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MORALITY BEFORE KNOWLEDGE

Impact of Iron Tablet and Moringa Leaf Capsule Supplementation on Hemoglobin Levels in Anemic Pregnant Women in Pariaman City, 2016

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ABSTRACT
Background: Iron deficiency anemia is a prevalent global nutritional problem, particularly affecting pregnant women in developing countries. This study aimed to evaluate the effects of iron tablet supplementation and Moringa leaf capsules on hemoglobin (Hb) levels in anemic pregnant women in Pariaman City, Indonesia. **Method:** A total of 60 pregnant women were divided into two groups: one receiving iron tablets and the other Moringa leaf capsules for four weeks. Hemoglobin levels were measured before and after the intervention. **Findings:** In the iron supplementation group, the average Hb level increased from 9.05 g/dL to 9.46 g/dL, with a significant improvement ($p = 0.001$). Similarly, the Moringa capsule group showed an Hb increase from 8.99 g/dL to 9.27 g/dL ($p = 0.019$). While iron tablets resulted in a greater increase in Hb, Moringa capsules, rich in natural iron, also demonstrated significant effectiveness. The study concludes that both iron supplements and Moringa capsules are effective in increasing Hb levels, with Moringa capsules being a potential natural alternative for combating anemia in pregnant women. However, optimizing the dosage of Moringa could further enhance its efficacy. Factors such as adherence, diet, and knowledge of iron absorption enhancers and inhibitors play crucial roles in the success of the interventions.

KEYWORDS: iron deficiency anemia; pregnancy; iron tablets; Moringa leaf capsules; hemoglobin; adherence.

1. Introduction

Iron deficiency anemia is the most prevalent nutritional issue worldwide, affecting over two billion people. The estimated global prevalence of anemia is approximately 51%. Iron deficiency anemia tends to be more common in developing countries compared to developed ones. According to the World Health Organization (WHO), 40% of maternal deaths in developing nations are associated with anemia during pregnancy (Arisman, 2009; Gibney et al., 2007).

In Indonesia, nutritional anemia remains one of the four major nutritional problems, alongside protein-energy malnutrition, vitamin A deficiency, and endemic goiter. The prevalence of anemia among pregnant women in Indonesia, based on the 2007 Basic Health Research (Riskesdas) data, was 24.5%. However, this increased to 37.1% in the 2013 Riskesdas report, with nearly identical rates between urban (36.4%) and rural (37.8%) areas. These figures indicate that anemia in pregnant women is approaching the threshold of a severe public health problem, which is defined as a prevalence rate of ≥40%.

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The prevalence of anemia among pregnant women in West Sumatra Province, according to the 2015 Nutrition Status Monitoring Survey (PSG) conducted by the West Sumatra Provincial Health Office, was 43.1%. In the city of Pariaman, the incidence of anemia in pregnant women increased from 25.2% in 2014 to 33.6% in 2015, highlighting that anemia among pregnant women remains a public health concern (Indonesian Ministry of Health, 2015; Pariaman City Health Office, 2013; Pariaman City Health Office, 2014).

Pregnant women with anemia face a 3.6 times higher risk of mortality compared to those without anemia. Anemia also contributes significantly to maternal deaths in Indonesia, accounting for 50-70% of cases. Additionally, anemia in pregnant women can have adverse effects on the fetus, such as premature birth, low birth weight (LBW), fetal abnormalities, and an increased risk of fetal distress (Proverawati & Asfuah, 2009; Proverawati & Kusumawati, 2011).

Generally, the primary causes of anemia during pregnancy are iron deficiency and acute hemorrhage, or a combination of both (Soebroto, 2009). One of the government's efforts to address iron deficiency anemia in pregnant women is through the provision of iron supplement tablets (Fe). The Ministry of Health implements an iron deficiency anemia prevention program by distributing iron tablets for 90 consecutive days during pregnancy. According to the 2015 Nutrition Status Monitoring Survey (PSG) data for West Sumatra Province, the city of Pariaman achieved the highest iron tablet distribution rate among 19 districts/cities in West Sumatra, reaching 90%, surpassing the target of 66.8% (Indonesian Ministry of Health, 2015)

According o Iswanto (2012), one factor contributing to the continued rise of iron deficiency anemia among pregnant women, despite distribution targets being exceeded, is the low adherence of pregnant women in consuming iron tablets. A total of 74.16% of pregnant women were reported as non-compliant in taking the supplements. In line with Sudiyati's (2008) research, pregnant women cited various reasons for not finishing their prescribed iron tablets, including the unpleasant smell and taste of the tablets, nausea after consumption, and black stools.

