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Strawberry Juice Supplementation Enhances Hemoglobin Levels in Anemic Pregnant Women: A Quasi-Experimental Study

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Abstract

Anemia is a serious health problem, and an innovative iron supplement combined with strawberry juice (Fragaria ananassa) has been proposed as a complementary intervention to prevent anemia. This study examined the effects of strawberry juice (Fragaria ananassa) on hemoglobin levels in pregnant women with mild to moderate anemia. Using a quasi-experimental design, the sample of 32 participants was divided into two groups for comparison: the experimental group, consisting of 16 participants, received strawberry juice and iron tablets, while the control group, consisting of 16 participants, received only iron tablets without strawberry juice. Data collection used a digital Hb meter (Easy Touch GCHb) for pre- and post-test measurements, and the intervention was administered over 7 days. Statistical analysis employed the paired t-test and the independent samples t-test, with mean values before and after the test in the experimental group at 1.200 g/dL and 0.594 g/dL in the control group. The outcomes of the post-test independent-samples t-test indicated a significance level of 0.02 ($p < 0.05$), showing that the intake of iron supplements with strawberry juice influences hemoglobin levels in pregnant women with anemia. Statistical analysis shows a beneficial impact of providing strawberry juice (Fragaria ananassa) and iron supplements on boosting hemoglobin levels in anemic pregnant women.

Keywords: *strawberry (fragaria ananassa); hemoglobin; pregnant women; anemia; nutritional intervention*

INTRODUCTION

Anemia in pregnant women is a serious health issue in Indonesia and around the world, and has a significant impact on maternal mortality rates. The maternal mortality ratio (MMR) serves as a critical public health metric and is major aim of the Sustainable Development Goals (SDGs). The Sustainable Development Goals (SDGs) target a decrease in the MMR to under 70 per 100,000 births by 2030, as it serves as an essential measure of public health condition[1]. The WHO states that in 2023, the worldwide prevalence of anemia in pregnant women reached 35.5%, with Indonesia at 27.7% [2]. To this day, anemia remains a serious health problem, particularly at the primary health care level [3]. Local data indicate that there are cases of anemia among pregnant women at the Karangploso Community Health Center. According to 2023 data from the Malang Regency Nutrition Health Information System (Sikesga), there were 37 cases of mild anemia at the Karangploso Community Health Center [4]. This represents an increase compared to the preliminary study conducted at the health center, which found 41 cases of mild anemia and 22 cases of moderate anemia in October 2025 at the Karangploso Community Health Center.

Anaemia occurs when there is a lack of adequate haemoglobin or a deficiency in the size and number of erythrocytes, impairing the exchange of oxygen and carbon dioxide between blood and tissue cells. Iron deficiency anaemia is a condition resulting from the erythrocytes system's failure to sustain normal haemoglobin levels due to inadequate consumption of one or more nutrients [5]. Consequently, pregnant women are susceptible to anemia, and typical hemoglobin levels vary from those of non-pregnant women throughout pregnancy. Natural physiological changes during pregnancy can cause an increase in blood and serum volume, surpassing the priduction of blood cells, leading to blood dilution (*hemodilution*) that starts in the second trimester and peaks in the third trimester [6].

The iron tablet distribution program, implemented through community health centers (puskesmas) and village health posts (posyandu), is one of the government-supported initiatives. However, its implementation faces numerous challenges. One such challenge is mothers' inconsistent adherence to taking the prescribed iron tablets. A mother's adherence to iron tablet intake significantly determines the risk of anemia during pregnancy [7]. This condition has serious consequences for both the mother and the fetus, such as increasing the risk of postpartum hemorrhage, prolonged labor, preterm birth, and even maternal and infant mortality. Additionally, anemia has long-term effects on a child's growth and development and can potentially lead to stunting [8].

