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RESEARCH ARTICLE

Effect of Moringa Leaves and Combination of Fe Tablets on the Increase of Hb in Pregnant Women with Anemia

Rina Delfina,[1] Helmiyetti Helmiyetti,[2] Deni Maryani[3]

[1]Department of Nursing, Faculty of Mathematics and Natural Sciences, University Bengkulu, Bengkulu, Indonesia,
[2]Department of Biology, Faculty of Mathematics and Natural Sciences, University Bengkulu, Bengkulu, Indonesia,
[3]Department of Midwifery, Faculty of Mathematics and Natural Sciences,
University Bengkulu, Bengkulu, Indonesia

Abstract

Anemia during pregnancy can lead to complications during gestation, childbirth, and postpartum. The government recommends administering at least 90 Fe tablets to pregnant women to address this. Additionally, fulfilling nutritional needs is another strategy to combat anemia, with Moringa leaves emerging as a nutrient-rich food source known to elevate hemoglobin levels. This study investigated the impact of Moringa leaves and combined Fe tablet consumption on hemoglobin levels in anemic pregnant women. A quasi-experimental design incorporated pre-test and post-test evaluations with a control group in Bengkulu from June to November 2022. Purposive sampling yielded a cohort of 60 anemic pregnant women, divided equally into intervention and control groups. Data collected over two months were analyzed through univariate and bivariate methods using the Wilcoxon and Mann-Whitney tests at a 5% significance level. Findings indicated that the combination of Moringa leaves and Fe tablet significantly increased hemoglobin levels in pregnant women with anemia ($p<0.05$). Therefore, anemic pregnant women are encouraged to consume Moringa leaves as a potential measure to enhance their hemoglobin levels.

Keywords: Anemia, pregnant women, Moringa, Fe tablets

Introduction

Anemia remains a prevalent health issue among pregnant women in Indonesia. Pregnant women with hemoglobin (Hb) levels below 11 g/dl during their initial visits are diagnosed as anemic. Such women run a heightened risk of delivering infants with iron-deficiency anemia. This deficiency can persist throughout the early years of a child, hindering the growth of the brain and other cells. Consequently, it may delay the child's overall growth and development, potentially leading to stunting or wasting. These developmental setbacks can also have lasting and possibly irreversible impacts on cognitive development.[1–4]

World Health Organization (WHO) reports that around 42% of children under five and 40% of pregnant women worldwide are anemic. This condition contributes to 40% of maternal deaths in developing countries. Between 1990 and 2019, global anemia cases rose from 1.42 billion to 1.74 billion, spanning 204 countries. A 2018 survey showed anemia prevalence in pregnant women at 36.4% in urban settings, 49.5% in rural areas, and a combined rate of 48.9%. In 2020, Bengkulu city documented 308 anemic pregnant women, with the Beringin Raya Public Health Center reporting the most cases at 96.[5–7]

To counteract this, the government introduced the Integrated Antenatal Service program. This strategy involves nutritional counseling during pregnancy, hemoglobin level checks in the 1st and 3rd trimesters, and administering iron (Fe) tablets and at least 90 folic acid tablets throughout gestation. Despite these measures, adherence could be higher. Many pregnant women decline or neglect these guidelines due to adverse effects like nausea and vomiting. Consequently, anemia remains prevalent among them.[8,9]

Supplemental nutritional intake from food is indispensable to satisfy iron needs during pregnancy. A balanced diet during this period is crucial, emphasizing the consumption of both macro and micronutrients to fulfill varied dietary requirements. Factors like calorie intake, protein, carbohydrates, iron, folic acid, vitamin A, zinc, iodine, calcium, and other essential nutrients significantly influence a mother's nutritional status. Rahmawati and Daryanti's[10] study suggested that Fe tablets are most effective when paired with supplements promoting hemoglobin synthesis and iron absorption, such as Moringa leaf extract. Odura et al.[11] further highlighted that 100 grams of Moringa leaves contain an

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Correspondence: Ns. Rina Delfina, S.Kep., M.Kep. Department of Nursing, Faculty of Mathematics and Natural Sciences, University Bengkulu. Jln. Indragiri, Bengkulu 38225, Bengkulu, Indonesia. E-mail: rdelfina@unib.ac.id

impressive 28.29 mg of iron.

