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OPTIMIZATION OF MORINGA OLEIFERA LEAF TEA ADMINISTRATION FOR INCREASING HEMOGLOBIN (HB) LEVELS IN ANEMIC PATIENTS

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Abstract

Anemia remains a significant nutritional challenge in Indonesia. One of the leading causes of anemia is iron deficiency, which is attributed to the requirement of essential micronutrients in hemoglobin synthesis. Various plant sources have been explored for their potential in alleviating anemia, and one such candidate is the Moringa plant. Moringa leaves, in particular, are known for their rich iron content, and they are often processed into tea to address hemoglobin deficiencies. The primary objective of this study was to determine the optimal dosage of Moringa leaf tea for increasing hemoglobin levels in anemic patients. We conducted quantitative research employing the true experimental method, with a completely randomized design (CRD) involving four distinct treatments and five repetitions. The results revealed the following hemoglobin levels in the treatment groups: treatment 1 (1 gram) resulted in a hemoglobin level of 4.08 g/dl, treatment 2 (1.5 grams) showed a level of 4.78 g/dl, and treatment 3 (2 grams) resulted in a level of 4.08 g/dl. Notably, the control group, which did not receive any treatment, did not exhibit any significant increase in hemoglobin levels. Applying the Bonferroni Post Hoc test to compare the control group with the treatment groups, we observed a p-value of 0.000, where the p-value was less than 0.05, signifying a significant difference in hemoglobin levels before and after treatment. The most effective dose of Moringa leaf tea, determined to be 1.5 grams, yielded the most substantial increase in hemoglobin level.

Keywords: Anemia, Hemoglobin Levels, Moringa

1. INTRODUCTION

Anemia represents a condition characterized by a deficiency in red blood cells or insufficient hemoglobin content, thereby impairing its oxygen-carrying function in tissue perfusion (Handayani, 2008). Anemia affects individuals of all ages, ranging from infants, children, adults, the elderly, pregnant women, to postpartum mothers. The etiology of anemia may include iron deficiency, menstrual factors, disrupted iron absorption, and the presence of infectious diseases (Arisman, 2004). Persistent iron deficiency or anemia in adults and pregnant women can pose risks to their offspring, increasing the likelihood of preterm birth and low birth weight infants. Hence, women are advised to consume iron supplements before and during pregnancy to facilitate the elevation of iron stores throughout gestation (Yunita et al., 2020).

Anemia remains a prominent nutritional issue in Indonesia, as evidenced by the high prevalence rate reaching 21.7% in various population groups, including preschool children (32%) and pregnant women (30%). Anemia can manifest as reduced concentration, cognitive impairments, developmental delays, and even mortality. Iron deficiency is a major contributor, as it is an essential micronutrient vital for hemoglobin synthesis. Recommended dietary allowances (RDAs) for iron vary, with values for infants/children 0-9 years (0.3-10 mg), adult males >10 years (8-11 mg/day), and pregnant women adjusting for pregnancy stages (8-27 mg/day) (Kusnandar et al., 2020).

In the field of developmental biology, individuals initially do not comprehend the significance of nutrition in their diets. As knowledge about diseases began to develop, it became evident that various substances found in food, when deficient, can give rise to a myriad of health conditions. These dietary substances are commonly recognized as nutrients. One such nutrient whose deficiency can lead to health problems is iron. Iron is essential for numerous physiological processes, primarily serving as the foundational element in hemoglobin synthesis (the oxygen-carrying molecule in blood) and enzymatic functions. Women, in particular, have a higher iron requirement compared to men. A crucial component of the hemoglobin molecule is iron, and a deficiency in iron can result in diminished hemoglobin levels in the blood. The transport of oxygen to cellular tissues is affected by the level of hemoglobin in the blood, and this, in turn, can compromise cellular function. (Hikmah et al., 2021).