The WHO suggests administering oral tablets with 400 mg of folic acid and 30 to 60 mg of elemental iron (IFA) as the standard dosage in prenatal care beginning in the second trimester. It is recommended that

pregnant women begin taking iron supplements in the second trimester. Pregnant women ought to take a daily iron supplement throughout their pregnancy [9]. Taking iron tablets correctly during pregnancy reduces the risk of anemia. However, this has not been fully achieved due to low compliance with iron tablet consumption; a potential alternative is the use of natural ingredients rich in iron and vitamin C, such as strawberries *(Fragaria ananassa)*, which can help with optimal iron absorption [10].

In addition, strawberries can help reduce inflammation caused by oxidative stress resulting from a diet high in fat and carbohydrates. Strawberries contain a high amount of antioxidants per serving and have been shown to increase plasma antioxidant levels when consumed; when juiced, they are an excellent source of bioactive compounds with strong antioxidant potential. Strawberries also contain high levels of glutathione and vitamin C, both of which are antioxidants with high acid content, such as citric acid [11]. Therefore, strawberries are rich in vitamins, but the most important ones are ascorbic acid, folic acid, and polyphenolic compounds (anthocyanins and ellagic acid). In terms of minerals, the presence of iron indicates this [12].

Strawberries *(Fragaria ananassa)* contain high levels of vitamins, minerals, proteins, fats, and carbohydrates. They have anthocyanins, know for their antioxidant benefits, along with significant amounts of vitamin C and potassium. Moreover, each 100 mg of this fruit contains 0.41 mg of iron, 13 mg of magnesium, 24 mg of phosphorus, 153 mg of potassium, 0.022 mg of riboflavin, 24 mg of folate, 0.024 mg of thiamin, 60 mg of vitamin C, 2.2 mg of vitamin K, 0.29 mg of vitamin E, and 1 mg of vitamin A [13].

Findings from earlier studies by Kishimoto et., al 2021 in the work titled" *Effects of acute strawberry consumption on serum levels of vitamin C andfolic acid, the antioxidant potential of LDL and blood glucose response: arandomised cross-over controlled trial* "indicate that strawberries sarve as a benefical source of vitamin C and folate, potentially improving the antioxidant capacity of LDL in fertile young women [14]. The findings of study by Jemali & Sari (2018) named *"The Effect of Strawberry Juice Intake on Hemoglobin Levels in Third-Trimester Pregnant Women"* revealed that drinking 200 ml of fresh strawberry juice day for 7 days can boost Hb levels in pregnant women [15]. This study is important because this study is important as it proposes a natural safe, and easily accessible adjunct to iron therapy.

Consuming *strawberries (Fragaria ananassa)* not only indirectly enhances iron absorption; their antioxidant content can also alleviate symptoms of anemia that impair the quality of life of pregnant women [16]. This research seeks to assess the impact of strawberry juice comsumption on elevating hemoglobin levels in pregnant women experiencing mild to moderate anemia in the second and third trimesters of pregnancy. This study introduces the discussion of strawberry juice as a supplementary intervention that combines a natural vitamin C source with iron supplementation to boost hemoglobin levels in pregnant women experiencing mild to moderate anemia. This study's findings could affer insight into improving iron absorption

as an additional treatment alongside taking iron tablets for anemia.

METHODS

This kind quantitative study employs a quasi-experimental pretest - posttest control group design, where participant are categorized into an experimental group and a control group for comparison, but not chosen randomly. This no-equivalent control group design was selected due to the intervention being carried out in a standard communitybhealth center context, where it was impractical to randomize participants. The study involved a single cohort of pregnan women experiencing anemia. One portion of this group was given daily strawberry juice along with iron tablets, whereas the other portion did not receive any strawberry juice. This data retrieval was carried out between 10th February and 12st March, 2026 which includes the stage initial data collection (pre-test) both group, implementation the experimental group received strawberry juice and iron tablet, with the control group received a daily iron tablet, and post-test reflects the result or impact after the intervention, in this study, the emphasis was on how strawberry juice affects hemoglobinlevels in pregnant women with anemia. This research took place at the Community Health Center (UPT Puskesmas) in the karangploso Subdistrict, Malang Regency.

