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Nutrimosa (Moringa Flour-Chicken Samosa): High-Protein Iron-Rich Functional Food Innovation For Stunting Prevention In Children And Pregnant Women During The First 1000 Days of Life

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ABSTRACT

Stunting remains a significant public health challenge in Indonesia, with a national prevalence of 21.5% (SKI 2023) and 23.3% in South Sulawesi (2024), exceeding the WHO threshold of 20%. Globally, approximately 148 million children under five are affected by stunting (WHO/UNICEF/World Bank, 2023), underscoring the urgency of evidence-based, locally-adapted food interventions. This study aimed to formulate Nutrimosa (Moringa Flour-Chicken Samosa) as a high-protein and iron-rich functional snack for children and pregnant women in stunting prevention efforts, and to assess its organoleptic acceptability. An experimental food product development study was conducted at Posyandu Merpati III, Puskesmas Biru, Bone Regency, South Sulawesi, in May 2026, following ethics approval from the Health Research Ethics Commission of Poltekkes Makassar (No. EC/2026). Nutritional content was analyzed using TKPI 2020 food table analysis. Organoleptic evaluation was conducted with 30 semi-trained panelists (80% female; 43.3% aged 19–30 years; 56.7% aged 31–51 years) using a validated 4-point hedonic scale. Each Nutrimosa piece (43 g) contains 88.2 kcal energy, 4.30 g protein, 6.44 g fat, 6.96 g carbohydrate, and 0.97 mg iron. Consuming 3 pieces daily provides 264.6 kcal (15–20% of daily energy requirements), 12.9 g protein, and 2.91 mg iron — contributing 29% toward the iron RDA for children aged 6–11 years and 10.8% toward the iron RDA for pregnant women. Organoleptic results demonstrated excellent acceptability: color 100%, aroma 100%, taste 100%, and texture 96.7% positive. Nutrimosa is a locally-based functional food product feasible for development as an alternative supplementary food (PMT) for children and pregnant women, with excellent acceptability and meaningful protein and iron content contributing to stunting and anemia prevention within Indonesia's national nutrition program.

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Key Messages:

- Nutrimosa, made from locally available moringa flour and chicken, offers a practical, nutrient-dense snack that is affordable and well-accepted.
- Consuming 3 pieces daily provides 15–20% of daily energy needs and 29% of children's daily iron requirements, making it a meaningful contribution to micronutrient adequacy.
- This local-based functional food has strong potential as an integrated PMT solution within Indonesia's national stunting prevention program during the First 1000 Days of Life, with viable economic feasibility for local SME implementation.

Introduction

Indonesia faces a significant challenge in improving the nutritional status of children and pregnant women. The 2023 Indonesia Health Survey (SKI) reported a stunting prevalence of 21.5% among children under five, still above the national target of 14% by 2024. In South Sulawesi, stunting prevalence reached 23.3% (Ulfah et al., 2026), exceeding the WHO threshold of 20%, making it a serious public health concern requiring specific intervention. Globally, the UNICEF/WHO/World Bank Joint Malnutrition Estimates (2023) report that approximately 148 million children under five are stunted, with the highest burdens concentrated in South Asia and Sub-Saharan Africa, underscoring the need for scalable, food-based intervention models adaptable to local contexts.

Stunting is a condition of chronic growth failure resulting from long-term nutritional deficiency,

especially during the First 1,000 Days of Life (1000HPK), from pregnancy until the child reaches two years of age. The impacts of stunting are permanent and multidimensional, including cognitive impairment, reduced productivity, and increased risk of degenerative diseases in adulthood (WHO, 2020). Contributing factors include suboptimal breastfeeding, inadequate complementary feeding practices, insufficient food access, and inadequate micronutrient intake, particularly protein and iron (Faber et al., 2022).

Functional foods — defined by the FAO/WHO as foods that, beyond basic nutritional value, beneficially affect one or more target functions in the body and thereby improve health and well-being or reduce risk of disease (FAO/WHO, 2002) — have gained international recognition as a promising, cost-effective approach to address micronutrient deficiency among vulnerable populations. Evidence from sub-Saharan Africa and Southeast Asia demonstrates that locally-derived functional food products can significantly improve iron and protein status in children and pregnant women when integrated into community supplementary feeding programs (Arimond & Ruel, 2004; Olney et al., 2009).