Various plant species are employed as remedies for a multitude of ailments, and one such plant is Moringa. Moringa (*Moringa oleifera L.*) stands out as a prolific botanical resource rich in nutritional constituents. The botanical component that is notably endowed with diverse nutritional compounds is Moringa's leaves. Among the nutritional elements present in Moringa leaves are, but not limited to, iron, protein, calcium, and various vitamins (Aminah et al., 2015). In Indonesia, Moringa is recognized for its utility as a hedgerow plant, and its cultivation at the household level is widespread. Nevertheless, despite the accessibility of the Moringa plant, the full extent of its nutritional potential remains underutilized.

The nutritional content in 100 grams of Moringa leaves is notable, such as calcium content equivalent to that in milk, substantial iron, vitamin A comparable to carrots, and vitamin C comparable to oranges, as well as protein equal to that in yogurt. However, the fat content is relatively low (Kemenkes, 2017). Salman et al. (2016) reported that daily consumption of 8 grams of Moringa leaves by adolescents (16-18 years) contributes 14% of protein, 40% of calcium, 23% of iron, and nearly all the required vitamin A. Further, 100 grams of dried Moringa leaves can provide over one-third of daily requirements for calcium, iron, protein, magnesium, phosphorus, and vitamin B. The rich nutritional composition in Moringa leaves, both macro and micronutrients, emphasizes the positive impact they can have on health.

Drawing from the preceding observations, it is unmistakably apparent that iron supplementation holds the potential to ameliorate hemoglobin levels in individuals grappling with anemia. Moringa, distinguished by its rich iron content, emerges as a compelling avenue to explore. Accordingly, this study is propelled by the imperative need to delve into the meticulous optimization of Moringa leaf utilization (*Moringa oleifera L.*) as a method to heighten hemoglobin levels (Hb) in anemic individuals. The research endeavor seeks to intricately elucidate the refinement of Moringa leaf application for the enhancement of hemoglobin (Hb) levels in the cohort afflicted with anemia, along with the imperative quest to ascertain the most efficacious dosage of Moringa leaves for the augmentation of hemoglobin (Hb) concentrations among anemic patients.

2. RESEARCH METHOD

The type of research to be employed in this study is quantitative research utilizing the true experimental method with the use of a Completely Randomized Design (CRD). The subject of investigation in this research is the iron content in Moringa leaves, while the object under examination is the hemoglobin levels of anemic patients. A total of 20 anemic patients, aged 15-25, from the North Banjarmasin District and its vicinity will be studied.

Data collection in this research will involve the administration of Moringa leaf tea to 20 anemic patients over a duration of 7 consecutive days with varying dosages. There will be five individuals who receive no treatment, five individuals receiving 1 gram, five individuals receiving 1.5 grams, and five individuals receiving 2 grams of Moringa leaf tea daily. Blood samples from the anemic patients will be taken to determine hemoglobin levels before and after the 7-day Moringa leaf tea consumption. The materials utilized for preparing the Moringa leaf tea include Moringa leaves and water, while the materials for hemoglobin measurement consist of blood samples from anemic patients and hand sanitizer.

The steps for preparing Moringa leaf tea are as follows:

a. Placing Moringa leaves in a large tray and washing them thoroughly with running water.
b. Draining the washed Moringa leaves.
c. Patting dry the Moringa leaves that are still wet using a clean towel.
d. Spreading the Moringa leaves in a large tray.
e. Allowing the Moringa leaves to air-dry for 2 days while avoiding direct sunlight exposure.
f. Roasting the dried Moringa leaves until they become slightly crisp.
g. Placing a pre-weighed filter paper on an analytical balance.
h. Adding the dried Moringa leaves onto the filter paper to measure their weight.
i. Placing the weighed Moringa leaves in a plastic bag.
j. Inserting a label that contains the respective dosages on the plastic bag.
k. Documenting the label on the plastic clip.

The data analysis will be conducted using SPSS software with statistical methods involving analysis of variance (ANOVA). Prior to the analysis, normality and homogeneity tests will be performed to assess the normal distribution and equality of variances among the data groups. Subsequently, the Bonferroni test will be carried out to examine the results of each treatment. Finally, the conclusions will be drawn based on the analysis conducted.