The study's population included all pregnant women in their second and third trimesters amounting to 47 individuals, within the district of the Karngploso Community Health Center (Puskesmas). A sample of 32 individuals was divided into two groups, with participants paired based on their initial health status, the intervention group (n=16) and the control group (n=16). Employing the Federer equation to calculate the sample size. The minimum sample size was determined using Federer's formula which resulted in a grade of n=16. The research implementation procedure was divided into three main stages: pre-treatment stage, implementation (treatment) stage, and post-treatment stage. During the implementation stage, both groups first underwent the same pre-test, which involved measuring baseline hemoglobin levels. The division of the experimental and control groups was carried out by matching respondents according to their initial health status, whereby those with acid reflux were placed in the control group, while those without a history of acid reflux were placed in the experimental group.

The initial stage of the procedure, hemoglobin levels were measured in the control group and the experimental group before to treatment. Then control group received a daily iron tablet with 60 mg of elemental iron and 0.4 mg of folic acid after meals. In the treatment phase, the experimental group took one iron tablet daily after meals, accompained by 200 ml of strawberry juice (*Fragaria ananassa*) prepared by the researchers in a hygienic manner using small, sterilized bottles. The preparation involved 150 grams of fresh strawberries, 50 ml of water, and 1 teaspoon of sugar. Participant adherence was monitored by community health workers and researchers through daily home visits and WhatsApp reminders. A daily consumption

monitoring sheet was used to record iron tablet intake and strawberry juice consumption. Participants were reminded not to consume tea or coffee around the time of taking the iron tablets, as these beverages can inhibit iron absorption. Once the intervention ended, both groups participant in a post-intervention assessment, which mirrored the pre-test to evaluate alterations in hemoglobin levels after treatment. Hemoglobin levels were assessed from capillary blood prior to and following the intervention, untilizing the same device for every participant, the Easy Touch GCHb Hemoglobin Meter [15]. Sociodemographic factors such as age, gestational duration, and parity, were obtained from the maternal and child health (MCH) records of the patients. The tools untilized consisted of a hemoglobin meter, a daily intake tracking sheet, the participats' MCH records, and a checklist for observations.

The data analysis approach in this research included an initial analysis normality test was tasted using the Shapiro-Wilk and homogeneity was using Levene's Test, followed by hypothesis testing parametric test Independent Samples t-Test if the followed assumption. If the not followed of normality or homogeneity was met, the nonparametric Mann-Whitney test was used. A normality test and homogeneity test of variances where the condition states that a p-value is > 0.05, indicates normal and homogen variances. The intervention effect size was calculating using to assess if the significance level (Sig.) is <0.05 Independent Samples t-Test, based on pooled group standard deviation.

In this study, ethical clearance was secured from the Research Ethics Committee of the LPPM ITSK Dr. Soepraoen Hospital in Malang, which approved this study under No. KEPK-EC / 505 / II / 2026. accordance with ketentuan, dokumen izin etika is disiapkan to be sent to journals. After receiving explanations regarding the purpose, methodology, benefits, potential risks of the study, and the need for them to assess themselves as soon as possible without considering the consequences, all respondents provide their persetujuan. Kerahasiaan data responden is used in data collection, analysis, and analysis.

RESULT

Table 1. Characteristics of Pregnant Women Anemic Respondents in the Intervention and Control Groups

Characteristics	Intervention Group (n = 16)	Control Group (n = 16)	p-value
Age of Respondents			
<19 years	2 (12,4%)	1 (6,2%)	
20–31 years	9 (56%)	12 (74%)	0,764
32–43 years	5 (31,4%	3 (18.6%)	
>44 years	0	0	
Gestational Age			
Second Trimester	5 (30,5%)	7 (43,6%)	0,509
Third trimester	11 (68,5%)	9 (55,4%)	
Parity			
Primiparous	8 (50,4%)	6 (37,6%)	0,492
Multipara	9 (56,2%)	9 (56,2%)	

Source primary data from February 2026

Table 1 indicates that the majority of respondents were aged 20 to 31 years in the intervention and control groups, with 56% and 74%, respectively. Regarding gestational age, most were in the third trimester, with 11 participats (68.5%) in the intervention group and 9 participants (55.4%) in the control group. Most of the participants were multipara, with 9 respondents (56.2%) in the intervention group and control group.

