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Original Article

The Impact of Moringa Leaf-Based Innovations on Hemoglobin Levels among Pregnant Women

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Abstract

Background: Anemia among pregnant women remains a pressing public health concern, particularly in regions with limited access to nutritious food. This study assessed the impact of supplementing Moringa leaf extract in conjunction with iron (Fe) tablets on Hemoglobin (Hb) levels during pregnancy.

Methods: This study used a quasi-experimental approach conducting both pre- and post-tests on participants who were given either Moringa extract along with Fe tablets (intervention group) or only Fe tablets (control group). Conducted in Penyengat Olak Village, Muaro Jambi Regency, Indonesia from March to November 2024, the study involved 80 pregnant women who were randomly allocated into two equal groups. Hemoglobin levels were assessed before and after a 14-day intervention. Data were analyzed using paired and independent t-tests.

Results: The experimental group experienced a significant increase in mean Hb levels from 11.27 g/dL to 12.12 g/dL (P<0.0001). The control group also saw an improvement (11.27 g/dL to 11.70 g/dL; P<0.0001), though to a lesser extent. The difference in post-intervention Hb levels between the two groups was statistically significant (P=0.017).

Conclusions: The dual supplementation of Moringa leaf extract and Fe tablets demonstrated greater efficacy in raising Hemoglobin levels among pregnant women as compared with iron tablets alone.

Keywords: Anemia, Pregnant women, Moringa Oleifera, Hemoglobin, Complementary therapy

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1. Introduction

Anemia during pregnancy remains one of the most prevalent micronutrient deficiencies worldwide (1-3). Based on WHO estimates, nearly 40% of pregnant women worldwide are impacted by anemia, with about 27% of these cases coming from Southeast Asia. In 2019, the prevalence of anemia among women of reproductive age was estimated to be 29.9%, with rates reaching 36.5% in pregnant populations (4). In Indonesia, this trend is even more alarming, with the 2018 national health survey (Riskesdas) revealing a rise in anemia cases among pregnant women from 37.1% in 2013 to 48.9% in 2018 (5). Provincial health data from Jambi further underscore the challenge, showing that 20–22% of pregnant women in the region were affected by iron deficiency anemia between 2019 and 2021 (6).

The high prevalence reflects the severity of anemia as a public health concern, given its negative impacts on maternal and fetal health. Consequences include weakened immunity, reduced cognitive ability, and increased risk of complications during pregnancy and childbirth, all of which may contribute to maternal mortality. Left unaddressed, anemia can lead to depleted energy, premature delivery, and heightened risk of hemorrhage during labor (7-10).

Iron deficiency represents the primary cause of anemia during pregnancy, leading to reduced efficiency in the body's oxygen transport system. National programs addressing this issue include the distribution of iron supplements (Fe tablets) to pregnant women. However, the effectiveness of these interventions remains limited due to factors such as low compliance with tablet consumption, suboptimal iron absorption, and nutrient interactions that inhibit iron uptake. Consequently, alternative strategies are necessary to enhance the effectiveness of anemia treatment (11, 12).

Moringa oleifera leaves have emerged as a promising local food source to support anemia treatment. With 28.2 mg of iron per 100 grams of dried leaves, Moringa surpasses many conventional iron sources. These leaves are also rich in vitamin C, which improves iron absorption, and antioxidants like vitamin A, which help minimize oxidative stress. Several studies demonstrated the potential of Moringa to increase Hemoglobin levels in pregnant women (13-16).

Despite their benefits, the use of Moringa leaves as a standalone intervention has certain limitations. Combining Moringa leaves with iron supplements, such as Fe tablets, offers a promising complementary approach. Fe tablets provide a reliable and consistent source of iron, while Moringa enhances iron absorption and delivers additional nutritional benefits. This combination is expected to improve Hemoglobin levels more significantly than either intervention alone (16).