3. RESULT AND DISCUSSION

3.1. Result Research

3.1.1. Anemia Test Results and Hemoglobin Levels

The subjects experiencing anemia are presented in the following table, both at the pretest and posttest stages. The table below indicates that the characteristics of the subjects with mild and moderate anemia levels are as follows: 8 individuals, or 40% of the participants, fall under the mild anemia category, while 4 individuals, or 20%, are classified as having moderate anemia. Furthermore, no subjects in the study were found to be without anemia. The characteristics of anemia in the subjects at the pretest are provided in the following table:

Table 1. Anemia Status Before Treatment

Anemia	F	Percentage
Mild	8	40%
Moderate	8	40%
Severe	4	20%
Non-Anemic	0	0%

The levels of anemia after the post-test, following the intervention, can be observed in the following table:

Table 2. Anemia Status After Treatment

Anemia	F	Percentage
Mild	4	20%
Moderate	0	0%
Severe	0	0%
Non-Anemic	16	80%

The table above shows that the characteristics of the subjects following the intervention indicate an increase in hemoglobin levels, with mild and severe anemia categories shifting to non-anemic. Specifically, 4 individuals, or 20%, fall under the mild anemia category, while a significant majority of 16 individuals, or 80%, are no longer anemic. The hemoglobin levels of the subjects are presented in the following table, both at the pretest and posttest stages:

Table 3. Hemoglobin Levels Before Treatment

Experiment	Min	Max	Average	Std.Dev
Control (0)	11,80	11,90	11,86	0,055
Application 1 (1 Gram)	8,80	10,80	9,92	1,026
Application 2 (1.5 gram)	7,70	9,10	8,38	0,572
Application 3 (2 Gram)	7,70	10,00	8,56	0,902

Table 3 depicts the average hemoglobin levels within the control group, with a pre-intervention mean of 11.86 g/dl and a standard deviation of 0.055. The lowest observed hemoglobin level was 11.80 g/dl, and the highest was 11.90 g/dl. In contrast, for experimental group 1, the pre-intervention average hemoglobin level was 9.92 g/dl, accompanied by a standard deviation of 1.026. The lowest recorded hemoglobin level was 8.80 g/dl, while the highest was 10.80 g/dl. Experimental group 2 exhibited an average pre-intervention hemoglobin level of 8.38 g/dl, with a standard deviation of 0.572, ranging from a minimum of 7.70 g/dl to a maximum of 9.10 g/dl. Finally, in experimental group 3, the pre-intervention mean hemoglobin level was 8.56 g/dl, with a standard deviation of 0.902, fluctuating between a minimum of 7.70 g/dl and a maximum of 10 g/dl. The hemoglobin levels after the intervention can be observed in the following table:

Table 4. Hemoglobin Levels After Treatment

Experiment	Min	Max	Average	Std.Dev
Control (0)	11,80	12,50	12,06	0,270
Application 1 (1 Gram)	12,90	15,00	14,20	1,017
Application 2 (1.5 gram)	12,70	14,20	13,36	0,695
Application 3 (2 Gram)	11,00	14,20	12,94	1,280

Table 4 presents the post-intervention mean hemoglobin levels in the control group at 11.80 g/dl, with a standard deviation of 0.270. The lowest recorded hemoglobin level was 11.80 g/dl, and the highest was 12.50 g/dl. In contrast, the mean hemoglobin levels in experimental group 1 were 14.20 g/dl, with a standard deviation of 1.017. The lowest observed hemoglobin level was 12.90 g/dl, while the highest was 15.00 g/dl. For experimental group 2, the mean post-intervention hemoglobin level was 13.36 g/dl, with a standard deviation of 0.695, ranging from a minimum of 12.70 g/dl to a maximum of 14.20 g/dl. Meanwhile, the mean post-intervention hemoglobin level in group 3 was 12.94 g/dl, with a standard deviation of 1.280, and hemoglobin levels ranged from a minimum of 11.00 g/dl to a maximum of 14.20 g/dl.

