher, J. T., Morgan, D., M. P., S., B., G.B.M., & Mehta, S. (2022). Portable devices for measurement of vitamin A concentrations in edible oils: Field readiness of available options. *ACS omega, 7*(21), 17502-17518.

Ihotu, O. E., & Etim, E. E. (2024). Proximate composition and functional properties of soybeans (Glycine max) enriched carbohydrate diets. *American Journal of Food Science and Technology, 3*(2), 53–59. https://doi.org/10.54536/ajfst.v3i2.3443

Ismail, B. P. (2024). Determination of ash content was performed using Nielsen's Food Analysis Laboratory Manual (pp. 129–131). *Cham: Springer International Publishing.*

Kancherla, V., Chadha, M., Rowe, L., Thompson, A., Jain, S., Walters, D., & Martinez, H. (2021). Reducing the burden of anemia and neural tube defects in low-and middle-income countries: an analysis to identify countries with an immediate potential to benefit from large-scale mandatory fortification of wheat flour and rice. *Nutrients, 13*(1), 244.

Kari, N. M., Ahmad, F., & Ayub, M. N. A. (2022). Proximate composition, amino acid composition and food product application of anchovy: a review. *Food research, 6*(4), 16-29.

Kumar, B. R., Anupam, A., Manchikanti, P., Rameshbabu, A. P., Dasgupta, S., Dhara, S. (2018). Identification and characterization of bioactive phenolic constituents and anti-proliferative and anti-angiogenic activities of stem extracts of Basella alba and rubra. *Journal of Food Science and Technology, 55*(5), 1675–1684.

Kumar, P. C., Oberoi, H. S., & Azeez, S. (2022). Basella is an underutilized green leafy vegetable with potential for functional food development. *Food Reviews International, 38*(sup1), 456-473.

Kumar, S. S., Prabhakaran Manoj, Parvatam Giridhar, Richa Shrivastava, Mausumi Bharadwaj, 2015. Fruit extracts of Basella rubra that are rich in bioactives and betalains exhibit antioxidant activity and cytotoxicity against human cervical carcinoma cells.*Journal of Functional Foods*, 15509-515.

Laenggeng, A. H., Tangge, L., & Rafiqa, R. (2025). Nutrification of Moringa Leaf Flour (Moringa oleifera) in Wet Noodle Production and Its Effect on Macronutrient Content. Prisma Sains: *Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram, 13*(3), 810-818.

Lawless, H. T., & Heymann, H. (2010). *Sensory evaluation of food: Principles and practices* (2nd ed.). Springer. https://doi.org/10.1007/978-1-4419-6488-5

Marques, C., Correia, E., Dinis, L. T., & Vilela, A. (2022). An overview of sensory characterization techniques: From classical descriptive analysis to the emergence of novel profiling methods. *Foods, 11*(3), 255. https://doi.org/10.3390/foods11030255

Maurya, V. K., Shakya, A., Bashir, K., Kushwaha, S. C., & McClements, D. J. (2022). Vitamin A fortification:

Recent advances in encapsulation technologies. *Comprehensive Reviews in Food Science and Food Safety, 21*(3), 2772-2819.

Mercado, J. M. T. (2021). Pancit: Explicating the culinary safeguarding culture of Philippine noodles – The case of Luzon Island. *Journal of Culinary Science & Technology, 20*(5), 1–25. https://doi.org/10.1080/15428052.2020.1871146

Mercado, J. M. T., & Andalecio, A. B. P. (2020). Ysla de Panciteria: A preliminary study on the culinary heritage significance of pancit using the heritage documentation approach—the case of Luzon Island, Philippines. *Journal of Ethnic Foods, 7,* 19. https://doi.org/10.1186/s42779-020-00057-1

Mir, R. R., Kumar, A., Pandey, M. K., & Isobe, S. N. (2021). Achieving nutritional security and food safety through genomics-based crop breeding. *Frontiers in Nutrition, 8,* 638845.