This study was conducted in Penyengat Olak Village, Muaro Jambi Regency, Indonesia, an area with a high prevalence of anemia among pregnant women. Despite the routine provision of Fe tablets, many pregnant women in the region continue to experience anemia, highlighting the need for a new approach that can be integrated into public health programs. Leveraging local resources, such as Moringa leaves, not only has the potential to improve maternal health but also promotes sustainability and local self-reliance in addressing nutritional challenges.

The novelty of this study lies in integrating traditional plant-based remedies with conventional medical practices. This approach aims to provide a practical, accessible, and potentially more effective solution for addressing maternal anemia. Additionally, it enriches existing evidence on the benefit of combining Moringa leaf extract with Fe tablets and can inform community health policies in high-risk regions. Therefore, the present study aimed to evaluate the effect of Moringa leaf extract supplementation on Hemoglobin concentrations among pregnant women residing in Penyengat Olak Village, Muaro Jambi Regency, Indonesia.

2. Methods

2.1. Study design

This study used a quasi-experimental approach incorporating a two-group pre-test and post-test structure. The study participants were divided into two groups: an intervention group receiving both Moringa leaf extract and iron (Fe) tablets, and a control group receiving only Fe tablets. The study followed the CONSORT guidelines for non-randomized trials, and participant flow was illustrated in a standardized diagram.

2.2. Study Setting and Period

This study was conducted in Penyengat Olak Village, Muaro Jambi Regency, Indonesia from March to November 2024. The study population comprised all pregnant women in the village, totaling 80 individuals.

2.3. Participants

A simple random sampling method was used to ensure unbiased participant selection. A list of eligible pregnant women was compiled, and participants were chosen using a computerized random number generator. The 80 selected women were randomly allocated into two groups of equal size (n=40 for each group). Sample size determination was based on Cohen's d formula for comparing two independent means, using a 5% alpha level and 80% power. The calculation referred to previous research findings (17) that demonstrated significant differences in Hemoglobin levels following similar interventions.

The inclusion criteria required participants to be pregnant women in any trimester who consented to take part and were able to read and write. Women with any diagnosed health conditions that might affect pregnancy outcomes (such as preeclampsia, eclampsia, diabetes, or a known allergy to Moringa leaves) and those with severe anemia were excluded from the study.

2.4. Intervention

Women in the intervention group received a daily dose of Moringa leaf extract (in standardized capsule form) along with one Fe tablet, taken each morning for 14 consecutive days. Morning intake was selected to optimize nutrient absorption and minimize interference from food intake. The control group followed the same schedule but received only Fe tablets. All participants were instructed and monitored to ensure adherence to the intervention regimen.

2.5. Data Collection

Baseline data were collected before the start of the intervention including: demographic information (age, education, occupation, parity, and gestational age) and clinical indicators (hemoglobin concentration and anthropometric measurements). After 14 days of supplementation, follow-up assessments were conducted using the same parameters to evaluate changes in hemoglobin levels and overall nutritional status.

During the intervention period, compliance was monitored through daily check-ins and capsule count verification. Both groups were assessed on the 14th day post-intervention using standardized procedures and calibrated equipment.

2.6. Data Analysis

Data analysis in this study involved two primary approaches: descriptive and inferential statistics. Descriptive analysis was employed to summarize the participants' general characteristics, including variables such as age, occupation, educational background, parity, and trimester of pregnancy, along with baseline values of measured indicators like hemoglobin levels. The results were reported as mean value, standard deviation, frequency, and percentage to illustrate the overall distribution and trends within the sample.