Moringa presents as a compelling alternative for alleviating anemia. Its nutritional content outshines many common foods: it has seven times the vitamin C of oranges, ten times the vitamin A of carrots, seventeen times the calcium of milk, fifteen times the potassium of bananas, twenty-five times the iron of spinach, and nine times the protein of yogurt.[12] Besides these, Moringa is enriched with B vitamins, chromium, copper, magnesium, manganese, phosphorus, and zinc. For expectant mothers, Moringa leaves contain essentials: thiamin, riboflavin, niacin, beta-carotene, calcium, iron, phosphorus, magnesium, zinc, vitamin C, antioxidants, and anti-inflammatories. These components are pivotal in staving off the activation of leukocytes and oxidative stress from free radicals.[13–15] A study in Senegal asserted that Moringa leaf powder is beneficial in preventing malnutrition among infants, pregnant women, and nursing mothers, with no proven side effects from Moringa consumption to date.[16]

Many sources advocate for a daily intake of 100 grams of fresh Moringa leaves, citing it as an adequate and safe measure to meet nutritional needs.[17] *Moringa oleifera* is recognized as a natural powerhouse of nutrients. Various parts of this tree—its leaves, fruit, flowers, and pods—are consumed as nourishing vegetables in countries like India, Pakistan, the Philippines, Hawaii, Africa, and Indonesia. Comprehensive studies on Moringa compounds reveal a wealth of essential components, including vitamins, minerals, antioxidants, and amino acids, fulfilling many of the nutritional requirements of expectant mothers. The plant is particularly abundant in micronutrients vital for pregnant women, such as thiamin, riboflavin, niacin, beta-carotene, calcium, iron, phosphorus, magnesium, zinc, and vitamin C. Given its rich content, Moringa can serve as an alternative to conventional multiple micronutrient supplements, enhancing the nutritional well-being of pregnant women. Additionally, Moringa is dense in protein and amino acids and exhibits antioxidant and anti-inflammatory properties.[18–21]

This study investigated the impact of Moringa leaves and combined Fe tablet consumption on hemoglobin levels in anemic pregnant women.

Methods

This study utilized a quantitative approach with a quasi-experimental design (pre-post test with a control group) conducted in Bengkulu city from June to November 2022. Hb levels of both groups were assessed before and after the treatment phase. The intervention for the treatment group entailed administering Moringa leaves and Fe tablets, while the control group received only Fe tablets over eight weeks. Using purposive sampling, the study included 60 anemic pregnant women, equally divided with 30 in the treatment group and 30 in the control group. The research instrument was a data collection form capturing details such as name, age, education, parity, and gestational age. Additionally, a digital Hb measurement tool was used to gauge the Hb levels of the participants. Both univariate and multivariate analyses were employed for data analysis. The Health Research Ethics Committee of the Faculty of Nursing of Universitas Jember approved the study, number 126/UN25.1.14/KEPK/2022.

Bivariate analysis was conducted to determine the difference in the average Hb before and after the intervention in the same group using the Wilcoxon signed ranks test. Meanwhile, the Mann-Whitney test was used to determine the difference in the average Hb before and after the intervention in different groups.

Before the above bivariate analysis, the data normality test was performed using the Shapiro-Wilk test. The results of the Shapiro-Wilk test showed that the data were not normally distributed.

Results

Table 1 shows that most (90%) of intervention respondents with age are not at risk, most (76.6%)) had a high school education, more than some (60%) were multi-gravida, and most (86.7%) were in the 3rd trimester. In the control respondents, most (86.7%) were not at risk, almost half (46 7%) with high school education, most (76.7%) with multi-gravida parity, and some (50%) respondents were in the 1st trimester.

Table 2 shows that the average Hb of respondents in the intervention group before treatment was 10.62 g/dl. The standard deviation was 0.364 g/dl, and it is believed that 95% of the average Hb of respondents before treatment was in the range of 10.34 to 10.62 g/dl. The average Hb of respondents in the control group before being given treatment was 10.44 g/dl, standard deviation of 0.318, and it is believed that 95% of

Table 1 Distribution of Respondents in the Two Groups

Characteristics	IG (n=30)	CG (n=30)
Age		
No risk	27	26
Risk	3	4
Education		
Junior high school	2	5
Senior high school	23	14
D3/S1	5	11
Parity		
Primi gravida	12	7
Multi gravida	18	23
Gestational age		
1st trimester	1	15
2nd trimester	3	2
3rd trimester	26	13

Note: IG: intervention group, CG: control group

Table 2 Distribution of Respondents based on the Average Hb before and after Treatment

Variables	IG (n=30)	CG (n=30)
Hb before		
Mean	10.48	10.44
Median	10.55	10.40
Min	9.6	9.6
Max	10.9	10.8
SD	0.364	0.318
95% CI	10.34–10.62	10.32–10.56
Hb after		
Mean	11.92	10.64
Median	11.90	10.70
Min	10.7	10.0
Max	13,5	11.0
SD	0.724	0.290
95% CI	11.64–12.19	10.53–10.75

Note: IG: intervention group, CG: control group

the average Hb of respondents before being given treatment was in the range of 10.32 to 10.56 g/dl.

