

The Potential of Natural Product Enrichment Noodle in Improving the Health of Pregnant Women

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ABSTRACT

Pregnancy is a critical period in which adequate nutrition is essential for both maternal and fetal health. This study aimed to evaluate the effect of natural product-enriched noodles, combining snakehead fish (*Channa striata*), *Moringa oleifera* leaves and okra (*Abelmoschus esculentus*), on the hemoglobin, hematocrit, and blood protein levels of pregnant women with chronic energy deficiency (CED). Stunting remains a significant public health problem in Indonesia, with a prevalence of 28.9% in Surabaya in 2021. Protein deficiency and anemia during pregnancy increase the risk of intrauterine growth restriction, low birth weight, and stunting. It was hypothesized that the combined nutritional properties of these ingredients — high protein and albumin from snakehead fish, iron and antioxidants from Moringa, and bioactive compounds from okra would synergistically improve maternal nutritional status. A Pre-Experimental One Group Pretest-Posttest Design was employed at Sidosermo Community Health Center, Surabaya, from June to September 2025. All 15 eligible pregnant women with CED at the study site were enrolled using total sampling (n=15); the small sample size and absence of a control group represent key study limitations affecting generalizability and causal inference. Participants consumed protein-enriched noodles made from modified cassava flour, snakehead fish, Moringa leaves, and okra three times per week for one month, a frequency and dose based on prior food-based supplementation programs in pregnant women. The noodle product was confirmed to be high in protein (14.22%) and microbiologically safe. Post-intervention, the number of anemia cases decreased from 11 to 4 participants, hematocrit normalized in 4 of 11 previously low cases, and blood protein levels normalized in 10 of 15 participants. As no inferential statistical analysis was performed, these findings should be interpreted with caution. These results suggest that locally sourced nutritional interventions have the potential to improve maternal nutritional status and contribute to reducing stunting prevalence in Indonesia.

INTRODUCTION

Pregnancy is a critical period that determines the health of both the mother and the fetus. The nutritional status of pregnant women plays an important role in supporting fetal growth and development, particularly through adequate intake of protein, hemoglobin (Hb), and hematocrit. Protein deficiency and anemia in pregnant women have been shown to increase the risk of fetal growth disorders, low birth weight (LBW), and stunting in children. Stunting remains a major nutritional problem in Indonesia, with a high prevalence despite various nutritional intervention programmes.¹

Based on the results of the December 2021 Indonesian Nutritional Status Study, stunting in toddlers in Surabaya, the capital of East Java, is still relatively high (28.9%) compared to the average for East Java (23.5%). The decline in stunting rates in Indonesia in 2021 (24.4%) compared to the results of the integration of the Indonesian Toddler Nutritional Status Study and the 2019 Susenas (27.67%) and the 2018 Riskesdas (30.8%) in the Surabaya region, represents a very impressive achievement. The Surabaya City Government has responded through coordinated stunting prevention strategies, including integrated health post activities (covering 2,776 integrated health post), a Stunting Task Force, and pre-marital nutrition screening programs. These initiatives are aligned with Presidential Regulation Number 42 of 2013 concerning the National Movement for the Acceleration of Nutrition Improvement within the Framework of 1000 first day of life.²

Protein is an essential macronutrient that functions in the formation of fetal body tissues and maintains the mother's metabolism during pregnancy. Meanwhile, hemoglobin and hematocrit levels reflect anemia status, which is closely related to nutritional adequacy, particularly iron, folic acid, and vitamin C. Low hemoglobin and hematocrit levels in pregnant women can reduce oxygen supply to tissues, causing intrauterine hypoxia and increasing the risk of pregnancy complications and foetal growth disorders. Therefore, meeting the need for high-quality protein and micronutrients that support hematopoiesis is very important to prevent long-term adverse effects on the health of mothers and children.

