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A Comparative Quasi-Experimental Study of Beetroot–Red Guava Juice and Salak Pondoh Juice on Hemoglobin Levels in Pregnant Women with Anemia in Depok, Indonesia

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ABSTRACT

Introduction: Anemia remains a common concern during pregnancy due to increased iron requirements. Alternative nutritional approaches from natural food sources may help improve hemoglobin levels, particularly among women who are reluctant to consume iron supplements. This study aimed to compare the effectiveness of beetroot–red guava juice and salak pondoh juice in increasing hemoglobin levels among third-trimester pregnant women with anemia.

Methods: This research employed a quasi-experimental design with a pretest-posttest control group methodology. Purposive sampling was used to choose 150 anemic pregnant women in their third trimester. Participants were categorized into two groups: Seventy-five participants were administered beets combined with red guava juice (intervention group), whereas another seventy-five participants received salak pondoh juice (comparison group). Hemoglobin levels were evaluated pre- and post-intervention utilizing a hemoglobin assessment observation sheet. Data were analyzed utilizing paired t-tests to evaluate within-group differences and independent t-tests to compare inter-group differences.

Results: The average elevation in hemoglobin levels was 0.46 g/dL (95% CI: 0.35–0.57) for the beetroot–red guava group and 0.34 g/dL (95% CI: 0.32–0.37) for the salak pondoh group. The intergroup difference was 0.30 g/dL (95% CI: 0.15–0.45), indicating a moderate effect size (Cohen's d = 0.62). The effect size analysis indicated a substantial effect in the beetroot–red guava group (Cohen's d = 0.92) and an exceedingly large effect in the salak pondoh group (Cohen's d = 3.2). The intergroup comparison produced a moderate effect size (Cohen's d = 0.62).

Conclusion: These findings indicate short-term increases in hemoglobin levels associated with both interventions. However, the modest magnitude of change and short duration of intervention warrant cautious interpretation and further longitudinal investigation.

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INTRODUCTION

Anemia remains a critical global public health concern, particularly in underdeveloped countries. About one-third of the global population is affected, with women of reproductive age and pregnant women being the most vulnerable groups (1). The weight of anemia continues to increase globally and contributes substantially to disability and reduced quality of life. Epidemiological studies indicate women have a higher prevalence of anemia than men, largely due to physiological conditions such as menstruation, pregnancy, and childbirth (2).

Iron is essential for the development of the fetus and the preservation of maternal health during pregnancy. Several adverse outcomes, Postpartum hemorrhage, premature birth, low birth weight, and heightened maternal and newborn mortality risk are linked to iron deficiency anemia during pregnancy (3). Most of the time, infants who are born to moms who are anemic have insufficient iron levels at birth. This can make them more susceptible to anemia during their early years, which can potentially hinder their cognitive development as well as their physical growth (4).

To prevent anemia during pregnancy, The World Health Organization recommends routine administration of iron and folic acid, with at least 90 iron tablets consumed throughout pregnancy. In Indonesia, however, the coverage of iron supplementation among pregnant women remains below the national target despite ongoing public health interventions (5). This indicates that pharmacological approaches alone may not be sufficient and should be complemented by dietary strategies that increase the intake of iron-rich foods and micronutrients such as vitamin C to enhance iron absorption (6).

Functional foods derived from fruits and vegetables have gained increasing attention as alternative nutritional interventions for anemia. Fruit juices are widely consumed beverages produced by mechanically extracting liquids from fresh fruits while preserving their natural flavor, aroma, and nutritional value (7). Among these, beetroot (Beta vulgaris) has attracted considerable interest due to its high content of iron, folate, antioxidants, and nitrates that may support hematopoiesis and improve hemoglobin levels (8). Numerous studies have indicated that the consistent consumption of beetroot juice can substantially elevate hemoglobin levels in individuals with anemia (9).

Another nutritious fruit is red guava (Psidium guajava), known for its significant quantities of iron and vitamin C, both crucial for the process of erythropoiesis. Vitamin C enhances the absorption of iron by transforming ferric iron (Fe^{3+}) into ferrous iron (Fe^{2+}), which is a more easily absorbed type in the small intestine, thus aiding in the formation of hemoglobin and the generation of red blood cells (10). Furthermore, vitamin C is involved in the mobilization of stored iron and the prevention of the formation of iron complexes that are not readily bioavailable (11).

Salak pondoh (Salacca zalacca), a tropical fruit commonly found in Indonesia, also contains micronutrients including iron that contribute to red blood cell formation. Iron is an essential trace element required for hemoglobin synthesis and oxygen transport in the body, and its absorption can be enhanced in the presence of vitamin C (12).

