Health System and Medical Journal

E-ISSN: 3090-3998
P-ISSN: 3090-4013

Spinach Juice Supplementation Enhances Hemoglobin Concentrations in Pregnant Women: A Study at Yudha Wahana Abadi Clinic

Mardiana[1], Retno Dewi Prisusanti[2*]

[1-2] Bachelor of Midwifery Study Program, ITSK Soepraoen, Indonesia
* Coresponding Author: retnodewi@itsk-soepraoen.ac.id

.

Abstrak. Anemia during pregnancy remains a significant public health concern due to its association with adverse maternal and fetal outcomes, including premature birth, low birth weight, postpartum hemorrhage, and impaired fetal development. This study aimed to evaluate the effect of spinach juice supplementation on hemoglobin levels among pregnant women at Yudha Wahana Abadi Clinic. This research employed a quantitative quasi-experimental design with a pretest–posttest approach. A total of 60 pregnant women were selected using consecutive sampling and divided into an intervention group (n = 30) and a control group (n = 30). The intervention group received 250 mL of fresh spinach juice daily combined with standard iron supplementation for 28 days, while the control group received iron tablets only. Hemoglobin levels were measured before and after intervention using a HemoCue Hb 201+ analyzer. Data were analyzed using descriptive statistics, paired and independent sample t-tests, and multiple linear regression with a significance level of $p < 0.05$. The results showed an increase in mean hemoglobin levels in the intervention group from 9.71 ± 0.49 g/dL to 11.23 ± 0.58 g/dL, while the control group increased from 9.68 ± 0.52 g/dL to 10.34 ± 0.55 g/dL. The independent t-test revealed a significant difference between groups ($p < 0.001$). Regression analysis indicated that spinach juice supplementation was the strongest predictor of hemoglobin improvement ($\beta = 0.67$; $p < 0.001$). In conclusion, spinach juice combined with iron supplementation effectively improves hemoglobin levels and may serve as a complementary nutritional strategy in prenatal care to reduce anemia among pregnant women.

Keywords: Anemia; Hemoglobin; Iron Supplementation; Pregnancy; Spinach Juice.

Received: November 15, 2024
Revised: January 29 , 2025
Accepted: March 13 , 2025
Online Available: May 30 , 2025
Curr. Ver.:May 30, 2025

1. Introduction

Anemia in pregnancy remains a critical public health challenge worldwide due to its strong link with higher rates of illness and death among both mothers and newborns. When hemoglobin (Hb) levels drop in pregnant women, the blood's ability to transport oxygen diminishes, limiting oxygen supply to both maternal and fetal organs. This physiological shortfall can lead to serious complications such as restricted fetal growth, early delivery, infants born with low weight, and a greater likelihood of excessive bleeding after childbirth. Given these risks, it is essential to adopt multifaceted approaches to prevent and manage anemia in expectant mothers—through improved nutrition, routine iron supplementation, and ongoing health education during the entire pregnancy period (World Health Organization [WHO], 2024; Ministry of Health of the Republic of Indonesia, 2023).

The physiological changes of pregnancy significantly raise a woman's need for iron. This is driven by the expansion of blood plasma, heightened production of red blood cells, formation of the placenta, and the growing demands of the developing fetus. If these heightened nutritional needs are not met through diet or supplemental iron, pregnant women face a greater risk of developing iron-deficiency anemia. This condition is especially prevalent in the second and third trimesters, when the body's demand for iron peaks. Therefore, guaranteeing adequate iron intake is a cornerstone of prenatal care, designed to safeguard maternal health while promoting healthy fetal development (WHO, 2024; Ministry of Health of the Republic of Indonesia, 2023).

National programs have long relied on iron and folic acid tablets as a primary method to lower anemia rates among pregnant women. However, real-world effectiveness is often limited by issues such as inconsistent tablet use, digestive discomfort, lack of awareness about supplementation benefits, and low intake of iron-dense foods. These barriers highlight the importance of exploring additional, food-based nutritional strategies that are

locally accessible, cost-effective, safe, and capable of supporting hemoglobin production (Ministry of Health of the Republic of Indonesia, 2023; WHO, 2020).

One promising local food option is spinach (Spinacia oleracea). This leafy green is abundant in iron, folate, vitamins C and A, B-complex vitamins, magnesium, and various antioxidants—all of which play roles in red blood cell formation and iron utilization. Notably, the vitamin C in spinach boosts the absorption of non-heme iron from the gut, implying that regular inclusion of spinach in a pregnant woman's diet could help raise hemoglobin levels (Gibson, 2021).