Table 2 Differences Pre-test Hemoglobin Levels in Anemia Pregnant Women

Category	Intervention Group (n = 16)	Control Group (n = 16)	p-value
Normal (>11g/dL)	0	0	0,042
Mild Anemia (10-10,9 g/dL)	14 (87,6%)	12 (75,1%)	
Moderate Anemia (7-9,9 g/dL)	2 (12,4%)	4 (24,9%)	
Weight Anemia (<7 g/dL)	0	0	

Table 2 indicates that the Hb levels prior to the intervention in both the treatment and control groups were <11 g/dL, with all respondents, or 100% classified as anemic.

Table 3 Differences Post-test Hemoglobin Levels in Anemia Pregnant Women

Category	Intervention Group (n = 16)	Control Group (n = 16)	p-value
Normal (>11g/dL)	15 (93,8%)	10 (62,5%)	0,002
Mild Anemia (10-10,9 g/dL)	1 (6,2%)	6 (37,5%)	
Moderate Anemia (7-9,9 g/dL)	0	0	
Weight Anemia (<7 g/dL)	0	0	

Table 3 shows all intervension group demonstrated a more pronounced increase in hemoglobin levels, in the almost 15 participants (93.8%) showed an improvement in Hb levels. At least 1 participant (6.2%) continued to be categories as mild anemic. This variable had a significance level (p >0.05).

Table 4 Normality Test

Study Group	Statistic	df.	Sig.	Interpretation
Ekperimen	0,950	16	0,493	Normal
Control	0,908	16	0,108	Normal

**Shapiro Wilk p >0.05*

Table 4 shows the Shapiro-Wilk normality test were used in this study, showed that each variable had a significance level (p >0.05), indicating that the assumption of normality was met in the groups. Therefore, the analysis was conducted using parametric tests.

Table 5 The Effects of Strawberry Juice (*Fragaria* ananassa) Comsumption on Hemoglobin Levels in Anemic Pregnant Women

Hemoglobin Level value	Mean±SD	Mean Difference	P-	Interpretation
Eksperimen	1,200 ±.197	0,51875	0,002	High affect
Control	0,594 ±.254			Lees affect

**Paired Sampels* and *Independent t-Test*

Table 5 highlighting a contrast in mean hemoglobin levels between pregnant women two group. The average hemoglobin level in the control group was 0.594 g/dL, whereas the experimental group exhibited a higher average level of 1.200 g/dL with a. An mean difference hemoglobin level data from the two groups revealed of 0.51875 g/dL, suggesting a larger increase in hemoglobin levels in the group that ingested both iron tablets and strawberries. A p-value of 0.002 suggesting that this difference is statistically meaningful (p <0.05). thus, the inclusion of strawberry juice alongside iron supplementation significantly enhances iron absorption in pregnant women with anemia at the Karangploso Community Health Center.

DISCUSSION

This research assessed the impact of taking strawberry juice with iron tablets on raising hemoglobin (Hb) levels in anemic pregnant women. Nutritional interaction affects iron absorption for example, consuming foods rich in various minerals may produce a combined effect that enhances bioavailability. Besides iron, strawberries provide vitamin C, which creates readily absorbed soluble iron ascorbate complexes. Strawberries are rich in folate, which helps with the body's creation of new red blood cells. Moreove, vitamin C anhances the absorption of iron in the body and assists in its transportation through the bloodstream [17]. Results from

the statistical test indicated that the average hemoglobin level in the treatment group was 1.200 g/dL greater than in the control group, which had a level of 0.594 d/dL, resulting in a difference of 0.51875 g/dL between the two groups. The findings from the *independent t-test* indicated a Sig. (2-tailed) *P*-value of 0.02 with < 0.05, indicates a significant difference in hemoglobin levels between the treatment group and the control group at the Karangploso Community Health Center.