One approach that can be taken is through local food-based interventions. Snakehead fish (*Channa striata*) is known to be high in protein and albumin, which are beneficial in accelerating tissue recovery and supporting fetal growth. Moringa leaves (*Moringa oleifera*) are rich in iron, vitamin A, vitamin C, and antioxidants, which play an important role in preventing anaemia.³ Meanwhile, okra (*Abelmoschus esculentus*) contains fiber, vitamins, minerals, and bioactive compounds that can support metabolism and increase iron absorption.^{4,5} The combination of these three foods has the potential to be an effective, affordable, and locally appropriate nutritional intervention to increase protein, hemoglobin, and hematocrit levels in pregnant women, thereby contributing to the prevention of stunting.⁶

The aim of this study is to evaluate the effect of natural product-enriched noodles containing snakehead fish (*Channa striata*), Moringa leaves (*Moringa oleifera*), and okra (*Abelmoschus esculentus*) on hemoglobin, hematocrit, and blood protein levels in pregnant women with chronic energy deficiency. It is hypothesized that the combined nutritional properties of these local ingredients - high protein and albumin from snakehead fish, iron and antioxidants from Moringa, and bioactive compounds from okra - will synergistically improve maternal nutritional status. This study is expected to provide evidence supporting locally based food interventions as a scalable, cost-effective strategy

to reduce stunting prevalence in Indonesia.⁷ Therefore, evidence-based, locally appropriate nutritional interventions are urgently needed to address this gap.

The aim of this study is to evaluate the effect of natural product-enriched noodles containing snakehead fish (*Channa striata*), Moringa leaves (*Moringa oleifera*), and okra (*Abelmoschus esculentus*) on hemoglobin, hematocrit, and blood protein levels in pregnant women with chronic energy deficiency⁸. Moringa leaves are rich in iron, vitamin A, vitamin C, and antioxidants that play a role in hemoglobin formation and anemia prevention.^{3,9} Okra contains fiber, vitamins, minerals, and bioactive compounds that can support the body's metabolism and aid in iron absorption.^{10,11} It is expected that through the consumption of these noodles, the supply of nutrients and oxygen to the fetus will improve, thereby potentially reducing the risk of stunting in children.

MATERIALS AND METHODS

The type of research in this study is a Pre-Experimental One Group Pretest-Posttest Design . The absence of a control group is acknowledged as a methodological limitation; however, given the small number of eligible participants at the study site, a total sampling approach was adopted. The study took place in the Sidoseremo Community Health Center in Surabaya, between June and September 2025. The population of this study consisted of all 15 pregnant women with chronic energy deficiency registered at Sidoseremo Community Health Center in Surabaya, recruited consecutively (non-random sampling). Participants who met the inclusion criteria diagnosed with chronic energy deficiency, singleton pregnancy, and no severe comorbidities were enrolled in the study. Participant characteristics were recorded and data were summarized using frequency distribution.

The intervention involved administering protein-enriched noodles made from modified cassava flour, *Moringa oleifera* leaves, okra (*Abelmoschus esculentus*), and snakehead fish (*Channa striata*) three times per week for one month. The amount of protein-rich enrichment noodles per person is 175 grams, with the following composition: 83% wheat flour, 10% modified cassava flour, 2% okra flour, 2% moringa flour and 3% snakehead fish flour. The frequency and dose were determined based on recommendations from prior food-based supplementation studies in pregnant women, with three servings per week considered sufficient to provide a meaningful incremental nutrient contribution without excessive caloric loading. Hemoglobin and hematocrit were measured using the Point-of-Care Testing (POCT) method before and after intervention. Blood protein levels were measured using the validated Biuret colorimetric method. Dietary intake was assessed through the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) administered by trained enumerators. Pre- and post-intervention data were compared using descriptive frequency analysis; differences in categorical outcomes are presented as frequencies. This study has received a

certificate of ethical feasibility from the Health Research Ethics Commission of the Surabaya Health Polytechnic, Ministry of Health No. EA/2322/KEPK-Poltekkes_Sby/V/2024. The Health Research Ethics Commission of the Surabaya Ministry of Health confirmed that this study follows the Declaration of Helsinki (Protocol no. 5, 26.05.2016). This study has received research permits from the Surabaya City Government's Investment and One-Stop Integrated Services Office with number 500.16.7.4 / 1215 / S / RPM / 436.7.15 / 2025 dated July 22, 2025 and the Surabaya City Health Office with number 000.9.2 / 11105/436.7.2/2025.