In the TPMB R midwifery clinic in Depok, several pregnant women have been identified with moderate to severe anemia, increasing health risks for both mother and fetus. Limited knowledge regarding nutritional approaches to prevent and manage anemia remains a contributing factor. Therefore, research exploring effective food-based nutritional interventions, such as fruit-based juices rich in iron and vitamin C, is needed to support anemia prevention and management during pregnancy.

Despite increasing interest in food-based interventions for anemia in pregnancy, comparative studies evaluating different locally available fruit-based interventions remain limited. Most existing research has focused on single interventions without direct comparison. As a result, this study provides new comparative data concerning the effects of salak pondoh juice and beetroot–red guava juice on hemoglobin concentrations in pregnant women suffering from anemia in a practical primary healthcare setting.

METHOD

Research Design

This research utilized a quasi-experimental design incorporating a pretest-posttest control group methodology. This approach was selected to examine alterations in hemoglobin (Hb) levels prior to and during the intervention in two distinct treatment groups. This study was executed at Independent Midwifery Practices R, from

October 2024 to March 2025. This approach allowed scientists to assess how two varieties of fruit juice impact hemoglobin concentrations in pregnant women experiencing anemia.

Inclusion and Exclusion Criteria

Participants were selected based on specific criteria for inclusion and exclusion. The criteria for inclusion included expectant mothers who have been identified as having anemia, specifically those with hemoglobin levels of approximately 8 g/dL (moderate anemia) and 9–10 g/dL (mild anemia), who consented to participate and complete the study, and who had no known allergies to the intervention components (beetroot, red guava, or salak pondoh). The exclusion criteria encompassed pregnant women utilizing iron or vitamin supplements during the intervention period, individuals with pregnancy difficulties or comorbidities such as hypertension or diabetes, and participants who withdrew or failed to finish the intervention.

Research Sample

The study comprised 150 pregnant women diagnosed with anemia who satisfied the inclusion criteria. sample was executed via a purposive sample strategy aligned with the study goals. individuals were proportionally allocated into two intervention groups: 75 individuals received a blend of beetroot and red guava juice, whereas 75 participants received salak pondoh juice. This categorization facilitated a comparative assessment of the efficacy of each juice type in elevating hemoglobin levels in anemic pregnant women.

Intervention

The one-week intervention period was intended to assess short-term hematological responses to nutritional intake. While hemoglobin synthesis typically requires a longer duration, previous studies have reported early changes in hemoglobin levels following increased intake of iron-rich and vitamin C–enhancing foods. Each participant was instructed to consume 200 ml of juice twice daily, once in the morning and once in the evening. The first group received a mixture of beetroot and red guava juice, while the second group received salak pondoh juice. During the intervention period, participants were advised not to consume any additional iron supplements or other iron-rich products beyond their usual diet. This procedure ensured that any increase in hemoglobin levels could be attributed primarily to the juice intervention.

Data Measurement

Hemoglobin levels were assessed pre- and post-intervention utilizing the Easy Touch GCHb instrument, which delivers accurate measurements of capillary blood hemoglobin levels. All measures were conducted by qualified health professionals to guarantee the precision and uniformity of the results. The documented results were subsequently analyzed statistically.

Data Analysis

Descriptive and inferential statistics were implemented to analyze the data. Descriptive statistics were employed to delineate the participants' characteristics, encompassing age, gestational age, and baseline hemoglobin levels. Inferential analysis utilized the paired t-test to compare hemoglobin levels before and after the test within each group. A significance level of $p < 0.05$ was employed to ascertain the statistical significance of the observed differences.

Alocation Baseline

Participants were assigned to intervention groups using purposeful allocation depending on the sequence of recruitment. Due to the non-randomized design, baseline comparability between groups was assessed using independent t-tests and chi-square tests for relevant variables.

Ethical Approval

This research received ethical approval from the Health Research Ethics Committee, Faculty of Health Sciences, with approval number 07/e-KEPK/FIKES/I/2025. Before participation, all respondents were apprised of the study's objective, procedures, advantages, and potential dangers. Participation was wholly voluntary, and all participants executed an informed consent form to affirm their willingness to engage in the research.