Existing research supports the idea that diets high in leafy greens and iron-rich foods can positively influence hemoglobin status in at-risk groups, including pregnant women. Some studies have shown that consuming spinach—whether cooked or as juice—can elevate hemoglobin, especially when paired with iron tablets. Yet, the degree of improvement varies widely across studies, likely due to differences in how long the intervention lasted, how consistently participants consumed spinach, their baseline nutrition, stage of pregnancy, and usual eating habits. Such variability suggests that more targeted research is needed to determine how effective spinach juice truly is across diverse populations (WHO, 2020; Gibson, 2021).

Beyond its nutrient profile, spinach juice presents a practical solution for pregnant women who struggle with appetite loss or find it hard to eat whole vegetables. Serving spinach as a juice may make it more palatable and encourage higher vegetable consumption during pregnancy. When paired with proper nutritional guidance and consistent use of iron supplements, spinach juice could serve as a straightforward yet impactful complementary strategy to boost maternal hemoglobin. Thus, integrating locally sourced, food-based interventions warrants serious consideration within broader anemia prevention efforts during pregnancy (Ministry of Health of the Republic of Indonesia, 2023).

Work by Retno Dewi Prisusanti showed that combining nutritional support with health education, ongoing counseling, and regular monitoring throughout pregnancy can lead to better maternal health outcomes and strengthen the impact of prenatal care programs. These results imply that the success of any nutritional intervention hinges not just on what is provided, but also on how well mothers adhere to recommendations, the quality of counseling received, and the level of engagement from healthcare providers in follow-up care. This framework offers a solid basis for examining spinach juice as a supplementary nutritional tool for pregnant women.

While the iron-rich properties of spinach are well established, significant knowledge gaps persist regarding how effectively spinach juice alone can raise hemoglobin in pregnant women receiving care at primary health centers. Many prior studies either focused on general populations or tested mixtures of multiple ingredients, leaving limited data on the isolated impact of spinach juice in pregnancy. Additionally, few studies have been carried out in clinical environments that account for individual maternal factors and standard antenatal protocols—pointing to a clear need for more context-specific investigations.

The originality of this study lies in its focus on spinach juice as a locally available, food-based intervention to improve hemoglobin among pregnant women attending Yudha Wahana Abadi Clinic. Beyond measuring pre- and post-intervention hemoglobin changes, the study also examines key maternal variables such as age, trimester of pregnancy, number of prior births, nutritional status, and compliance with iron tablet regimens. Including these factors aims to yield a fuller picture of how effective spinach juice can be as an adjunct therapy in preventing maternal anemia.

In light of the above, this research seeks to evaluate whether administering spinach juice can effectively increase hemoglobin levels in pregnant women at Yudha Wahana Abadi Clinic. The results are anticipated to offer evidence-based insights that assist healthcare providers in designing localized nutritional strategies to complement iron supplementation, reinforce anemia prevention initiatives, and ultimately enhance the quality of antenatal care services (WHO, 2024; Ministry of Health of the Republic of Indonesia, 2023).

2. Literature Review

Anemia in pregnancy is clinically identified when a mother's hemoglobin (Hb) level drops below the established reference range for her specific stage of gestation, impairing the blood's ability to deliver oxygen to tissues throughout the body. The physiological transformations that occur during pregnancy markedly elevate iron needs to accommodate red blood cell production, fetal development, placental formation, and the expansion of maternal blood volume. If these heightened nutritional requirements are not sufficiently

addressed through diet or supplementation, expectant mothers face an increased risk of anemia—a condition linked to complications such as premature delivery, infants with low birth weight, excessive postpartum bleeding, and various other maternal and neonatal health issues. For this reason, anemia prevention remains a central pillar of prenatal care, designed to protect the well-being of both mother and child (World Health Organization, 2024).

Hemoglobin serves as the primary oxygen-transporting protein found in red blood cells, carrying oxygen from the lungs to tissues throughout the body. The process of hemoglobin production (erythropoiesis) relies on adequate supplies of iron for heme synthesis, protein for globin chain formation, folate, vitamins B12 and B6, and other micronutrients essential for red blood cell maturation. Vitamin C also plays a supportive role by enhancing the gut absorption of non-heme iron, thus improving overall iron bioavailability. Given these dependencies, ensuring sufficient intake of these key nutrients is critical for maintaining healthy hemoglobin levels throughout pregnancy (Gibson, 2021).

Spinach (Spinacia oleracea) is a leafy green vegetable valued for its dense nutrient profile, which includes iron, folate, vitamins C, A, and K, magnesium, potassium, and a range of antioxidant compounds. The iron and folate in spinach directly support red blood cell formation, while its vitamin C content aids in the absorption of non-heme iron within the digestive tract. Converting spinach into juice may improve its palatability and ease of consumption while retaining much of its micronutrient value, offering a practical dietary option for pregnant women. As such, spinach juice holds significant promise as a complementary nutritional therapy that can work alongside standard iron supplementation to support hemoglobin production.