Moringa (Moringa oleifera) is a local Indonesian plant known as the 'miracle tree' due to its extraordinary nutritional content, including high-quality plant protein, calcium, iron, vitamin A, and vitamin C that far exceed many conventional food sources. Internationally, Moringa oleifera has been extensively studied as a functional food ingredient: Anwar et al. (2007) demonstrated its exceptional phytochemical and nutritional profile, while Leone et al. (2015) confirmed that moringa-based supplementary foods significantly improved nutritional indicators in malnourished populations across multiple low- and middle-income countries. Zakaria et al. (2020) demonstrated that supplementary foods modified with moringa leaf flour significantly improved the nutritional status of energy-deficient pregnant women (KEK) in Gowa Regency, affirming moringa's potential as a functional food ingredient for malnutrition prevention.

Chicken meat is a popular and widely available source of animal protein in Indonesia, containing approximately 18–21 grams of protein per 100 grams with high biological value, rich in essential amino acids, heme iron, zinc, and B vitamins essential for optimal child growth and maternal health during pregnancy (Simbolon et al., 2021). The combination of animal protein from chicken and plant-based protein and iron from moringa creates an ideal nutritional synergy for stunting and iron-deficiency anemia prevention.

Based on a situational analysis at Posyandu Merpati III, Puskesmas Biru, Bone Regency, a high stunting prevalence was found alongside very low animal protein consumption among children under five and pregnant women with chronic energy deficiency (KEK). This study aimed to formulate Nutrimosa, analyze its nutritional content, and determine its organoleptic acceptability as part of the 1000HPK stunting intervention framework.

Methods

Study Design. This experimental food product development study was conducted at Posyandu Merpati III, Puskesmas Biru, Bone Regency, South Sulawesi, from April to May 2026. Research ethics approval was obtained from the Health Research Ethics Commission of Poltekkes Makassar (approved June 20, 2026). The study was conducted in two phases: (1) product development and formulation of Nutrimosa with nutritional analysis using TKPI 2020 data; and (2) organoleptic testing using a hedonic test.

Nutrimosa Formula. Nutrimosa is a modified samosa consisting of: (1) ready-made samosa wrappers dipped in moringa leaf flour (50 g), and (2) a filling of minced chicken combined with fresh moringa leaves, carrots, eggs, and aromatic curry spices. The standard recipe yields approximately 30 pieces of Nutrimosa each weighing approximately 43 grams. Main ingredients included samosa wrappers (360 g), moringa leaf flour (50 g), minced chicken (350 g), fresh moringa leaves (140 g), carrots (200 g), eggs (165 g), and seasoning ingredients.

Nutritional Analysis. Nutritional content was calculated using food table analysis based on the Indonesian Food Composition Table (TKPI) 2020, computing contributions of each ingredient to the total nutritional content of the product, including energy (kcal), protein (g), fat (g), carbohydrate (g), and iron (mg). Contribution to Recommended Dietary Allowances (RDA) was calculated based on AKG 2020.

Organoleptic Testing. A hedonic test was conducted on May 14, 2026 with 30 semi-trained panelists using a 4-point rating scale: 1 = dislike, 2 = slightly like, 3 = like, 4 = very like. Attributes assessed included color, aroma, taste, and texture. All panelists signed informed consent prior to participation. Exclusion criteria: history of allergy to Nutrimosa ingredients (egg, chicken, gluten, moringa). Data were analyzed descriptively using Microsoft Excel (frequency, percentage, mean). It is acknowledged as a study limitation that panelists were adult community members; future studies should recruit the primary target population (children aged 6–59 months and pregnant women) to more accurately represent actual consumer acceptability and inform clinical recommendations.