RESULTS

Table 1. Mean Hemoglobin Levels of Pregnant Women Before and After in the Intervention Group with Beetroot–Guava Juice

Intervention: Beetroot–Red Guava Juice	N	Mean	Std. Error	Std. Deviation	Min	Max
Pre-test	75	9.91	0.11	0.50	8.8	11.4
Post-test	75	10.37	0.11	0.50	9.3	11.7

Parameter	Pre-test (N=75)	Post-test (N=75)	Mean Different	p-value (Paired t-test)
Hemoglobin (g/dL)	9.91 ± 0.50	10.37 ± 0.50	0.46	0.000 (Significant)

According to Table 1, the pregnant women in the beetroot-red guava juice intervention group had an average hemoglobin level of 9.91 g/dL before the intervention. The range of this level was 8.8–11.4 g/dL, with a 0.50 g/dL standard deviation. Following the intervention, the mean hemoglobin level rose to 10.37 g/dL, with a 0.50 g/dL standard deviation. The level ranged from 9.3 g/dL to 11.7 g/dL.

Table 2. Mean Hemoglobin Levels of Pregnant Women Before and After in the Intervention Group with Salak Pondoh Juice

Intervention: Salak Pondoh Juice	N	Mean	Std. Error	Std. Deviation	Min	Max
Pre-test	75	10.08	0.11	0.11	8.9	11.5
Post-test	75	10.42	0.11	0.10	9.3	11.7

Table 2 shows that the average hemoglobin level of pregnant women in the salak pondoh juice intervention group before the intervention was 10.08 g/dL with a standard deviation of 0.11 g/dL, maximum hemoglobin level of 11.5 g/dL, and minimum of 8.9 g/dL. Mean hemoglobin level postintervention was 10.42 g/dL (SD=0.10 g/dL, range 9.3-11.7 g/dL.

Table 3. Hemoglobin Levels of Pregnant Women in Pre-test and Post-test After Beetroot–Red Guava Juice Intervention

Intervention: Beetroot–Red Guava Juice	N	Mean	Std. Error	Std. Deviation	*p*-Value
Pre-test	75	9.91	0.11	0.50	0.000
Post-test	75	10.37	0.11	0.50	

Table 3 reveals that the average hemoglobin concentration during the pre-test was 9.9 g/dL, whereas in the post-test, it increased to 10.3 g/dL. The average hemoglobin level before the test was 9.9 g/dL, which was lower than the average after the test, recorded at 10.3 g/dL. This shows a significant elevation of hemoglobin levels for Women in the intervention group who were pregnant, with a mean difference of 0.4 g/dL.

Table 4. Hemoglobin Levels of Pregnant Women in Pre-test and Post-test After Salak Pondoh Juice Intervention

Intervention: Beetroot–Red Guava Juice	N	Mean	Std. Error	Std. Deviation	*p*-Value
Pre-test	75	9.91	0.11	0.50	0.000
Post-test	75	10.37	0.11	0.50	

Table 4 showing that the mean pre-test value was 10.08 g/dL, while the post-test mean value was 10.42 g/dL. Since the mean pre-test value (10.08 g/dL) was lower than the post-test value (10.42 g/dL), Pregnant women in the intervention group showed a notable rise in hemoglobin levels, with a mean difference of 0.34 g/dL.

Table 5. Differences in Mean Hemoglobin Levels of Pregnant Women in the Post-test between Beetroot–Red Guava Juice and Salak Pondoh Juice Groups

Group	Mean	N	Std. Deviation	Std. Error	*t*	*p*-value
Beetroot–Red Guava Juice	10.3	75	0.50	0.11	13.286	0.000
Salak Pondoh Juice	10.0	75	0.46	0.10	10.776	

According to Table 5, the pregnant women in the beetroot–red guava juice group had a mean hemoglobin level of 10.3 g/dL with a standard deviation of 0.50. The pregnant women in the salak pondoh juice intervention group had a mean hemoglobin level of 10.0 g/dL with a standard deviation of 0.46. The disparity in post-test average hemoglobin levels between the two groups was 0.3 g/dL. The test results produced a p-value of $p < 0.001$, indicating a statistically significant effect of the salak pondoh juice and beetroot-red guava juice treatments on the hemoglobin levels of expectant mothers.

Although the increase in hemoglobin levels was statistically significant, the magnitude of change (0.34–0.46 g/dL) is relatively modest and may not represent a clinically meaningful improvement in anemia status.

DISCUSSION

Mean Hemoglobin Concentrations in Pregnant Women Pre- and Post-Administration of Beetroot–Red Guava Juice and Salak Pondoh Juice. The findings of this study demonstrate that the administration of beetroot-red guava juice and salak pondoh juice had a substantial impact, with a significance value (p, 2-tailed) of $0.00 < 0.05$. This finding demonstrates that both interventions significantly influenced hemoglobin levels among pregnant women.