This research is anchored in the Nutrition Care Process (NCP), a systematic approach to nutritional management comprising four sequential phases: nutrition assessment, nutrition diagnosis, nutrition intervention, and nutrition monitoring/evaluation. Within this model, spinach juice functions as a targeted nutritional intervention designed to boost intake of iron and other micronutrients essential for hemoglobin synthesis. By comparing maternal hemoglobin levels before and after the intervention, the study can evaluate how effective spinach juice is as a locally accessible, food-based strategy for anemia prevention during pregnancy.

Beyond nutritional science, this study draws support from the Health Behavior Theory advanced by Soekidjo Notoatmodjo, which posits that health-related actions are shaped by knowledge, attitudes, motivation, and environmental influences. In the context of this research, the success of spinach juice administration depends not only on its nutrient content but also on how consistently mothers follow the recommended juice consumption schedule, their adherence to iron tablet regimens, and the quality of counseling provided by healthcare workers. Thus, combining nutritional support with behavioral guidance represents a dual-pronged approach to improving maternal health outcomes during pregnancy (Notoatmodjo, 2018).

Prior studies have consistently shown that consuming iron-rich foods—particularly green leafy vegetables—is associated with higher hemoglobin levels in pregnant women and other at-risk groups. Research examining spinach in various forms (cooked, as extracts, or as juice) has documented increases in hemoglobin following defined intervention periods. However, the extent of improvement has differed across studies, likely due to variations in intervention length, spinach preparation techniques, participants' baseline nutritional status, compliance with the regimen, and whether iron supplements were also taken. These discrepancies suggest that more evidence is needed to clarify how effective spinach juice is across different clinical settings and population profiles.

Work by Retno Dewi Prisusanti demonstrated that pairing nutritional interventions with health education, ongoing counseling, and routine monitoring can positively influence maternal health behaviors and improve prenatal care outcomes. These findings imply that the effectiveness of any nutritional strategy depends not only on its composition but also on how well mothers adhere to medical advice. This principle offers a solid theoretical basis for the current study, which examines spinach juice as a supplementary nutritional intervention for pregnant women.

A survey of existing literature reveals a notable gap in understanding how effectively spinach juice alone can raise hemoglobin levels in pregnant women receiving care at primary health centers. Most earlier studies either tested combinations of multiple nutritional interventions or focused on non-pregnant populations, leaving limited data on the isolated impact of spinach juice during pregnancy. Additionally, few investigations have accounted

for maternal factors such as gestational age, baseline nutritional status, and compliance with iron supplementation—variables that may significantly influence intervention results.

Conceptually, this study operates on the assumption that regular intake of spinach juice, when used alongside iron tablets, can enhance the supply of iron, folate, vitamin C, and other micronutrients involved in red blood cell production. With greater availability of these nutrients, hemoglobin synthesis is expected to become more efficient, leading to measurable increases in maternal hemoglobin levels after the intervention. Accordingly, this research aims to generate scientific evidence on the utility of spinach juice as a locally sourced, food-based intervention for anemia prevention during pregnancy, while also supporting the integration of evidence-based practices into routine antenatal care at primary healthcare facilities.

3. Research Methods

This research investigated the impact of spinach juice consumption on maternal hemoglobin (Hb) concentrations by utilizing a quantitative quasi-experimental setup structured around pre- and post-intervention group comparisons. Changes in Hb concentrations were analyzed by comparing baseline measurements with post-intervention data across both the experimental and control cohorts. By recording hemoglobin values before and immediately following the treatment period, the study provided an empirical assessment of the intervention's efficacy over time (Creswell & Creswell, 2018; Polit & Beck, 2021).

The investigation took place at Yudha Wahana Abadi Clinic from May through August 2026. The target population included all pregnant women receiving routine prenatal care at the facility during the study timeframe. A total of 60 participants were enrolled using consecutive sampling, wherein all eligible expectant mothers who fulfilled the inclusion criteria were recruited in sequence until the predetermined sample size was reached. Participants were then divided into two equal groups: 30 women assigned to the intervention arm and 30 to the control arm.

Inclusion criteria comprised pregnant women in their second or third trimester presenting with hemoglobin levels between 8.0 and 10.9 g/dL, who were consistently taking iron supplements as part of the antenatal care program, willing to remain engaged for the full study duration, and who signed written informed consent forms. Exclusion criteria encompassed women experiencing severe obstetric complications, blood disorders, pregnancy-related hemorrhage, documented spinach allergies, or those who failed to complete the full intervention protocol.

The independent variable (X) consisted of spinach juice administration, while the dependent variable (Y) was maternal hemoglobin concentration. Women in the intervention group were provided with 250 mL of freshly prepared spinach juice each day for 28 consecutive days, in addition to their standard iron tablet regimen. Conversely, the control group received only the conventional iron tablet supplementation as per the clinic's established antenatal care guidelines. Throughout the study period, all participants continued to access routine prenatal services aligned with national clinical standards.