Molani-Gol, R., Kheirouri, S., & Alizadeh, M. (2023). Does a high dietary diversity score predict dietary micronutrient adequacy in children under 5 years of age? A systematic review. *Journal of Health, Population and Nutrition, 42*(1), 2.

Mpalanzi, V. T., Chaula, D. N., & Wenaty, A. (2023). Proximate and mineral composition of noodles incorporated with Moringa and sardine powders. *Journal of Agricultural Science and Food Technology, 9*(3), 22–33.

Nur, M. A., Khan, M., Satter, M. A., Rahman, M. M., & Amin, M. Z. (2023). Assessment of physicochemical properties, nutrient content, and colorant stability of two varieties of Malabar spinach (Basella alba L.) fruits. *Biocatalysis and Agricultural Biotechnology 51*: 102746.

Ofori, K. F., Antoniello, S., English, M. M., & Aryee, A. N. (2022). Improving nutrition through biofortification–A systematic review. *Frontiers in nutrition, 9,* 1043655.

Olayinka, A. J., & Odeniran, O. M. (2025). Food Mineral Diversity Among Leafy Indigenous Vegetables. *International Journal of Nutrition and Food Sciences, 14*(5), 323-327.

Olorunsogo, S., Adebayo, S. E., Orhevba, B., & Awoyinka, T. (2023). Development, optimization and characterization of enriched noodles. *Journal of Agriculture and Food Research, 14,* Article 100651. https://doi.org/10.1016/j.jafr.2023.100651

Olson, R., Gavin-Smith, B., Ferraboschi, C., & Kraemer, K. (2021). Food fortification: The advantages, disadvantages and lessons from sight and life programs. *Nutrients, 13*(4), 1118.

Orisa, C. A., & Udofia, U. S. (2019). Proximate and mineral compositions of noodles made from Triticum durum, Digitaria exilis, Vigna unguiculata flour and Moringa oleifera powder. *Journal of Food Science and Engineering, 9*(7), 276–286. https://doi.org/10.17265/2159-5828/2019.07.003

Pandey, S., & Jayadeep, A. (2017). Fortification of Paddy and Rice Cereals. *In Developing Technologies in Food Science* (pp. 325-348). Apple Academic Press.

Park, S., & Liu, M. (2023). A positive causal relationship between noodle intake and metabolic syndrome: A two-sample Mendelian randomization study. *Nutrients, 15*(9), Article 2091. https://doi.org/10.3390/nu15092091

Prayitno, S. A., Patria, D. G., Mardiana, N. A., Utami, D. R., Kusumawati, R., Rochma, N. A., & Niam, M. K. (2022). Fortification of Moringa oleifera flour on quality of wet noodle. *Food Science and Technology Journal (Foodscitech),* 63–70. https://doi.org/10.25139/fstj.v5i2.4899

Ramoso, R. N. C., Moreno, M. I. C., Dans, L. F., Benzon, Z. P., De Mesa, R. Y. H., Fabian, N. M. C., ... Y Dans, A. M. L. (2024). Adherence of primary care providers to practice guidelines for common pediatric conditions in urban, rural, and remote sites in the Philippines: A cross-sectional study. *Acta Medica Philippina, 58*(21), 20.

Ramu, L., Basha, S. J., & Bhasker, V. (2018). Physio-chemical analysis of spinach paste fortified instant noodles. *International Journal of Chemical Studies, 6*(5), 2373–2381. https://www.chemijournal.com/archives/2018/vol6issue5/PartAJ/6-5-329-703.pdf

Regulations, F. fortification. (2021). Food fortification Regulations. *Printed and Published by the Federal Government Printer, Lagos, Nigeria, 108*(135), 3091–3108.

Rohner, F., Wirth, J. P., Zeng, W., Petry, N., Donkor, W. E., Neufeld, L. M., ... & Friesen, V. M. (2023). Global coverage of mandatory large-scale food fortification programs: a systematic review and meta-analysis. *Advances in Nutrition, 14*(5), 1197-1210.