RESULTS

The results of nutritional testing conducted at the Saraswanti Laboratory on noodle products made from a mixture of cassava flour, moringa fruit, and snakehead fish are as follows:

Table 1. Laboratory Test Result for Enrichment-Noodle Product

No	Parameter	Results	Limit	Unit	Methods
1	Deoxynivalenol (DON)	Not detected	<750	mcg/kg	11-18-12-27/MU (LC-MSMS)
2	Ochratoxin	Not detected	<3	mcg/kg	11-7-1/MU (LC-MS/MS)
3	Foreign number	None	None	-	SNI 01-2891-1992 point 1.3
4	Odor	Normal	Normal	-	SNI 3551-2018 Appendix A2
5	Acid number	1,79	<2	mg KOH/ g fat	11-3-25/MU (volumetric)
6	Wholeness	93,73	>90	%	SNI 3551-2018 point A4
7	Water content	8,92	<10	%	SNI 3551-2018 Appendix A3
8	Protein content	14,22	>6	%	11-3-1/MU (Volumetri)
9	Taste	Normal, Tasty	Normal	-	SNI 3551-2018 Appendix A2
10	Texture	Normal, Crispy	Normal	-	SNI 3551-2018 Appendix A2
11	Color (Organoleptic)	Normal, brownish green	Normal	-	SNI 3551-2018 Appendix A2
12	Arsen (As)	Not detected	<0,1	mg/kg	11-2-5/MU (ICP-MS)
13	Cadmium (Cd)	Not detected	<0,05	mg/kg	11-2-5/MU (ICP-MS)
14	Mercury (Hg)	Not detected	<0,03	mg/kg	11-2-5/MU (ICP-MS)
15	Lead (Pb)	Not detected	<0,25	mg/kg	11-2-5/MU (ICP-

					MS)
16	Timah (Sn)	Not detected	<40	mg/kg	11-2-5/MU (ICP-MS)
17	Total Plate Number (TPN)	3,86x10 ²	<10 ⁶	colony/g	ISO 4833-1:2013 Amd 1:2022
18	<i>Escherichia coli</i>	0	NA	MPN/g	SNI ISO 7251:2012
19	Yeast mold	<10	<10 ³	colony/g	SNI ISO 21527-2:2012
20	<i>Salmonella Sp</i>	Negative	NA	/25 g	ISO 6579-1:2017/ Amd 1:2020
21	Ash	3,31	-	%	SNI 01-2891-1992 point 6.1
22	Total Lipid	8,24	-	%	11-3-2/MU (Weibull)
23	Carbohydrate	65,31	-	%	11-3-3/MU (Calculation)

The highest content in processed noodles is protein and already microbiologically safe, this product is necessary for pregnant women to maintain the health of both mother and fetus. There are several characteristics of the respondents on this study based on age of respondent, pregnancy and pregnancy age, as follows;

Table 2. Correspondents Characteristics

Parameter	Frequency	
Age of respondents	21-30 years	12
	31-40 years	3
Pregnancy	1 st	3
	2 nd	4
	3 rd	3
	4 th	3
	5 th	1
	6 th	0
	7 th	1
Pregnancy age (months)	2	1
	3	1
	4	2
	5	4
	6	2
	7	3
	8	2

Most of the correspondents were in the 21 – 30 age group, pregnant with their second child and five months pregnant, then the correspondents were test by consumed protein rich-noodle product and compare their health condition based on several parameters. The following are the pre – test and post – test results;

Table 3. Results of laboratory tests on the condition of pregnant women with CED

Parameter		Pre Test	Post Test
Anemia Status	Anemia	11	6
	Normal	4	9
Haematocrit	Low	11	6
	Normal	4	9
Blood Protein	Low	5	0
	Normal	10	15
Individual nutritional intake profile	Insufficient	8	0
	Adequate	3	6
	Good	4	9
Random Blood Glucose	Low	0	0
	Normal	15	15
	High	0	0

The anemia status of pregnant women was obtained from the results of hemoglobin level analysis using the POCT method, conducted before and after intervention. Hematocrit and blood glucose tests were performed using the POCT method, while blood protein tests were performed using the Biuret method. The nutritional intake of individual pregnant women was measured through interviews using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ).