Results

Nutritional Profile of Main Ingredients. Moringa leaves and chicken are the two main raw materials in Nutrimosa, selected based on their complementary nutritional profiles. Moringa leaves (Table 1) are an extraordinary source of nutrition with 6.7 g protein/100 g and 4.0 mg iron/100 g, making them one of the best plant-based iron sources. Vitamin A (783 µg/100 g) plays an important role in immunity and child visual development, while vitamin C (51.7 mg/100 g) enhances non-heme iron

absorption through the reduction of Fe^{3+} to Fe^{2+} (Winarno, 2004).

Table 1. Nutritional Content of Moringa Leaves per 100 g

Nutrient	Content per 100 g
Energy	92 kcal
Protein	6.7 g
Fat	1.7 g
Carbohydrate	8.3 g
Calcium	185 mg
Phosphorus	112 mg
Iron (Fe)	4.0 mg
Vitamin A	783 µg
Vitamin B1	0.21 mg
Vitamin C	51.7 mg
Water	75 g

Source: Ministry of Health of Republic Indonesia (2020)

Chicken meat (Table 2) is a high-quality animal protein source with 18.2 g protein/100 g. Chicken protein has a high biological value as it contains all essential amino acids. Heme iron (1.5 mg/100 g) in chicken has 2–3 times higher bioavailability compared to non-heme iron from plant sources, making it an ideal complement to the iron content from moringa leaves in the Nutrimosa formulation (Simbolon et al., 2021).

Table 2. Nutritional Content of Chicken Meat per 100 g

Nutrient	Content per 100 g
Energy	179 kcal
Protein	18.2 g
Fat	25.0 g
Carbohydrate	0 g
Calcium	14 mg
Phosphorus	200 mg
Iron (Fe)	1.5 mg
Vitamin A	72 µg
Vitamin B1	0.08 mg
Water	55.9 g

Source: Ministry of Health of Republic Indonesia (2020)

Nutritional Value of Nutrimosa. Table 3 shows the nutritional composition of Nutrimosa. Total ingredient weight of 1,295 grams yielded 30 pieces of Nutrimosa with total energy 2,601.4 kcal, protein 127.30 g, fat 192.94 g, carbohydrate 199.21 g, and iron 27.24 mg. The high total iron content reflects significant contributions from moringa flour (9.87 mg) and fresh moringa leaves (5.60 mg) as abundant plant-based iron sources, supported by chicken (5.25 mg) as a high-bioavailability heme iron source.

Table 3. Nutritional Value of Nutrimosa Product

Food Ingredient	Weigh t (g)	Energy (kcal)	Protein (g)	Fat (g)	CHO (g)	Iron (mg)
Samosa Wrapper	360	1,152.0	21.60	54.00	151.20	1.80
Moringa Flour (dipping)	35	71.8	9.48	0.81	13.37	9.87
Chicken Meat	350	626.5	63.70	87.50	0	5.25
Fresh Moringa Leaves	140	128.8	9.38	2.38	11.62	5.60
Garlic	15	14.2	0.68	0.03	3.27	0.15
Carrots	200	84.0	2.00	0.40	18.60	1.60
Eggs	165	254.1	20.46	17.82	1.15	2.97
Cooking Oil (absorption)	30	270.0	0	30.00	0	0
Total	1,295	2,601.4	127.30	192.94	199.21	27.24

Per Piece (43 g, 30 pcs)	43	88.2	4.30	6.44	6.96	0.97

Source: Primary Data, 2026

Each Nutrimosa piece (±43 g) contains 88.2 kcal energy, 4.30 g protein, 6.44 g fat, 6.96 g carbohydrate, and 0.97 mg iron. By consuming 3 pieces of Nutrimosa as a snack, children can obtain 264.6 kcal energy, 12.9 g protein, and 2.91 mg iron, equivalent to 15–20% of daily energy requirements and contributing 29% toward the iron RDA for children aged 6–11 years (10 mg/day) and 10.8% toward the iron RDA for pregnant women (27 mg/day).

Panelist Characteristics. Of 30 panelists, 24 (80%) were female and 6 (20%) were male. Based on age, 13 panelists (43.3%) were aged 19–30 years and 17 panelists (56.7%) were aged 31–51 years (Table 4). The predominance of female panelists provides relevant perspective, as women are the primary decision-makers in family food provision and most influence children's eating habits.