Shere, P. D., Devkatte, A. N., & Pawar, V. N. (2018). Studies on production of functional noodles with incorporation of spinach puree. *International Journal of Current Microbiology and Applied Sciences, 7*(6), 1618–1628. https://doi.org/10.20546/ijcmas.2018.706.192

Singh, R., & Sonkar, S. (2024). A study on the development and standardization of instant soup mix using Malabar spinach (Basella alba) leaf powder. *Int. J. Adv. Biochem. Res., SP-8* (2), 514-518.

Sinkinson, C. (2017). Triangle test. In M. Delwiche (Ed.), *Discrimination testing in sensory science* (pp. 153–170). Woodhead Publishing. https://doi.org/10.1016/B978-0-08-100354-5.00010-4

Smith, T. J., Hess, S. Y., Angeles-Agdeppa, I., Goyena, E., Gelli, A., & Olney, D. K. (2024). Diets, fruit and vegetable intake, and nutritional status among children, adolescents, and adults in the Philippines: A scoping review. *Maternal & Child Nutrition*, e13786.

Soriano, P. C., Villame, R. G. E., Calumba, K. F. A., Alviola, J. N. A., Delima, A. G. D., Alviola, P. A., & Bayogan, E. R. V. (2020). Utilization of'Alugbati'(Basella alba L.) Leaf Powder to Increase Vitamin A Content of Fresh Egg Noodles. *Philippine Journal of Science, 149*(2).

Suri, S., Kumar, V., Singh, B., & Singh, D. (2020). Sensory attributes, cooking quality, and proximate composition of noodles supplemented with quinoa (Chenopodium quinoa) flour. *Journal of Food Science and Technology, 57*(12), 4290–4297. https://doi.org/10.1007/s13197-020-04506-w

Susanti, S., Dwiloka, B., Bintoro, V. P., Hintono, A., Nurwantoro, N., & Setiani, B. E. (2021). Antioxidant status, nutrition facts, and sensory of spinach extract fortified wet noodles. *Food Research, 5*(6), 266–273. https://doi.org/10.26656/fr.2017.5(6).755

Tan, P. Y., Chan, C. L., Som, S. V., Dye, L., Moore, J., Caton, S., Gong, Y. (2024). Prevalence and key determinants of the triple burden of childhood malnutrition in Southeast Asian countries: a systematic review and meta-analysis within an adapted socio-ecological framework. *Critical Reviews in Food Science and Nutrition,* 1-15.

Tongco, J. V. V., Añis, A. D., & Tamayo, J. P. (2015). Nutritional analysis, phytochemical screening, and total phenolic content of Basella alba leaves from the Philippines. *International Journal of Pharmacognosy and Phytochemical Research, 7*(5), 1031-1033.

Ulep, V. G., Talamayan, J. T., Casas, L., Conjares, M. N. T. M., Valentin, C. S., & Nkoroi, A. (2025). Harvesting insights: Assessment of food systems for children in the Philippines (No. 2025-18). PIDS Discussion Paper Series.

Yakum, K. N., Ariahu, C. C., Ariahu, E. C., & Igoli, J. O. (2024). Physicochemical properties of fortified coconut milk–based chocolate-like drinks as influenced by cocoa powder and sugar levels. *American Journal of Food Science and Technology, 3*(1). https://doi.org/10.54536/ajfst.v3i1.2573

Yan, C., Kim, W., Ruiz, W., & Farmer, J. (2022). Storage stability of vitamins in microcapsules: Aluminum foil-sealed packaging offers the best protection. *Journal of Food Stability, 5*(1), 1–10. https://doi.org/10.37256/jfs.5120221105

Zula, A. T., Ayele, D. A., & Egigayhu, W. A. (2021). Proximate composition, antinutritional content, microbial load, and sensory acceptability of noodles formulated from Moringa oleifera leaf powder and wheat flour blend. *International Journal of Food Science, 2021*(1), 6689247. https://doi.org/10.1155/2021/6689247