In the intervention group, the average Hb after being given treatment was 11.92 g/dl, the standard deviation was 0.724 g/dl, and it is believed that 95% of respondents' average Hb before being given treatment was in the range of 11.64 to 12.19 g/dl. The average Hb of respondents in the control group after being given treatment was 10.64 g/dl, the standard deviation was 0.290, and it is believed that 95% of the average Hb of respondents before being given treatment was in the range of 10.53 to 10.75 g/dl.

The results of the data normality test with Shapiro-Wilk showed $p<0.05$, meaning that the Hb data before the treatment had an abnormal distribution in the intervention and control groups. Meanwhile, the Hb variable after treatment in the intervention group had $p>0.05$, meaning that the Hb data after treatment had a normal distribution; in the control group, $p<0.05$, indicating that the Hb data after treatment had an abnormal distribution. So the test used is non-

Table 3 Differences in Hb levels of Response before and after Moringa Leaves Combination with Fe Tablets in the Intervention Group

Hemoglobin (Hb)	n	Median (Min–Max)	Z	p
Before intervention	30	10.55 (9.6–10.9)	–4.785	0.000*
After intervention	30	11.90 (10.7–13.5)		

Note: *Wilcoxon test, p>0.05 significant

Table 4 Differences in Hb Levels of Respondents before and after Giving Fe Tablets in the Control Group

Hemoglobin (Hb)	n	Median (Min–Max)	Z	p
Before intervention	30	10.40 (9.6–10.8)	–4.899	0.000*
After intervention	30	10.70 (10.0–11.0)		

Note: *Wilcoxon test, p>0.05 significant

Table 5 Effect of Moringa Leaf and Fe Tablet Combination on the Increase of Hb in Pregnant Women with Anemia

Hemoglobin (Hb)	Median (Min–Max)	U	p
Intervention	1.350 (0.20–3.00)	32,500	0.000*
Control	0.300 (0.10–3.00)		

Note: *Mann-Whitney test, p>0.05 significant

parametric.

Table 3 shows difference in the intervention group's median Hb before and after treatment Moringa leaves combination with Fe tablets (p=0.000, p<0.05). Table 4 shows difference in the control group's median Hb before and after giving Fe tablets (p=0.000, p<0.05).

Table 5 illustrates the analysis results using the Mann-Whitney test, which shows a difference in the median increase in Hb levels before and after the intervention in the intervention and control groups (p=0.000, p<0.05). So, there is an effect of giving Moringa leaves and a combination of Fe tablets to increase Hb in anemic pregnant women.

Discussion

The data reveals that most participants in both groups were within an age range considered safe for pregnancy: 90.0% in the intervention group and 86.7% in the control group. The optimal age for gestation is between 20 and 35 years, when the reproductive system is at its peak, thus minimizing pregnancy and delivery complications.[22] Sjahriani and Faridah's[23] study underscores this by showing that pregnant women below 20 years or above 35 are 1.8 times more likely to develop anemia than those aged between 20–35 years. The heightened risk of anemia in women of reproductive age is attributed to iron loss during menstruation and childbirth and increased iron demands during pregnancy.[24]

Education significantly impacts one's cognitive processes and information acquisition. A higher educational level facilitates better assimilation of health-related knowledge. Conversely, limited education among pregnant women can hinder efforts to address nutritional and family health issues, as emphasized by Hidayati and Andyarini.[25] Economic status also plays a crucial role in determining access to quality nutrition. While knowledge can be derived from education, personal experiences, media, and one's environment, well-educated pregnant women better understand iron deficiency anemia and its treatment, leading to better adherence to recommendations.[26,27]

Parity, the number of live births a woman has had, significantly influences the likelihood of anemia in pregnant women. The National Population and Family Planning Board defines parity as the total number of live births a woman has had during her reproductive years.[28] Multiple pregnancies heighten the risk of anemia. This is of concern as parity is a dominating factor for anemia during pregnancy. Women who have given birth more than twice or frequently face physical and mental demands. With every successive pregnancy, the woman's body requires more iron to support her well-being and fetal growth. However, repeated pregnancies can deplete the body's optimal iron stores, as the mother and fetus continually utilize the iron.[26] This is consistent with Purwandari et al.'s[27] study, which found a significant correlation between a woman's parity and her risk of anemia.