The drawbacks of chemical medications like iron supplements—such as high cost, discomfort due to side effects, high drug resistance, and the potential for accumulation in the body—have led many to turn to natural, locally available foods as an alternative to chemical treatments (Kurniasih, 2015).

Various studies have examined the efficacy of Moringa leaves in increasing blood hemoglobin levels. Nadimin (2015) found that Moringa leaves can effectively substitute for iron intake, as the administration of Moringa leaf extract to pregnant women led to hemoglobin levels comparable to those of pregnant women receiving iron and folate supplements (Editorial Team, 2011). Similarly, Yulianti (2015) demonstrated that Moringa leaf extract is beneficial for adolescent girls, particularly those with anemia. This is consistent with Iskandar et al. (2014) study in Gowa Regency, which reported that Moringa leaf extract significantly improved hemoglobin levels in pregnant women. Muis et al. (2014) further supported this finding in her research on pregnant women in the informal sector in Makassar, concluding that Moringa leaf extract effectively increased hemoglobin levels among this group (Yulianti, 2015). Given these insights, the objective of the current study is to evaluate the effect of iron tablet and Moringa leaf capsule supplementation on changes in hemoglobin levels among anemic pregnant women in Pariaman City in 2016.

2. Methods

This study was conducted in Pariaman City, focusing on pregnant women in their third trimester who are experiencing anemia. The research utilized both primary and secondary data. Primary data was collected from anemic pregnant women in their third trimester, while secondary data was obtained from the 2015 Health Office Profile of Pariaman City. The study employed a quasi-experimental design, specifically a randomized pretest-posttest group design, to assess the impact of iron tablet and Moringa leaf capsule

supplementation on changes in hemoglobin levels among anemic pregnant women in Pariaman City.

2.1 Time and place

This study was conducted in Pariaman City from January to June 2016.

2.2 Population and sample

2.2.1 Population

The population for this study consisted of all pregnant women in their third trimester experiencing anemia in Pariaman City, totaling 67 individuals.

2.2.2 Sample

The sample size for the study was determined using Gay's formula for minimum sample size in experimental research, which recommends a minimum of 15 participants per treatment group (Umar, 2011). Given that there were two treatment groups, the total sample size was 30. Out of 67 pregnant women in their third trimester who were anemic, 30 were selected through simple random sampling using a lottery method. Additionally, the assignment of participants to either Treatment Group I or Treatment Group II was also done through simple random sampling.

Participants needed to meet specific criteria to be included in the study. Inclusion criteria required that pregnant women consent to participate and adhere to the study protocols. Additionally, they must have had no history of infectious diseases, as determined during the initial antenatal care (ANC) assessment, and their hemoglobin levels needed to be below 11 mg/dL, indicating anemia. Conversely, the exclusion criteria encompassed pregnant women with anemia who declined to participate in the study, those who developed infectious diseases during the study as diagnosed by a treating physician, and participants who could not be contacted after more than three attempts.

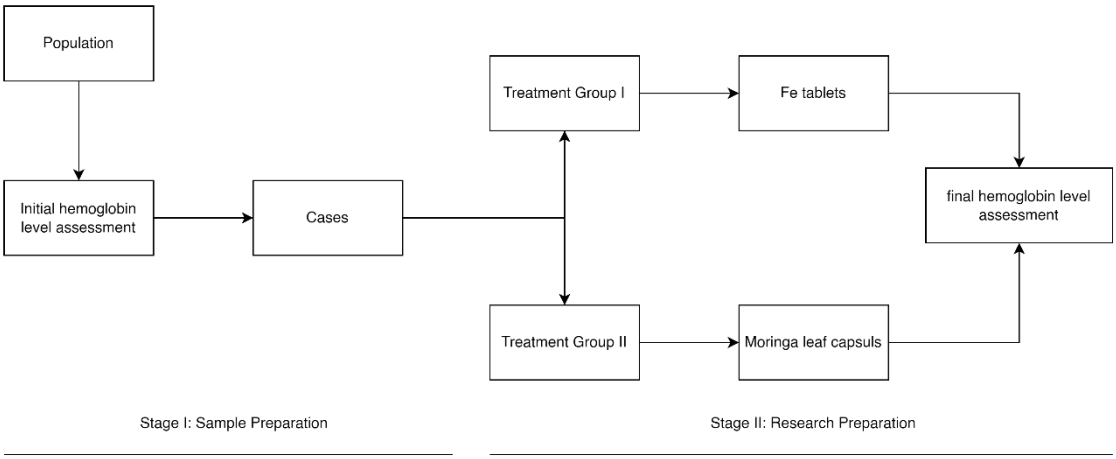

Fig 1. Research workflow

Stage I: Sample Preparation

The study population consisted of all pregnant women in their third trimester in Pariaman City. Hemoglobin levels of these pregnant women were assessed based on monthly anemia reports from each community health center. Pregnant women with anemia who met the inclusion criteria were selected as the study sample.