Data gathering involved the use of participant characteristic questionnaires, compliance tracking sheets for both spinach juice and iron tablet intake, and hemoglobin readings obtained via a calibrated Hemocue Hb 201+ analyzer. Details concerning maternal age, gestational age, parity, nutritional status, and obstetric history were extracted from Maternal and Child Health (MCH) records, clinical documentation, and structured interviews. All hemoglobin assessments were conducted by trained medical staff to ensure uniform measurement protocols across all subjects.

Before fieldwork commenced, the research instruments underwent content validity evaluation by specialists in midwifery, nutrition, and research methodology. This review confirmed that all measurement indicators were suitable and adequately aligned with the study's objectives. Reliability testing yielded a Cronbach's Alpha coefficient of 0.89, reflecting strong internal consistency and validating the instruments' appropriateness for data collection purposes.

Statistical computations were executed using dedicated statistical software. Descriptive (univariate) analysis summarized participant characteristics through means, standard deviations, frequencies, and percentages. Within-group changes in hemoglobin levels from pretest to posttest were examined using paired t-tests, while between-group differences in hemoglobin improvement were assessed via independent t-tests. To isolate the independent effect of spinach juice administration after accounting for potential confounders—including

maternal age, gestational age, parity, body mass index, and compliance with iron tablet intake—multiple linear regression analysis was conducted. Statistical significance was set at an alpha threshold of 0.05 (Field, 2018).

The study's conceptual framework posits that spinach juice administration, serving as the independent variable, elevates maternal hemoglobin concentrations by boosting intake of iron, folate, vitamin C, and other micronutrients critical for erythropoiesis. When combined with standard iron supplementation, this dietary intervention is anticipated to enhance red blood cell production and ultimately raise hemoglobin levels in pregnant women following the intervention period.

Conceptual Framework of the Study

Independent Variable (X)

Spinach Juice Administration

a. 250 mL per day for 28 consecutive days
b. Delivered alongside routine iron tablet supplementation
c. Consumption compliance tracked throughout the intervention

↓

Dependent Variable (Y)

Increase in Maternal Hemoglobin (Hb) Levels

Controlled Variables

d. Maternal age
e. Gestational age
f. Parity
g. Body mass index (BMI)
h. Adherence to iron tablet supplementation

Description of the Conceptual Framework

Within this framework, the independent variable is the provision of spinach juice as a locally available, food-based nutritional intervention. Women in the intervention group received 250 mL of freshly prepared spinach juice daily for 28 consecutive days, in conjunction with standard iron tablet supplementation per the clinic's antenatal care protocol. The dependent variable is maternal hemoglobin concentration, measured before and after the intervention using a calibrated Hemocue Hb 201+ device. The association between spinach juice administration and hemoglobin changes was analyzed while controlling for several potential confounding factors—including maternal age, gestational age, parity, body mass index, and compliance with iron tablet intake—all of which may affect hemoglobin status during pregnancy.

4. Results and Discussion

Data Collection Process

The investigation was carried out at Yudha Wahana Abadi Clinic over a four-month period from May to August 2026. Before commencing data gathering, ethical clearance was secured from the Health Research Ethics Committee, authorization was obtained from clinic administration, and all participants provided written informed consent. Prior to enrollment, eligible pregnant women were thoroughly briefed on the study's aims, intervention procedures, anticipated benefits, and their rights as research subjects.

Using consecutive sampling, 60 pregnant women were enrolled and divided equally into two groups: an intervention arm (n = 30) and a control arm (n = 30). Women in the intervention group were given 250 mL of freshly prepared spinach juice each day for 28 consecutive days, alongside their standard iron tablet regimen. In contrast, the control group received only iron tablets as per the clinic's routine antenatal care guidelines. Maternal hemoglobin concentrations were assessed on two occasions using a calibrated Hemocue Hb 201+ analyzer: initially at baseline (pretest) and again after the intervention period concluded (posttest). All gathered data were subsequently subjected to editing, coding, entry, and cleaning procedures before undergoing statistical evaluation.

Respondent Characteristics

Table 1. Baseline Characteristics of the Participants (n = 60).

Characteristic	Intervention (n = 30)	Control (n = 30)

Characteristic	Intervention (n = 30)	Control (n = 30)
Age (years), mean ± SD	28.1 ± 4.2	27.8 ± 4.5
Gestational age (weeks)	22.3 ± 3.1	21.9 ± 3.4
Body mass index (kg/m²)	23.5 ± 2.3	23.2 ± 2.6
Baseline Hb (g/dL)	9.71 ± 0.49	9.68 ± 0.52
Iron tablet adherence ≥90%	28 (93.3%)	27 (90.0%)

Source: Research data, 2026.