One of the parameters used to determine whether an individual is anemic is hemoglobin concentration, which is influenced by nutrients required by the body, particularly iron (13). When hemoglobin levels are low, efforts should be made to increase them, such as improving dietary patterns, consuming iron supplements, and eating foods rich in nutrients that enhance hemoglobin synthesis (14). According to Muzzaki in Yanti (2024) , the iron content of beetroot is approximately 0.8 mg (15). Suryana in Padhilah (2024) reports that several fruits contain iron, such as beetroot (0.8 mg), grapes (0.5 mg), dragon fruit (0.55–0.65 mg), oranges (0.4 mg), pineapple (0.3 mg), watermelon (0.2 mg), and terong belanda (tamarillo) (0.2 mg) (16).

Salak pondoh juice contains 32.8 mg of iron. Iron is a trace mineral crucial for the synthesis of red blood cells (17). Krisnanda asserts that iron absorption is affected by vitamin C consumption; increased vitamin C correlates with accelerated absorption (18). Vitamin C creates an acidic environment that facilitates the conversion of ferric iron to ferrous iron, thus improving its uptake in the small intestine (19). Salak pondoh contains 10.25 mg of zinc, fulfilling the daily need of 9 mg (20). Zinc contributes to hemoglobin production by replacing iron during periods of low iron availability (21). Iron and zinc have a favorable connection; during instances of anemia, a reduction in iron levels correlates with a decrease in zinc levels (22). Combining both iron and zinc in therapy has shown greater effectiveness in addressing iron-deficiency anemia (23).

Red guava possesses a substantial nutritional profile, with 51 kcal of calories, 11.88 g of carbs, 0.82 g of protein, 0.6 g of fat, and 183.5 mg of vitamin C per 100 g of fruit, with an edible portion of 82% (19). In addition to its high nutritional content, red guava also has a high fiber content and lycopene pigment which gives it a red color of 0.69 mg/100 g of material that is useful as an antioxidant (24).

Research by Ikawati and Rokhana found that beetroot contains more vitamin C than oranges and can increase Hb levels by 1.3 g/dL (12%) (21). An organoleptic test conducted by Astrit Utami (2022) revealed that beetroot–red guava juice meets the Indonesian National Standard (SNI) for its characteristic color, aroma, and taste (25).

The researcher asserts that the rise in hemoglobin levels among the study's pregnant participants was attributable to the vitamin C content found in beetroot, red guava, and salak pondoh. The amalgamation of beetroot and red guava conceals the less palatable flavor of beetroot, and consuming the juice bi-daily may improve the absorption of iron and folic acid from iron supplements given to pregnant women at night. When consumed together, beetroot and red guava deliver both the primary substrate (iron) and the catalytic agent (vitamin C) necessary for efficient hemoglobin production. This synergistic interaction optimizes iron uptake more effectively than consuming either fruit in isolation, which could result in greater and more rapid increases in hemoglobin levels. Furthermore, beetroot is also rich in folate, an essential ingredient for DNA synthesis and the formation of healthy red blood cells, aiding in the prevention of anemia during pregnancy. Red guava contributes additional health-promoting compounds such as lycopene and polyphenolic antioxidants, which support vascular health, reduce oxidative stress, and strengthen immune function.

Differences in outcomes may potentially be influenced by factors such as palatability and adherence; however, these variables were not assessed in the present study. This makes beetroot–red guava juice not only a nutritionally powerful intervention but also a practical and attractive dietary approach for enhancing hemoglobin levels sustainably. It is crucial to acknowledge that palatability and adherence were not measured in this study. Therefore, any interpretation related to these factors should be considered speculative.

The current study did not explicitly assess iron absorption, vitamin C levels, or related biochemical mechanisms. Therefore, the proposed explanations regarding iron and vitamin C synergy should be interpreted as theoretical considerations rather than empirically verified findings.

Recommendations

The present study contributes to the existing literature by offering comparative and context-specific evidence regarding the utilization of locally accessible fruit-based interventions for anemia in pregnancy, particularly within a primary maternal healthcare setting.

CONCLUSION

This study found that hemoglobin levels increased after the administration of beetroot–red guava juice and salak pondoh juice among pregnant women with anemia. Both interventions were associated with improvements in hemoglobin levels. However, further research with more rigorous study designs is needed to confirm these findings.

AUTHOR CONTRIBUTION STATEMENT

Author 1 was responsible for the conceptualization and study design, data collection and analysis, and drafting of the manuscript.

Author 2 was responsible for critical review of the scientific content, research supervision, and approval of the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this study, including financial interests or personal relationships that could inappropriately influence the research outcomes.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that generative AI and AI-assisted technologies were used solely to support language refinement, improve clarity, and enhance the overall readability and structure of the manuscript. The authors confirm that the use of these tools did not influence the scientific content, data interpretation, or conclusions of the study, and that full responsibility for the content of the manuscript remains with the authors.

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