Inferential statistical methods were employed to evaluate the research hypotheses and derive meaningful interpretations. First, the normality of the dataset was assessed using the Shapiro-Wilk test. Given the normal distribution of the data, parametric statistical tests were deemed appropriate. Paired t-tests were used to analyze intra-group differences by comparing pre- and post-intervention Hemoglobin levels within each group. To evaluate differences between the intervention and control groups, independent t-tests were applied. All analyses adhered to a significance threshold of $P<0.05$, with values below this cutoff indicating statistically significant differences,

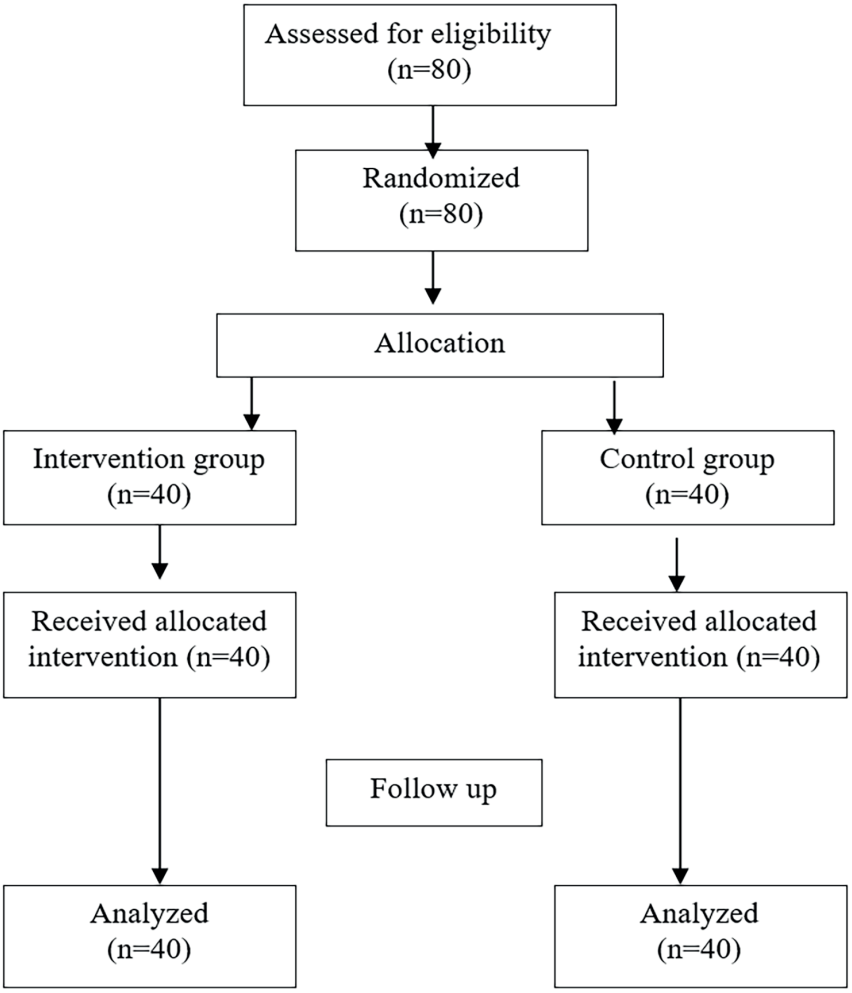

Figure 1: The figure shows the flow diagram of the study.

either across groups or between baseline and post-intervention measurements.

2.7. Ethical considerations

The ethical clearance approved by the Health Research Ethics Committee of the Jambi Health Polytechnic (Approval No. LB.02.06/2/408.1/2024). All participants were given informed consent as a proof of their willingness to participate. The confidentiality of the research was assured. Participation was entirely voluntary and the participants could withdraw from the study at any stage.

3. Results

A total of 80 pregnant women were initially screened for eligibility, all of whom fulfilled the inclusion criteria of the study and were enrolled. Eligibility requirements comprised: (1) voluntary consent to participate, (2) being in any trimester of pregnancy, and (3) the ability to read and write. Figure 1 shows a flow diagram of the selection and analysis process of participants in a randomized controlled trial. The participants were excluded if they had comorbidities that could potentially influence pregnancy outcomes, such as preeclampsia, eclampsia, diabetes mellitus, or if they had a known allergy to Moringa leaves or were diagnosed with severe anemia. All qualified participants were then randomly allocated into two equal groups, with 40 assigned to the intervention arm and 40 to the control arm.