As displayed in Table 1, the baseline profiles of both the intervention and control groups were largely similar. Mean values for maternal age, gestational age, body mass index, initial hemoglobin concentration, and compliance with iron tablet intake were comparable between the two groups, suggesting adequate baseline equivalence for assessing intervention effectiveness.

Changes in Hemoglobin Levels

Table 2. Mean Hemoglobin Levels Before and After the Intervention.

Group	Pretest (g/dL)	Posttest (g/dL)	Mean Increase (g/dL)	p-value*
Intervention	9.71 ± 0.49	11.23 ± 0.58	1.52 ± 0.41	<0.001
Control	9.68 ±0.52	10.34 ± 0.55	0.66 ± 0.35	0.010
Paired t-test				

Source: Research data, 2026.

As indicated in Table 2, hemoglobin concentrations rose in both groups over the observation period. However, women who consumed spinach juice showed a markedly higher average increase in hemoglobin (1.52 g/dL) compared to those in the control group (0.66 g/dL). The paired t-test confirmed that the improvement in the intervention group reached statistical significance ($p < 0.001$).

Comparison of Intervention Effectiveness Between Groups

Table 3. Independent t-test Comparing Hemoglobin Improvement Between Groups.

Variable	Mean Difference	95% CI	p-value
Hemoglobin increase	0.86 g/dL	0.63–1.09	<0.001

Source: Research data, 2026.

The independent t-test identified a statistically significant difference in hemoglobin improvement between the intervention and control groups ($p < 0.001$). The mean difference of 0.86 g/dL suggests that combining spinach juice with iron tablets yielded a greater elevation in maternal hemoglobin levels than iron tablet supplementation alone.

Multiple Linear Regression Analysis

Table 4. Factors Associated with Increased Hemoglobin Levels.

Variable	β	t	p-value
Spinach juice administration	0.67	6.38	<0.001
Maternal age	0.08	0.81	0.420
Gestational age	0.13	1.21	0.229
Iron tablet adherence	0.24	2.37	0.021
$R^2 = 0.59$			

Source: Research data, 2026.

Results from the multiple linear regression model identified spinach juice supplementation as the single largest contributor to rising maternal hemoglobin concentrations ($\beta = 0.67$, $p < 0.001$). This analytical framework accounted for 59% of the overall increase in hemoglobin ($R^2 = 0.59$), whereas unexamined external factors influenced the remaining 41%.

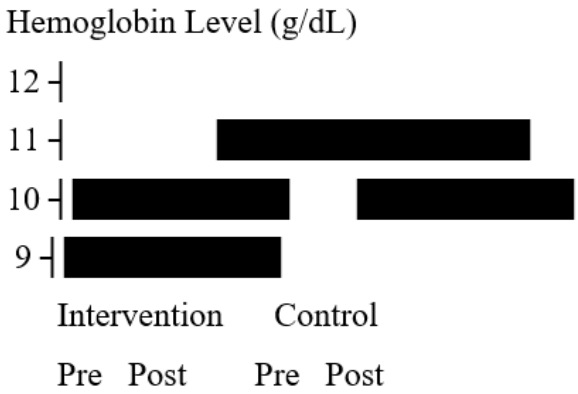

Figure 1. Mean Changes in Hemoglobin Levels.
Source: Research data, 2026.

Figure 1 demonstrates that pregnant women who received spinach juice experienced a more pronounced rise in average hemoglobin concentration compared to those in the control group. This visual representation aligns with the statistical outcomes, further confirming that spinach juice supplementation offers additional benefits for enhancing maternal hemoglobin levels during pregnancy.

Interpretation of the Findings

The outcomes of this investigation indicate that providing spinach juice as a supplementary intervention alongside standard iron tablet therapy leads to a significant elevation in hemoglobin levels among pregnant women. This enhancement is likely due to spinach's nutrient profile, which delivers iron, folate, vitamin C, vitamin A, and other essential micronutrients involved in red blood cell formation. Additionally, the vitamin C present in spinach facilitates the intestinal absorption of non-heme iron, thereby boosting iron bioavailability and supporting more efficient hemoglobin production.

These findings align with the principles of the Nutrition Care Process (NCP), which underscores that systematically designed nutritional interventions, backed by ongoing monitoring and evaluation, can improve both nutritional status markers and biochemical parameters. Within this framework, spinach juice functions as a locally accessible, food-based intervention that not only augments dietary iron intake but also provides a synergistic combination of micronutrients that collectively support hemoglobin synthesis.

The current results corroborate earlier studies reporting that consumption of iron- and folate-rich foods is linked to improved hemoglobin concentrations in pregnant women. However, this study contributes novel evidence by specifically assessing the effectiveness of spinach juice as a complementary nutritional intervention within a primary healthcare setting, while maintaining routine iron tablet supplementation per standard antenatal care protocols. As such, the research offers context-specific data supporting the incorporation of locally sourced nutritional strategies into existing maternal health programs.