Stage II: Research Preparation

Pregnant women who met the criteria were randomly assigned into two groups using simple random sampling to determine Treatment Group I and Treatment Group II. Treatment Group I received iron tablets (1 capsule per day) for one month (4 weeks). Treatment Group II was given Moringa leaf capsules (2 capsules per day) for one month (4 weeks). The iron tablets used in Treatment Group I were sourced from the iron supplementation program provided by the Pariaman City Health Office.

Before administering the supplements, the researcher provided explanations about anemia, its effects during pregnancy, the benefits of supplementation, and potential side effects (including the characteristic taste and smell of Moringa leaves). Both groups received regular supplementation from field staff once a week for one month (4 weeks). The field staff monitored supplement intake by reminding participants daily via mobile phone, checking with a family member who had agreed to provide information, and verifying the remaining number of capsules. Home visits were conducted weekly to motivate the pregnant women and their families to take the capsules consistently twice a day.

After one month (4 weeks), hemoglobin levels were reassessed using the digital Hemosmart method, and data processing followed.

2.3 Operational definitions

Table 1. Research operational definitions

Variable	Definition	Measurement Method	Measurement Tool	Measurement Outcome	Measurement Scale
Iron Tablets	Administration of iron tablets containing 60 mg of elemental iron and 0.25 mg of folic acid (equivalent to 200 mg of ferrous sulfate), given as 1 capsule per day for 4 weeks, categorized into consumed and not consumed.	Observation	Consumption Record Form	Number of capsules consumed in mg/day	Ratio
Moringa Leaf Capsules	Administration of Moringa leaf capsules containing 400 mg of Moringa leaf powder, given as 2 capsules per day for 4 weeks, categorized into consumed	Observation	Consumption Record Form	Number of capsules consumed in mg/day	Ratio

	and not consumed.				
Hemoglobin Levels	Measurement of hemoglobin levels in anemic pregnant women, assessed before and after the intervention in both Treatment Group I and Treatment Group II.	Observation	Hemosmart Digital Method	Hemoglobin levels in g/dL	Ratio

2.4 Research instruments

The instruments used in this study include a hemoglobin level measuring device employing the Hemosmart digital method. Additionally, a data form was utilized for identifying anemic pregnant women. The study also employed an Informed Consent Form, a respondent application form, and an explanation sheet for respondents. To monitor supplement intake, a supplementation monitoring form for Treatment Groups I and II was used. A form listing family members who monitored supplement consumption in these treatment groups was also included. Finally, a form was used to record hemoglobin level measurements for both Treatment Groups I and II.

2.5 Types of data

Primary Data includes the initial hemoglobin levels of anemic pregnant women in their third trimester and the hemoglobin levels of these women after the intervention. **Secondary Data** encompasses information on the general profile of Pariaman City, as well as data on third-trimester pregnant women, including those with anemia. This also includes any additional data required for the study.

2.6 Data collection methods

Data for both treatment groups were collected by directly measuring hemoglobin levels using the Hemosmart digital method. The measurement results were recorded in the provided measurement forms.

2.7 Workflow

The research preparation involved obtaining research permits from the Office of Kesbang Linmas Pariaman City, the Pariaman City Health Office, and relevant community health centers (Puskesmas). Subsequently, research locations were visited, and relevant stakeholders were approached to secure necessary approvals. For data collection, samples were identified from monthly anemia reports provided by community health centers in Pariaman City. Hemoglobin levels were measured in collaboration with health analysts, and eligible subjects were asked to consent to participate in the study and proceed with the subsequent research phases. Data on the characteristics of anemic pregnant women, including age, parity, and socio-economic status (education, occupation, income), were collected through interviews and home visits using a structured questionnaire. Initial hemoglobin levels were measured using the Hemosmart digital method. For Treatment Group I, iron tablets containing 60 mg of elemental iron and 0.25 mg of folic acid (equivalent to 200 mg of ferrous sulfate) were prepared, while Treatment Group II received capsules

containing 400 mg of Moringa leaf powder. Both groups underwent treatment for one month (4 weeks), with daily monitoring via mobile phone and consumption tracked using a supplement monitoring form, overseen by a family member. If a sample could not be contacted after three visits, it was excluded from the study. Finally, after four weeks, hemoglobin levels were reassessed and recorded using the provided measurement forms.