In the intervention group, a significant majority (86.7%) of the respondents were in their third trimester, while in the control group, half (50%) of the respondents were in their first trimester and experienced anemia. These findings agree with a study by Hidayati and Andyarini,[25] which identified a correlation between gestational age and the prevalence of anemia in pregnant women. Anemia can manifest in both the 1st and 3rd trimesters. Specifically, anemia is 20% in the first, 70% in the second, and 70% in the third. The iron requirement is minimal in the first trimester due to the absence of menstruation and slow fetal growth. However, from the second trimester onward, a woman's blood volume escalates by up to 35%, necessitating an equivalent of 450 mg of iron for red blood cell production, supporting the increased oxygen demand of the growing fetus. Furthermore, childbirth results in blood loss that requires an additional 300–350 mg of iron. Overall, by the time of delivery, a pregnant

woman's daily iron needs approximately double to around 40 mg, compared to when she is not pregnant.[29]

Pregnancy leads to increased blood volume, termed hypervolemia, which dilutes hemoglobin concentration. This phenomenon, known as hemodilution, is characterized by a 30–40% surge in plasma volume, an 18–30% increase in red blood cells, and a 19% increase in hemoglobin. If a mother's pre-pregnancy hemoglobin level is roughly 11g%, hemodilution can decrease to 9.5–10g%, resulting in anemia.[30]

The results showed that the average Hb of the respondents in the intervention group before treatment was 10.62 g/dl, and the standard deviation was 0.364. The average Hb of the control group respondents before treatment was 10.44 g/dl, and the standard deviation was 0.318. This increase in Hb occurs because Moringa leaves are rich in iron and other essential nutrients needed for iron metabolism. These results are in line with research by Shija et al.[31] on the effect of *Moringa oleifera* leaf powder supplementation on reducing anemia in children under two years in Kisarawe district, Tanzania. It was found that there was a change in the average hemoglobin (Hb) concentration, and the prevalence of anemia was compared between the two groups.

The results showed differences in the increase in Hb in anemic pregnant women before and after the intervention of giving Moringa leaves and a combination of Fe tables. It was higher in anemic pregnant women who only consumed Fe tablets. In line with the results of Fauziandari,[32] it showed that there was a significant difference between the levels before and after the administration of Moringa leaf extract. Moringa is an alternative in reducing anemia because Moringa contains seven times more vitamin C than oranges, ten times vitamin A from carrots, 17 times calcium from milk, 15 times more than bananas, 25 times iron from spinach. And nine times the protein of yogurt. Differences in Hb levels of respondents before and after being given Fe tablets in the control group.[12]

The study highlighted the positive impact of administering Moringa leaves with Fe tablets on elevating Hb levels in pregnant women. Moringa leaves are packed with nutrients, vitamins, minerals, antioxidants, and amino acids essential for expecting mothers. These findings echo the research of Shija et al.,[31] which demonstrated a notable shift in mean hemoglobin concentration and anemia prevalence between the intervention and control groups after the Moringa administration. Similarly, Rahmawati and Daryanti's[10] study documented the beneficial effect of Moringa leaf extract on augmenting hemoglobin levels in expectant mothers during their 2nd and 3rd trimesters, with $p<0.05$. Another study by Sindhu et al.[33] in Bangalore found that *Moringa oleifera* notably enhanced hemoglobin levels in anemic women.

Anemia remains a prevalent health challenge for pregnant women. Iron deficiency can impede brain development during this crucial phase and potentially damage cognitive growth. Furthermore, iron plays a pivotal role in forming myoglobin (an oxygen-carrying protein for muscles), collagen (a protein present in bones, cartilage, and connective tissues), and vital enzymes. Iron also fortifies the body's defense mechanisms.[12]

Moringa leaves, beneficial in modest and higher dosages, have proven particularly effective for anemic patients. These leaves are frequently incorporated as vegetables in diets. They house phytosterols, potent agents for boosting breast milk production in lactating mothers, and are also instrumental in addressing anemia issues in children and pregnant women. Moringa leaf extract is enriched with Fe 5.49 mg/100 g, sitosterol 1.15%/100 g, and stigmasterol 1.52%/100 g. The observed substantial increase in red and white blood cell counts upon Moringa leaf consumption emphasizes its potential as a dietary supplement. It holds promise as an alternative iron source, especially beneficial for anemic pregnant women.[13,34]

Conclusion

Findings indicated that the combination of Moringa leaves and Fe tablet significantly increased hemoglobin levels in pregnant women with anemia.

Conflict of Interest

The authors declare no conflicts of interest in this article.

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