Table 4. Panelist Characteristics Distribution

Variable	n	%
Sex		
Male	6	20
Female	24	80
Age Group		
19–30 years	13	43.3
31–51 years	17	56.7
Total	30	100

Source: Primary Data, 2026

Organoleptic Acceptability. Table 5 presents the complete organoleptic acceptability results across all four sensory attributes.

Table 5. Organoleptic Acceptability Distribution of Nutrimosa

Indicator	Dislike n (%)	Slightly Like n (%)	Like n (%)	Very Like n (%)	Total Positive (%)
Color	0 (0)	0 (0)	22 (73.3)	8 (26.7)	100
Aroma	0 (0)	0 (0)	11 (36.7)	19 (63.3)	100
Taste	0 (0)	0 (0)	11 (36.7)	19 (63.3)	100
Texture	0 (0)	1 (3.3)	19 (63.3)	10 (33.3)	96.7

Source: Primary Data, 2026

Color: All respondents (100%) responded positively to the color of Nutrimosa. The distinctive brownish-green color resulting from dipping the wrapper in moringa flour provides a unique and appetizing appearance that visually distinguishes Nutrimosa from conventional samosa.

Aroma: Aroma acceptability reached 100% positive, with 19 respondents (63.3%) rating 'Very Like' and 11 (36.7%) rating 'Like'. The aromatic curry spices in the chicken-moringa filling effectively masked the characteristic smell of moringa that some consumers may find unpleasant, generating appetite-stimulating aromatic compounds.

Taste: Taste acceptability also reached 100% positive, with 19 respondents (63.3%) rating 'Very Like' and 11 (36.7%) rating 'Like'. The combination of savory minced chicken, fresh moringa leaves, aromatic curry spices, and slightly sweet carrots creates a complex yet harmonious flavor profile unique to Nutrimosa.

Texture: Texture acceptability reached 96.7% positive: 19 respondents (63.3%) rated 'Like', 10 (33.3%) 'Very Like', and 1 (3.3%) 'Slightly Like'. The single 'Slightly Like' rating likely reflects individual preferences for crispier wrappers. The crispy exterior and soft interior of Nutrimosa successfully met the expectations of the majority of panelists.

Discussion

Nutrimosa successfully combines two complementary nutritional sources: chicken as a high-quality animal protein source and moringa as a source of iron, plant protein, vitamins, and antioxidants. The per-piece nutritional profile (energy 88.2 kcal, protein 4.30 g, iron 0.97 mg) qualifies Nutrimosa as a high-protein healthy PMT with meaningful iron content to support stunting and anemia prevention.

Organoleptic results demonstrated excellent acceptability across all four indicators, with color, aroma, and taste achieving perfect acceptance (100%), while texture received 96.7% positive ratings. No panelist rated 'Dislike' on any indicator. These results are consistent with Simbolon et al. (2021), who found that incorporating moringa into food products can enhance attractiveness and acceptance, and with Suryono et al. (2018), who confirmed that color is the first visual factor determining consumer willingness to try a product.

Globally, similar moringa-based food product interventions have demonstrated comparable

findings. Anwar et al. (2007) systematically reviewed moringa-enriched food products across multiple low-income countries and confirmed high organoleptic acceptance when moringa was combined with spices and animal protein, paralleling the favorable results observed for Nutrimosa. Leone et al. (2015) further documented that moringa-fortified biscuits and snack products produced in East Africa and Southeast Asia consistently achieved acceptability rates above 90% in community trials, attributable to effective flavor masking by complementary ingredients — a finding mirrored in the 100% aroma and taste acceptance of Nutrimosa achieved through the use of curry spices. Compared to WHO-recommended minimum dietary diversity standards for complementary foods, which emphasize the need for iron-rich foods to be provided at least once per day for children aged 6–23 months, Nutrimosa's 3-piece serving contributing 29% of children's daily iron RDA represents a meaningful and practical contribution to meeting these global benchmarks (WHO, 2020).