The primary method for increasing iron levels in patient with IDA is through oral iron supplementation. The most commonly used nonheme iron supplements are ferrous sulphate and ferric succinate. The sole dietary element shown to improve iron absorption, aside from animal tissue, is vitamin C [18]. The rise in hemoglobin levels can be understood through the physiological process of iron uptake. Biochemically, vitamin C acts to convert ferric iron ions (Fe^{3+}), which are not very soluble, into ferrous iron (Fe^{2+}), which is more soluble and readily absorbed by the mucosa of the small intestine. The vitamin C xomplex with (Fe^{2+}) stays stable at the small intestine's alkaline pH, therapy improving iron bioavailability for effective absorption in the formation of red blood cells [19] . In pregnant women, the need for iron doubles because of a 50% rise in blood plasma volume and the development of the fetus and placenta [20] .

According to Imrar et., al (2023), for the synthesis of haemoglobin and the replacement of damaged haemoglobin, the body need 20–25 mg of iron per day; these two processes account for 60–70% of total haemoglobin production. To improve iron absorption and metabolic processes, vitamin C is frequently utilised. However, when iron intake is out of balance or vitamin C intake is insufficient, the body's ability to use vitamin C is compromised, which lowers haemoglobin levels. The teenagers who don't have enough vitamin C suffer from anemia [21]. Additionally, other nutrients such as folic acid and antioxidants in strawberries support the process of erythropoiesis (red blood cell formation). The potentional antioxidants capacity of strawberry my furrther mitigate oxidative stress, which is often exacerbated in anemic condition. Hb concentration and serum ferritin are essential indicators of iron metabolism, since hemoglobin, the primary element of red blood cells, relies on iron for heme group synthesis, a process controlled by erythropoietin in the bone marrow [22].

When iron loss surpasses intake, the body's reserves are diminished. This happens as a result of the depletion of iron stored as ferritin and hemosiderin, which lowers availability for daily requirements. Additionally, it disrupts the apotransferrin transport protein's iron supply [23]. As a result, there are more receptors in the bloodstream and less transferrin saturation. Iron deficiency leads to decreased production of hemoglobin and red blood cells. Anemia can also arise from a lack of essential nutrients for erythropoiesis, mechanisms via which vitamin C regulates ineffective [24]. Pregnant women need about 90 mg of vitamin C per day, and eating foods high in vitamin C, like strawberry fresh (100 grams), which supply 60 mg, the strawberries used in this study weighed 150 mg, which is equivalent to a daily intake of 90 mg of vitamin C.

The findings closely match those presented by Jemali & Sari (2020), who observed a 2.4 g/dL rise in hemoglobin levels after giving strawberry juice [15]. A separate research by Azizah & Suprapti (2024) showed that eating vitamin C-rich fruits can improve the efficacy of iron treatment in pregnant women suffering from [25]. Nonetheless, the outcomes of this reserch vary in the extent of the rise in hemoglobin levels when compared to earlier studies. This study has limitations, specifically that dietary intake wasn't completely managed, permitting the possibility that other factors beyond the intervention affected the rise in respondents' hemoglobin levels. This research stands out for incorporating strawberry juice into a complementary nutritional approach that can be easily implemented within the community.

While oral iron tablets remain the main treatment for anemia, there are challenges related to factors impacting hemoglobin levels in pregnant women, including baseline nutritional status and adherence issues with iron tablet consumption. This is shown through a combined approach using strawberry juice, which is quite safe, simple to apply, and is tolerated well by pregnant women. Vitamin C can enhance the absorption of non-heme iron by as much as four times when paired with iron [26]. This study serves as valuable information and adds significant evidence regarding the benefits of *strawberry* juice as an evidence-based iron supplement and non-pharmacological adjunct, which is more effective at increasing hemoglobin levels by activating the catalyst for iron absorption.

CONCLUSIONS

This study demonstrates that strawberry juice, which contains vitamin C, can enhance iron absorption, thereby increasing hemoglobin levels. Statistical analysis revealed that pregnant women with anemia experienced an increase in hemoglobin levels when given strawberry juice and iron tablets simultaneously as a complementary intervention to enhance iron absorption. Strawberry juice can serve as a complementary nutritional intervention alongside iron tablets, which is easily implemented in the community.

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