2.8 Data processing

Data processing involved several key steps to ensure accuracy and reliability. The first step, editing, focused on assessing the completeness, clarity, and accuracy of the hemoglobin values recorded in the measurement forms. Following this, coding was carried out to identify, classify, and assign codes to the hemoglobin values. The next step, data entry, involved inputting the coded data into computerized records for processing. Cleaning followed, where any errors encountered during data entry were corrected. Finally, data tabulation was performed, compiling the processed data into tables and graphs to facilitate analysis and presentation.

2.9 Data analysis

Data analysis was conducted in two phases. Univariate analysis was used to describe the research variables by presenting the distribution and percentage of each variable. This analysis provided detailed information on frequency distributions, standard deviations, means, and both maximum and minimum values of hemoglobin levels. On the other hand, bivariate analysis explored the relationships between independent and dependent variables. To compare hemoglobin levels within each treatment group, a paired t-test was utilized. Additionally, an independent sample t-test was employed to analyze the differences in hemoglobin levels between the two treatment groups.

3. Results and Discussion

3.1 Univariate and bivariate analysis

Univariate and bivariate analyses were conducted to assess the distribution of hemoglobin (Hb) levels before and after intervention in both treatment groups, as well as to determine the average change in Hb levels within each group. The results are presented in tables and explained in narrative form.

3.1.1 Univariate Analysis

3.1.1.1 Initial Hb Levels of Respondents Before Intervention in Pariaman City

The Hb levels of respondents before the intervention are shown in Table 2:

Table 2. Initial Hb Levels of Respondents Before Intervention in Pariaman City, 2016

Group	Mean	SD	Min	Max
Treatment I (Fe supplement)	9.05	0.99	7.9	10.6
Treatment II (Moringa supplement)	8.99	0.96	7.6	10.6

According to the table, the average Hb level in Treatment Group I before the intervention was 9.05 g/dL, while in Treatment Group II it was 8.99 g/dL.

3.1.1.2 Hb Levels of Respondents After Intervention in Pariaman City

The Hb levels of respondents after the intervention are shown in Table 3:

Table 3. Hb Levels of Respondents After Intervention in Pariaman City, 2016

Group	Mean	SD	Min	Max
Treatment I (Fe supplement)	9.46	0.93	7.9	10.6
Treatment II (Moringa supplement)	9.27	0.92	8.1	11.1

Based on the table, the average Hb level in Treatment Group I after the intervention was 9.46 g/dL, while in Treatment Group II it was 9.27 g/dL.

3.1.1.3 Average Change in Hb Levels in Treatment Groups I and II Before and After Intervention in Pariaman City

The average change in Hb levels in Treatment Groups I and II before and after intervention is shown in Table 4:

Table 4. Change in Hb Levels Before and After Intervention in Pariaman City, 2016

Group	Before Mean	SD	After Mean	SD	Difference
Treatment I (Fe supplement)	9.05	0.99	9.46	0.93	0.41
Treatment II (Moringa supplement)	8.99	0.96	9.277	0.92	0.29

The table indicates that the average increase in Hb levels in Treatment Group I was 0.41 g/dL, which is higher than the 0.29 g/dL increase observed in Treatment Group II.

3.1.2 Bivariate Analysis

3.1.2.1 Effect of Fe Supplementation on Hb Levels in Treatment Group I

The effect of Fe supplementation on Hb levels in Treatment Group I is shown in Table 5:

Table 5. Effect of Fe Supplementation on Hb Levels in Treatment Group I, Pariaman City, 2016

Group	Before Mean	SD	After Mean	SD	p-value
Treatment I (Fe supplement)	9.05	0.99	9.46	0.93	0.001

The table shows a significant increase in Hb levels in anemic pregnant women receiving Fe tablets, with a p-value of 0.001 ($p < 0.05$).

3.1.2.2 Effect of Moringa Capsule Supplementation on Hb Levels in Treatment Group II

The effect of Moringa capsule supplementation on Hb levels in Treatment Group II is shown in Table 6:

Table 6. Effect of Moringa Capsule Supplementation on Hb Levels in Treatment Group II, Pariaman City, 2016

Group	Before Mean	SD	After Mean	SD	p-value
Treatment II (Moringa supplement)	8.99	0.96	9.27	0.92	0.019

The table shows a significant increase in Hb levels in anemic pregnant women receiving Moringa capsules, with a p-value of 0.019 ($p < 0.05$).