3.1.2. ANOVA Test Results for Enhanced Hemoglobin Levels

ANOVA test was employed to assess the significant differences in hemoglobin level improvements among the four groups. However, prior to conducting this test, it is essential to confirm one of the ANOVA assumptions, which is the homogeneity of variances. Therefore, normality and homogeneity tests were conducted on the differences in hemoglobin levels before and after the intervention. Given that the sample size within each group consisted of five respondents, the Shapiro-Wilk test was utilized for normality testing. The results of the normality test for each treatment group are presented in the table below:

Table 5. Normality Test

Experiment	Statistic	Sig	Description
Control (0)	0,776	0,050	Normal
Application 1 (1 Gram)	0,914	0,490	Normal
Application 2 (1.5 gram)	0,894	0,377	Normal
Application 3 (2 Gram)	0,841	0,169	Normal

Based on Table 5, it can be observed that the differences in hemoglobin values before and after the intervention follow a normal distribution, as the p-values obtained before the intervention were ≥ 0.05.

Table 6. Homogeneity Test

	Statistic	Sig	Description
Levene Statistic	1,705	0,206	Homogeneous

Based on the Table 6 above, the homogeneity test yielded a p-value of 0.206, where $0.206 > 0.05$. Consequently, it can be concluded that the data exhibits homogeneity. Thus, the ANOVA test is valid for examining the differences in hemoglobin level improvements among the groups, and the analysis can proceed. Subsequently, to determine if there is a significant difference in hemoglobin level improvements among the groups, an ANOVA test was conducted. The results of the ANOVA test are presented in Table 7.

Table 7. ANOVA Test

	F	Sig	Description
ANOVA	82,658	0,000	Significant

Based on Table 7 above, the ANOVA test resulted in a p-value of 0.000, where p-value < 0.05. Therefore, it can be concluded that there is a significant difference in the mean hemoglobin level improvements among the four groups. This implies that there is an effect between the pre- and post-intervention Moringa leaf supplementation on the increase in hemoglobin levels in anemic patients. Subsequently, a Post Hoc Bonferroni test was conducted to determine which groups exhibited significant differences.

Table 8. Post Hoc Bonferroni Test

Group	F	Mean Difference	Sig.
Control	Experiment 1	4,0800	0,000
	Experiment 2	4,7800	0,000
	Experiment 3	4,1800	0,000

The results of the Bonferroni test, with a p-value < 0.05, indicate a significant difference in the mean increase in hemoglobin levels between the control group and Experiment 1, the control group and Experiment 2, and the control group and Experiment 3.

3.2.Discussion

3.2.1. Influence of Moringa Tea Consumption on the Increase in Hemoglobin Levels in Anemia Patients

The mean hemoglobin levels of the respondents in the five groups after various interventions showed statistically significant differences, as evidenced by a p-value < 0.05 in each group. This suggests a significant difference in hemoglobin levels before and after the intervention of Moringa leaf consumption for the improvement of anemia.

There was a significant difference in hemoglobin levels in experimental group 1, which received 1 gram of Moringa leaf. The average hemoglobin level before the intervention was 9.92 g/dl, and it increased to 14.20 g/dl afterward. Similarly, in experimental group 2, which received 1.5 grams of Moringa leaf, the average hemoglobin level increased from 8.38 g/dl to 13.36 g/dl. Experimental group 3, receiving 2 grams of Moringa leaf, saw their average hemoglobin level rise from 8.56 g/dl to 12.94 g/dl. In contrast, the control group's average hemoglobin level increased from 11.86 g/dl to 12.06 g/dl. Iron is a crucial element for hemoglobin synthesis. Its function is to improve red blood cell production. Hence, if the red blood cell production is insufficient due to iron deficiency, the hemoglobin levels may decrease (Mawaddah & Pratiwi, 2018). The most effective method to enhance iron absorption is by consuming iron-rich foods along with a source of ascorbic acid while avoiding polyphenols and other inhibitors in the diet. Moringa leaves are a rich source of iron (Fe). Iron from Moringa leaves can facilitate red blood cell production, thereby increasing hemoglobin levels in the blood. Subsequently, the study conducted by Hastuti &