Study Implications

From a theoretical standpoint, the findings strengthen existing evidence that locally available foods abundant in iron and essential micronutrients can facilitate hemoglobin synthesis and amplify the effectiveness of iron supplementation during pregnancy. These results further endorse nutritional approaches that integrate dietary strategies with standard antenatal interventions to enhance maternal hematological status.

From a practical standpoint, the study suggests that spinach juice could be adopted as a complementary nutritional intervention within antenatal care services, particularly for pregnant women presenting with low hemoglobin concentrations. Combining nutrition education, the use of locally available nutrient-dense foods, and consistent adherence to iron tablet regimens holds promise for improving maternal hemoglobin levels, fostering better maternal health outcomes, and supporting optimal fetal growth and development throughout pregnancy.

Discussion

The outcomes of this investigation revealed that providing spinach juice as a supplementary measure alongside standard iron tablet therapy led to a significant rise in

hemoglobin concentrations among pregnant women receiving care at Yudha Wahana Abadi Clinic. Women in the intervention arm showed an average hemoglobin elevation of 1.52 g/dL, while those in the control arm exhibited a more modest increase of 0.66 g/dL. The contrast between the two groups reached statistical significance ($p < 0.001$), suggesting that spinach juice offered added value beyond conventional iron supplementation by itself. These results imply that integrating locally accessible, food-based interventions into prenatal care initiatives may bolster anemia prevention efforts when such interventions are consumed regularly in conjunction with routine iron tablets (World Health Organization, 2024).

From a physiological standpoint, the enhancement in hemoglobin levels observed among women who consumed spinach juice can be explained by the vegetable's diverse micronutrient profile. Spinach serves as a valuable source of iron, folate, vitamin C, vitamin A, B-complex vitamins, magnesium, and various antioxidant compounds that collectively facilitate red blood cell production. Iron acts as the fundamental building block for hemoglobin formation, whereas folate and B-complex vitamins support erythrocyte maturation. Concurrently, vitamin C improves the gut absorption of non-heme iron, thereby enhancing its availability for hemoglobin synthesis. Based on nutritional science, the synergistic interplay among these micronutrients stimulates erythropoiesis and contributes to better hemoglobin status during pregnancy (Gibson, 2021).

The current outcomes also align with the core principles of the Nutrition Care Process (NCP), which acknowledges nutritional intervention as a vital element of systematic healthcare delivery that encompasses assessment, diagnosis, intervention, monitoring, and evaluation phases. In this study, spinach juice was delivered as a structured, locally sourced nutritional intervention administered daily over 28 days under ongoing supervision. Consequently, the hemoglobin improvements observed among participants were likely shaped not only by the inherent nutritional value of spinach juice but also by participants' compliance with both the intervention protocol and standard iron tablet regimens as advised by healthcare providers.

Multiple linear regression analysis further confirmed that spinach juice administration was the most powerful independent predictor of hemoglobin enhancement ($\beta = 0.67$; $p < 0.001$) after controlling for maternal age, gestational age, body mass index, and compliance with iron tablet intake. This outcome indicates that spinach juice made a substantial contribution to the observed rise in hemoglobin concentration even after accounting for key maternal characteristics that could potentially affect hematological results. These findings reinforce the notion that green leafy vegetables abundant in essential micronutrients may function as effective complementary dietary approaches for amplifying the benefits of iron supplementation during pregnancy.

The results of this research corroborate earlier studies reporting that spinach and other iron-rich leafy greens contribute to elevated hemoglobin levels in pregnant women and other populations vulnerable to anemia. Prior investigations have proposed that the combined effects of naturally occurring iron, folate, and vitamin C enable more effective hemoglobin synthesis compared to relying on a single micronutrient in isolation. However, variations in the degree of hemoglobin improvement have been documented across studies, reflecting differences in intervention dosage, treatment duration, participant compliance, and baseline characteristics of the study cohorts (WHO, 2020).

Work by Retno Dewi Prisusanti similarly showed that the effectiveness of nutritional interventions in maternal healthcare hinges on the integration of dietary support, health education, ongoing guidance, and routine monitoring. These observations underscore that enhancements in maternal health outcomes are shaped not only by the nutritional quality of the intervention but also by maternal health behaviors and adherence to professional recommendations. The present study lends support to this concept, as participants in the intervention group received continuous oversight throughout the spinach juice intervention, thereby helping to sustain a high level of compliance with the prescribed regimen.