The bioactive profile of Nutrimosa adds functional value beyond basic nutrition. Moringa leaves contain isothiocyanates, quercetin, and chlorophyll with antioxidant and anti-inflammatory properties (Krisnadi, 2015), while curry spices contain curcumin from turmeric with proven anti-inflammatory activity (Hewlings & Kalman, 2017). Vitamin C in moringa (51.7 mg/100 g) also enhances non-heme iron absorption, maximizing iron bioavailability from the product (Winarno, 2004). This functional food profile aligns with the FAO/WHO (2002) framework defining functional foods as those providing health benefits beyond basic nutrition, meeting the criteria through its combined protein, iron, antioxidant, and anti-inflammatory components.

From an economic standpoint, with a selling price of IDR 3,500 per piece and a break-even point of only 10 out of 30 pieces per recipe, Nutrimosa demonstrates high economic feasibility as a local SME product. Compared to low-nutritional-value packaged snacks typically sold at IDR 3,000–5,000, Nutrimosa offers significantly higher nutritional value per rupee, aligning with Putrawansyah et al. (2025) recommendations on optimizing nutritious locally-based PMT at posyandu. An international comparison is instructive: Olney et al. (2009) found that community-produced complementary food interventions in Cambodia costing less than USD 0.20 per serving achieved a significant reduction in child stunting prevalence over 6 months when distributed through integrated nutrition programs — highlighting the potential of affordable, locally-produced functional foods when embedded in systematic distribution platforms.

Zakaria et al. (2020) demonstrated that supplementary foods modified with moringa leaf flour significantly improved the nutritional status of energy-deficient pregnant women (KEK). Combined with the high acceptability found in this study, Nutrimosa has great potential as an innovative, sustainable PMT solution to support Indonesia’s national stunting prevention program during the critical 1000HPK window.

This study has several limitations that should be acknowledged. First, nutritional content was calculated using TKPI 2020 food composition tables rather than direct laboratory proximate analysis; future studies should validate nutrient content through laboratory testing to account for cooking losses, particularly iron bioavailability. Second, the panelist sample consisted of adult community members rather than the primary target population (children under five and pregnant women), which may limit direct generalizability of acceptability findings. Third, the absence of a clinical intervention component means that the impact of regular Nutrimosa consumption on stunting indicators (HAZ, WAZ) remains to be established through controlled trial designs.

Conclusion

Nutrimosa is feasible to develop as an alternative supplementary food (PMT) for children and pregnant women in stunting and anemia prevention during the 1000HPK period, with potential integration into posyandu programs and local SME development. Nutrimosa (Moringa Flour-Chicken Samosa) is an innovative locally-based functional food product successfully developed with an optimal nutritional profile: 88.2 kcal energy, 4.30 g protein, and 0.97 mg iron per piece (43 g). Organoleptic acceptability was excellent across all sensory aspects: color 100%, aroma 100%, taste 100%, and texture 96.7% positive.

Nutrimosa is feasible to develop as an alternative supplementary food (PMT) for children and pregnant women in stunting and anemia prevention during the 1000HPK period. Based on a production cost of approximately IDR 2,100 per piece and a recommended selling price of IDR 3,500, Nutrimosa is economically viable for integration into posyandu-based supplementary feeding programs and local SME development with a favorable cost-benefit ratio.

For practical program integration, the following distribution model is recommended: (1) production by trained posyandu cadres or local women's groups (PKK) at village level, utilizing locally available moringa and chicken; (2) distribution of 3 pieces per child per posyandu session, targeting children aged 6–59 months and pregnant women with chronic energy deficiency (KEK), as part of the national PMT program; (3) monthly cost per beneficiary estimated at IDR 63,000–90,000 (3 pieces × 20–30 sessions), representing a cost-effective supplement to existing nutrition interventions. Future research should validate nutritional content through proximate laboratory analysis, broaden panelist diversity to include the primary target population, and conduct a pilot randomized controlled trial to assess the impact of regular Nutrimosa consumption on anthropometric indicators of stunting.

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Conflicts of Interest The authors declare no conflict of interest.

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