Table 1 outlines the characteristics of the study participants. Most women aged 20–35 years, comprising 62.5% of the intervention group and 57.5% of the control group. A majority were housewives with high school education. In terms of parity, 55% of women in the intervention group were multiparous, while the control group had an even split between primiparous and multiparous participants.

Table 1: The association between Hemoglobin levels and respondent characteristics

Characteristics	Category	Intervention group	P value	Control group	P values
		n (%)		n (%)	
Age (Years)	<20	10 (25)	0.120	12 (30)	0.188
	20–35	25 (62.5)		23 (57.5)	
	> 35	5 (12.5)		5 (12.5)	
Occupation	Housewife	20 (50)	0.469	18 (45)	0.274
	Formal job	15 (37.5)		16 (40)	
	Informal job	5 (12.5)		6 (15)	
Education	Elementary/Junior school	8 (20)	0.352	10 (25)	0.093
	High school	20 (50)		18 (45)	
	College	12 (30)		12 (30)	
Parity	Primipara	18 (45)	0.533	20 (50)	0.037*
	Multipara	22 (55)		20 (50)	
Gestational age	Trimester I	8 (20)	0.267	10 (25)	0.097
	Trimester II	22 (55)		20 (50)	
	Trimester III	10 (25)		10 (25)	

Table 2: Hemoglobin levels of pregnant women before and after being given Moringa Leaf Extract and Fe tablets

Intervention	Mean±SD	Median	P value
Intervention			0.0001*
Pre-test	11.265±0.73	11.0	
Post-test	12.123±0.73	12.0	
Control			0.0001*
Pre-test	11.270±0.82	11.0	
Post-test	11.700±0.81	11.4	
Intervention-Control			0.017**
Post-test Intervention	12.122±0.73		
Post-test Control	11.700±0.781		

SD: Standard Deviation

Only parity showed a statistically significant association with Hemoglobin levels in the control group (P=0.037), indicating the potential influence of birth history. No significant links were found between Hb levels and other variables such as age, education, job type, or pregnancy trimester (P>0.05).

As shown in Table 2, baseline Hemoglobin levels were nearly identical between groups, averaging 11.27 g/dL. After 14 days of supplementation, the intervention group's Hb rose to 12.12 g/dL, while the control group reached 11.70 g/dL. Paired t-tests confirmed significant increases in both groups (P<0.0001), but the independent t-test revealed that the intervention group's improvement was significantly greater (P=0.017), supporting the enhanced effect of combining Moringa with Fe tablets.

4. Discussion

This study demonstrated that combining Moringa leaf extract with Fe tablets leads to a greater improvement in Hemoglobin levels than using Fe tablets alone. The intervention group showed a mean increase of 0.858 g/dL, as compared with 0.43 g/dL in the control group. This significant difference highlighted the superior effectiveness of the combined supplementation.

These results underscored the potential of Moringa oleifera as an effective supportive treatment for anemia during pregnancy. Moringa leaves are known for their high iron content 28.2 mg per 100 grams surpassing most conventional food sources. In addition to iron, they are rich in vitamin C, which enhances iron absorption, further contributing to improvements in Hemoglobin levels (17).

Moringa's benefits in increasing Hemoglobin can also be linked to its antioxidant properties. The presence of vitamins A and C helps neutralize free radicals, reducing oxidative stress and supporting the body's metabolic functions, including the production of red blood cells (18).

The greater improvement observed in the group receiving both Moringa and Fe tablets is consistent with previous studies that reported combining natural supplements with conventional iron therapy yields better outcomes than using Fe tablets alone (19-22). This combination not only delivers physiological benefits but also offers practical advantages. Moringa capsules are easy to consume and particularly suitable for use in rural or underserved communities such as Penyengat Olak Village, Muaro Jambi Regency, Indonesia.