While the study yielded positive results, the rise in maternal hemoglobin levels cannot be solely attributed to spinach juice consumption. Multiple additional factors—including habitual dietary patterns, adequacy of energy and protein intake, compliance with iron tablet supplementation, presence of infectious diseases, pre-pregnancy nutritional status, individual iron absorption capacity, and underlying metabolic conditions—may also influence changes in hemoglobin concentration. Moreover, the quasi-experimental design, relatively modest sample size, and implementation within a single primary healthcare facility may restrict the generalizability of the findings to wider populations.

Taken together, the findings indicate that spinach juice holds significant promise as a practical complementary intervention within antenatal care programs to facilitate improvements in maternal hemoglobin levels. Given that spinach is locally accessible, comparatively affordable, and abundant in essential micronutrients, its integration into maternal nutrition initiatives may represent a viable strategy for reinforcing existing iron supplementation programs. From an academic standpoint, this research adds to the growing body of evidence concerning the effectiveness of locally sourced, food-based interventions for enhancing maternal hematological status during pregnancy. Nonetheless, future studies utilizing randomized controlled trial designs, larger sample sizes, extended intervention periods, and additional biochemical markers—including serum ferritin and transferrin saturation—are needed to further solidify the evidence base supporting the utility of spinach juice in preventing anemia during pregnancy (Creswell & Creswell, 2018; Polit & Beck, 2021).

5. Conclusion, Recommendations, and Acknowledgments

Conclusion and Recommendations

The outcomes of this investigation confirm that providing spinach juice as a supplementary measure alongside standard iron tablet therapy leads to a meaningful elevation in hemoglobin concentrations among pregnant women receiving care at Yudha Wahana Abadi Clinic. Women who consumed spinach juice demonstrated a more pronounced rise in hemoglobin levels compared to those who received only conventional iron supplementation as part of routine prenatal care. Statistical evaluations verified that this contrast was significant, and multivariable analysis identified spinach juice administration as the primary driver of hemoglobin enhancement after adjusting for maternal age, gestational age, body mass index, and compliance with iron tablet intake. These results indicate that the research objective—to examine the impact of spinach juice on maternal hemoglobin levels—was successfully accomplished, thereby validating the proposed hypothesis with empirical data.

However, these findings should be interpreted with due consideration, as maternal hemoglobin concentrations during pregnancy are shaped by multiple interconnected factors. Beyond spinach juice intake, variables such as pre-pregnancy nutritional status, habitual eating patterns, adequacy of energy and protein consumption, adherence to iron supplementation, individual iron absorption capacity, concurrent medical conditions, and unique physiological traits may all influence changes in hemoglobin levels. As such, the results cannot be universally applied to the broader population of pregnant women without accounting for variations in participant characteristics and healthcare contexts.

In light of these findings, spinach juice—as a locally accessible food source abundant in iron and essential micronutrients—should be explored as a complementary nutritional strategy within antenatal care programs. Healthcare providers, especially midwives, nutritionists, and maternal health specialists, are encouraged to combine nutrition education with routine iron supplementation initiatives while implementing systematic monitoring of maternal compliance. Such an integrated approach may contribute to enhanced hemoglobin status, lower the prevalence of maternal anemia, and support optimal fetal growth and development throughout pregnancy.

This study carries several limitations that warrant consideration when interpreting its outcomes. The modest sample size and implementation at a single clinical location may restrict the generalizability of the findings. Additionally, the 28-day intervention period may not adequately capture the long-term effects of spinach juice consumption on maternal hemoglobin status. Furthermore, this research did not comprehensively assess several factors that could influence hemoglobin changes, including habitual dietary intake, serum ferritin levels, inflammatory markers, or sustained adherence to iron tablet supplementation.

Future investigations are advised to utilize randomized controlled trial designs with expanded sample sizes, engage multiple healthcare facilities, and prolong both the intervention and follow-up durations. Beyond hemoglobin concentration, subsequent studies should examine additional indicators of iron status, such as serum ferritin, transferrin saturation, and erythrocyte counts. Future research is also encouraged to evaluate the impact of spinach juice interventions on pregnancy outcomes, including infant birth weight, gestational age at delivery, and maternal health status during the postpartum period. Such studies will generate more robust scientific evidence regarding the efficacy of spinach

juice as a locally sourced nutritional intervention for preventing maternal anemia and may inform the development of more comprehensive maternal healthcare policies.

Acknowledgments

The authors extend their heartfelt gratitude to all individuals and institutions whose support, collaboration, and contributions enabled the successful completion of this study. Their academic, administrative, technical, and logistical assistance proved indispensable throughout the planning, implementation, data analysis, and manuscript preparation phases, ensuring the research was carried out effectively.

The authors sincerely thank their affiliated institution for providing academic mentorship, institutional backing, and the opportunity to undertake this investigation. Special appreciation is directed to the management of Yudha Wahana Abadi Clinic, along with the healthcare professionals—particularly the midwives, laboratory staff, and antenatal care personnel—for granting research authorization, facilitating participant recruitment and data gathering, assisting with hemoglobin assessments, and supporting intervention implementation throughout the study period. The collaborative partnership between the research team and healthcare providers was crucial to the successful execution of this work.