3.1.2.3 Difference in Hb Level Increase Between Treatment Groups I and I

The difference in Hb level increase between Treatment Groups I and II is shown in Table 7:

Table 7. Difference in Hb Level Increase Between Treatment Groups I and II, Pariaman City, 2016

Group	Mean Difference	SD	Min	Max	p-value
Treatment I (Fe supplement)	0.41	0.38	-0.10	1.10	0.393
Treatment II (Moringa supplement)	0.29	0.42	-0.50	1.10	0.3933

The table indicates that there is no significant difference in the increase of Hb levels between Treatment Groups I and II, with a p-value of 0.393 ($p > 0.05$).

3.2 Discussion

3.2.1 Iron supplementation group

The average hemoglobin (Hb) level in the iron supplementation group before the intervention was 9.05 g/dL. After the intervention, Hb levels increased to 9.46 g/dL, with an average increase of 0.41 g/dL. A statistical test showed a significant difference in Hb levels before and after the intervention, with a p-value of 0.001.

In iron supplementation therapy, a good response is indicated by an Hb increase of 0.15 g/day or 2 g/dL after 3-4 weeks. This result aligns with Kusumah's (2009) research, which found a significant correlation between Hb levels in pregnant women during the second and third trimesters and their intake of protein, iron, and folic acid.

Despite the lowest and highest Hb levels being the same before and after the intervention, the Hb increase varied. The lowest Hb level was 7.9 g/dL, and the highest was 10.6 g/dL both before and after the intervention. The variation in Hb increase can be influenced by factors such as dietary variations and adherence to iron tablet consumption by pregnant women with anemia. Compliance is often linked to their knowledge of nutrition and health, as well as their level of education (with 53.3% of participants having a bachelor's or diploma degree).

Several factors influence iron absorption, including knowledge of enhancers and inhibitors. Enhancers maintain iron in a soluble form, while inhibitors create complexes that precipitate iron, making it harder to absorb. For example, taking iron tablets with calcium supplements or drinking tea can inhibit iron absorption. In contrast, taking iron with vitamin C enhances absorption by at least 30%.

3.2.2 Moringa supplementation group

The average Hb level in the Moringa leaf capsule group was 8.99 g/dL before the intervention, rising to 9.27 g/dL afterward, with an average increase of 0.29 g/dL. A statistical test indicated a significant difference before and after the intervention, with a p-value of 0.019.

Moringa leaves are rich in iron, with 25 times more iron than spinach, making them a natural alternative to combat anemia in pregnant women. This finding is supported by research such as Nadimin (2015) and Yulianti (2015), which demonstrated the effectiveness of Moringa extract in raising Hb levels in pregnant women. Moringa is well-known in some areas of Pariaman and is easy to consume without side effects, contributing to the adherence of respondents to Moringa capsule supplementation.

3.2.3 Comparison of Hb Level Increases After the Intervention

After the 4-week intervention, there was a notable increase in Hb levels in both groups. The average Hb increase in the iron supplementation group was 0.41 g/dL, while in the Moringa capsule group, it was 0.29 g/dL. A T-test showed no significant difference between the two groups, with a p-value of 0.393.

The short intervention period of 4 weeks may limit comparisons, as Hb levels typically normalize within 4-10 weeks after starting iron supplementation. Research in countries like Vietnam, where iron-fortified fish sauce was given to anemic female factory workers, also demonstrated significant improvements in iron status over six months.

In this study, both interventions increased Hb levels in pregnant women with anemia. However, the iron tablet group showed a higher increase, possibly due to the lower dosage of Moringa capsules, which only provided about one-third of the iron in a typical iron tablet.

4. Conclusions

The conclusion of the research indicates that both iron supplementation and Moringa leaf capsules can effectively increase hemoglobin (Hb) levels in pregnant women with anemia. However, the group receiving iron tablets showed a slightly higher average increase in Hb levels compared to the group receiving Moringa capsules. This difference is likely due to the higher iron content in the iron tablets, as the Moringa capsules provided only about one-third of the iron dose found in the tablets.

Despite this, the Moringa capsules still demonstrated a significant increase in Hb levels, suggesting that they could be a viable natural alternative to conventional iron supplements, especially if given in higher doses. The research highlights that both interventions have the potential to improve anemia in pregnant women, but optimizing the dosage of Moringa capsules could yield even more favorable results. Factors such as adherence, diet, education, and knowledge about iron absorption enhancers and inhibitors also play a critical role in the effectiveness of the interventions.

Author Contribution

All author contributed fully to the writing of this article.

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Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflicts of Interest

The author declare no conflict of interest.

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