At the same time, this study emphasized the importance of proper nutrition during pregnancy. Pregnant women in low-resource settings often face limited access to nutrient-dense foods. Using locally available plants, such as Moringa, can serve as a low-cost and sustainable strategy to reduce maternal anemia.

Nevertheless, it is important to note that not all participants in the intervention group experienced a substantial rise in Hb levels. Several factors may explain this variation. Individual baseline health conditions, such as chronic anemia or coexisting illnesses, could affect iron absorption and Hemoglobin synthesis. Moreover, physiological differences in nutrient metabolism, diet composition, and the intake of substances that inhibit iron absorption (e.g., calcium or tannins) could have influenced the outcomes (23, 24).

Another consideration is the duration of the intervention. The 14-day treatment period may have been too short to produce significant improvements in participants with more severe anemia. Additionally, varying levels of adherence to the daily supplement regimen may have affected the results (25). External influences such as stress, infections, and deficiencies in other nutrients (e.g., folic acid and vitamin B12) may also have played a role in limiting the effectiveness of the intervention.

Therefore, these findings suggested that future research should address both individual health profiles and environmental factors. Longer intervention periods, larger sample sizes, and more comprehensive monitoring of dietary intake and micronutrient status could yield more consistent results (26, 27).

Overall, the evidence supports the use of Moringa leaf extract as a complementary, food-based strategy to improve hemoglobin levels in pregnant women. Its integration into public health nutrition programs, particularly in areas with high anemia prevalence, holds promise as a locally driven and sustainable intervention.

4.1. Limitations

While the findings of this study are encouraging, certain limitations should be acknowledged. Firstly, the intervention period was limited to 14 days, which may not be sufficient to achieve long-term or maximum therapeutic outcomes, particularly in individuals with moderate to severe anemia. Extending the intervention duration may yield more pronounced effects.

Secondly, although efforts were made to monitor compliance with daily supplementation, complete adherence could not be guaranteed outside supervised settings. Variations in compliance might have influenced the consistency of outcomes, especially in the intervention group.

Third, this study was limited to one rural area with a small, relatively uniform sample, which may reduce the applicability of the findings to broader populations or regions.

Additionally, the study did not control all possible confounding variables. Dietary intake, presence of infections, or coexisting micronutrient deficiencies (e.g., folate or vitamin B12) were not comprehensively assessed, though they could have impacted hemoglobin synthesis and iron absorption.

Future investigations should consider larger and more diverse samples, extended intervention periods, and in-depth assessments of dietary intake, health status, and biochemical profiles to better understand the full potential and limitations of Moringa-based supplementation strategies.

5. Conclusions

The results of this study confirmed that combining Moringa leaf extract with Fe tablets yields more significant improvements in Hemoglobin levels than using Fe tablets alone. Although both groups experienced meaningful increases, the combined intervention produced a greater effect.

These findings highlighted the value of integrating plant-based nutrition with conventional medical supplementation, especially in areas where anemia remains prevalent despite ongoing iron tablet distribution programs. Leveraging locally available resources like Moringa not only supports maternal health but also promotes sustainable and community-empowered health interventions.

Although the study had certain limitations, the study results suggested that Moringa oleifera is a promising adjunct in the management of anemia during pregnancy. Broader implementation and further research may enhance its role in public health nutrition strategies aimed at improving maternal and fetal outcomes in resource-limited settings.

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Authors' Contribution

Suryani Suryani: Contributions to the conception and design of the study; critical review of the manuscript for important intellectual content. Yuli Suryanti: Contributions to the data collection; drafting the work. Ika Murtiyarini: Data analysis and interpretations; drafting the work. Atika Fadhilah Danaz Nst: Contributions to the study conception; drafting the work. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work, such as the questions related to the accuracy or integrity of any part of the work.

Conflict of Interest: None declared.

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Ethical Approval

The Ethics Review Board of the Ethics Committee of the Ministry of Health, Jambi, approved the present study with the code of LB.02.06/2/408.1/2024. Also, written informed consent was obtained from the particpants.

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