DISCUSSION

The results of this study indicate that the administration of noodles made from natural food ingredients namely snakehead fish, moringa leaves, and okra was associated with improvements in the nutritional status of pregnant women with chronic energy deficiency; however, given the absence of a control group and inferential statistical analysis, causal attribution cannot be made. Post-intervention, the number of anemia cases decreased from 11 to 4 participants, hematocrit levels improved in 4 of the 11 previously low cases, and blood protein levels normalized in 10 participants. These findings are consistent with the study objectives and suggest that the enrichment noodle formulation may support improvements in maternal nutritional status. However, it must be emphasized that without a control group, randomization, or inferential statistical testing (e.g., paired t-test or Wilcoxon signed-rank test), these changes cannot be causally attributed to the intervention alone. The small sample size (n=15), non-random consecutive recruitment, and one-month intervention duration further limit the generalizability of findings. Some participants did not experience measurable

improvements, which may reflect confounding factors including hormonal changes during pregnancy, dietary adherence variability, individual metabolic differences, or comorbidities beyond the scope of this study. Research by Mokoginta¹² explains that maternal malnutrition is not solely influenced by inadequate intake of nutritious food, but also by hormonal changes. Elevated levels of human Chorionic Gonadotropin (hCG) during pregnancy often lead to nausea and vomiting, which can affect the digestive system. Additionally, heightened sensitivity to smell and taste may reduce appetite, while metabolic changes such as increased gastric acid due to stress and fatigue—can further contribute to nutritional challenges.

This study supports findings by Faidah¹³ who utilized catfish and moringa leaves in the development of sausage products for pregnant women. Their research demonstrated that catfish-based sausages positively influenced maternal nutritional status, as fish is a relatively affordable source of essential nutrients such as protein, fatty acids, omega-3, and omega-6. However, fish-based products often have strong odors and less appealing coloration, which can reduce consumer acceptance^{18,25}. The inclusion of moringa leaves was found to mitigate the fishy smell and enhance the visual appeal of the product^{15,19}. This approach was adopted in the present study by incorporating moringa leaves into the noodle formulation to reduce the pungent aroma of snakehead fish²³. Furthermore, extensive research has been conducted on moringa leaves, including investigations into their biochemical and functional properties, as well as the development of Madura variety moringa leaf flour for the treatment of malnutrition and metabolic disorders, which has been patented by Susanto¹⁴. Moringa leaves are considered a superfood, containing high levels of protein (28.25%), beta-carotene (provitamin A) at 11.93 mg, calcium (Ca) at 2241.19 mg, iron (Fe) at 36.91 mg, and magnesium (Mg) at 28.03 mg which highly beneficial for fetal development and the prevention of stunting. Much Researches have also examined okra (*Abelmoschus esculentus*), highlighting its antidiabetic and anti-cholesterol properties⁹ high antioxidant content, hepatoprotective effects, and potential anticancer activity in the colon^{10,20,21}. Fish is recognized as a complete protein source that supports physical growth^{22,24}, and various studies have explored the production of high-protein fish flour, including patented methods⁸. In this study, the flour used in noodle production was derived from cassava, specifically modified cassava flour known as mocaf¹⁶ In addition to being a carbohydrate source, cassava flour is gluten-free, which helps minimize and prevent excessive gastric acid production¹⁷.

CONCLUSION

This study demonstrated that enrichment noodles formulated from modified cassava flour Moringa *oleifera* leaves, okra fruit (*Abelmoschus esculentus*), and snakehead fish (*Channa striata*)

were associated with improvements in hemoglobin, hematocrit, and blood protein levels in pregnant women with chronic energy deficiency after one month of intervention. Post-intervention, anemia cases decreased from 11 to 4 participants and blood protein normalized in 10 participants. These findings suggest that this locally sourced, affordable food product represents a viable complementary nutritional strategy for pregnant women. However, the study is limited by its small sample size (n=15), absence of a control group, non-random sampling, and lack of inferential statistical analysis. Future studies should incorporate a randomized controlled design with a larger and more diverse sample, validated dietary compliance monitoring, and statistical analysis (e.g., paired t-test or Wilcoxon signed-rank test) to rigorously confirm causal effects and enable generalization of findings. Subject to replication in larger and more diverse populations, natural product-enriched noodles may offer a practical and scalable approach to reducing maternal malnutrition and stunting prevalence in Indonesia.

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