Sari (2022) found that Moringa leaf extract in capsule form, with the determined dose, is more efficient in preventing anemia and maintaining normal Hb levels. Common symptoms of anemia include pallor (on the lips, gums, eyes, and palm), easy fatigue, palpitations even with mild activity, pale conjunctiva, and cold extremities (Zidni et al., 2018). Based on the research conducted by Fitria (2020), the study found that the supplementation of 500 mg of Moringa leaf extract daily for 14 days significantly increased hemoglobin levels from 10.80 g/dl to 11.81 g/dl. Moringa Oleifera leaves contain a high level of antioxidants, with several bioactive compounds, mainly flavonoids like quercetin, kaempferol, and others. Quercetin is a powerful antioxidant whose potency is four to five times higher than vitamin C and vitamin E, which are known as potential vitamins. These antioxidants neutralize free radicals, protecting biomolecules from oxidative damage and providing significant protection (Pratiwi, 2020). The results of this study align with previous research, indicating the positive effects of Moringa leaf in increasing hemoglobin levels. A 14-day intervention in the three experimental groups led to an increase in hemoglobin levels, while no significant increase was observed in the control group.

3.2.2. Differences in Mean Hemoglobin Level Increases

In Table 2, the Post Hoc Bonferroni test shows that statistically, through the Post Hoc Bonferroni test, there is a significant difference in the increase in hemoglobin levels between the control group and experimental groups 1, 2, and 3, as the p-value is 0.000, which is less than 0.05. This suggests a significant difference in the increase in hemoglobin levels between experimental groups 1, 2, and 3 compared to the control group. Among the experimental groups, it was observed that a 1.5-gram supplementation of Moringa leaf was more effective and optimal in increasing hemoglobin levels, with an increase of 4.78 g/dl, compared to experimental groups 1 and 3. In experimental group 1, where 1 gram of Moringa leaf was administered, only a 4.08 g/dl increase in hemoglobin levels was noted. In experimental group 3, which received 2 grams of Moringa leaf, the contribution to the hemoglobin increase was 4.18 g/dl. In contrast, the control group, which did not receive the intervention, showed no significant increase in hemoglobin levels. Appropriate dosing plays a critical role in achieving an increase in hemoglobin levels in anemic patients. In this study, the most effective dosing was the supplementation of approximately 1.5 grams of Moringa leaf daily, which significantly increased iron levels in the blood of anemic patients. Based on the anemia characteristics table, it can be observed that after the intervention in group 2, where 1.5 grams of Moringa leaf were administered, there were no cases of moderate or severe anemia; the respondents' anemia levels were normalized. Typically, Moringa oleifera contains high levels of antioxidants, with its primary bioactive compounds being phenolics like quercetin, kaempferol, among others. Quercetin is a potent antioxidant, with four to five times the antioxidant capacity of vitamin C and vitamin E, both known for their antioxidant properties. These antioxidants function to neutralize free radicals, thereby preventing oxidative damage to various biomolecules and providing significant protection (Pratiwi, 2020).

4. CONCLUSION

Based on the research findings, it can be concluded that the administration of moringa tea has a significant positive impact on increasing hemoglobin (Hb) levels in the blood of anemic individuals. This conclusion is supported by the ANOVA analysis, which yielded a significance value of 0.000, indicating a significant difference between the pre- and post-treatment hemoglobin levels. Furthermore, the most optimal dosage of moringa tea for enhancing hemoglobin levels was determined to be 1.5 grams, as revealed by the post hoc Bonferroni analysis. This suggests that the administration of moringa tea at this specific dosage is effective in addressing anemia.

This research makes a significant contribution to the understanding of the potential of moringa tea as a therapeutic intervention for improving hemoglobin levels in anemic patients. By identifying the appropriate dosage, the administration of moringa tea can be integrated into an effective treatment strategy for addressing anemia. As further research is conducted, it is hoped that more scientific evidence will support the medical benefits of moringa tea, offering a more accessible and cost-effective alternative for anemia treatment.

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