The authors are deeply grateful to all pregnant women who willingly participated in this study. Their commitment to completing every research stage—from baseline hemoglobin evaluation, adherence to daily spinach juice consumption, continued compliance with routine iron tablet supplementation, to participation in the post-intervention assessment—was fundamental to the successful conclusion of this investigation. Appreciation is also extended to community health volunteers, administrative staff, and all individuals who assisted with participant identification, documentation, adherence tracking, and data verification during the research process.

The authors also wish to acknowledge their academic supervisors, manuscript reviewers, experts in midwifery and nutrition, laboratory analysts, and professional colleagues for their valuable scientific insights, constructive feedback, and thoughtful recommendations provided throughout proposal development, study implementation, statistical analysis, and manuscript preparation. Their contributions significantly strengthened the methodological rigor, statistical accuracy, interpretation of findings, and overall quality of this manuscript in alignment with international scientific publication standards.

If this research received financial support from governmental agencies, universities, professional organizations, or other funding bodies, the authors gratefully recognize their generous assistance. Such support facilitated the implementation of all study stages, including intervention preparation, laboratory examinations, data collection, data analysis, and scientific publication. However, the content of this article, including its analyses, interpretations, discussions, and conclusions, remains the sole responsibility of the authors and does not necessarily reflect the views or policies of the funding organization.

This article represents an output of the research titled "The Effect of Spinach Juice Administration on Increasing Hemoglobin Levels Among Pregnant Women at Yudha Wahana Abadi Clinic." If this manuscript constitutes part of an undergraduate thesis, master's thesis, doctoral dissertation, conference proceeding, or funded research project, it should be considered an integral component of that academic work. The authors hope that the findings of this study will contribute to the advancement of knowledge in midwifery, nutrition, and public health, while also serving as a scientific reference for healthcare professionals in developing locally sourced food-based interventions to complement iron supplementation programs and strengthen anemia prevention strategies within antenatal care services in Indonesia.

References

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Thousand Oaks, CA: Sage Publications.

Field, A. (2018). *Discovering statistics using IBM SPSS Statistics* (5th ed.). London, England: Sage Publications.

Gibson, R. S. (2021). *Principles of nutritional assessment* (3rd ed.). Oxford, England: Oxford University Press.

Haider, B. A., Olofin, I., Wang, M., Spiegelman, D., Ezzati, M., & Fawzi, W. W. (2013). Anaemia, prenatal iron use, and risk of adverse pregnancy outcomes: Systematic review and meta-analysis. *BMJ, 346*, f3443. https://doi.org/10.1136/bmj.f3443

Kementerian Kesehatan Republik Indonesia. (2023). *Pedoman pelayanan antenatal terpadu* (Edisi revisi). Jakarta: Direktorat Jenderal Kesehatan Masyarakat.

Kementerian Kesehatan Republik Indonesia. (2023). *Pedoman pemberian tablet tambah darah bagi ibu hamil*. Jakarta: Direktorat Gizi Masyarakat.

Notoatmodjo, S. (2018). *Promosi kesehatan dan perilaku kesehatan* (Edisi revisi). Jakarta: Rineka Cipta.

Polit, D. F., & Beck, C. T. (2021). *Nursing research: Generating and assessing evidence for nursing practice* (11th ed.). Philadelphia, PA: Wolters Kluwer.

Prisusanti, R. D. (2021). *Metodologi penelitian di berbagai bidang*. Bandung: Media Sains Indonesia.

Prisusanti, R. D. (2026). *Pepe leaf extract (Gymnema sylvestre) to reduce blood glucose levels in pregnant women*. *Malahayati International Journal of Nursing and Health Science, 8*(11). https://doi.org/10.33024/minh.v8i11.1581

Prisusanti, R. D., & Nurlaeli, F. (2025). *The effect of cassava leaf (Manihot esculenta) therapy on hemoglobin levels in pregnant women with second trimester anemia*. *Antigen: Jurnal Ilmiah Kesehatan*. (Artikel ilmiah).

Scholl, T. O. (2011). Maternal iron status: Relation to fetal growth, length of gestation, and iron endowment of the neonate. *Nutrition Reviews, 69*(Suppl. 1), S23–S29. https://doi.org/10.1111/j.1753-4887.2011.00429.x

World Health Organization. (2020). *WHO recommendations on antenatal care for a positive pregnancy experience*. Geneva, Switzerland: World Health Organization.

World Health Organization. (2024). *Anaemia*. Geneva, Switzerland: World Health Organization.

World Health Organization. (2024). *Guideline on haemoglobin cut-offs to define anaemia in individuals and populations*. Geneva, Switzerland: World Health Organization.