



The effect of soy milk on haemoglobin levels in pregnant women with anaemia

Ugi Sugiarsih¹, Eneng Solihah^{2*}, Yati Budiarti³

ABSTRACT

Background: Anaemia is one of the health problems that occur in pregnant women, often associated with a lack of iron intake. One approach to overcoming iron deficiency anaemia is through the use of functional foods, such as soy milk, because it contains high protein and iron, which can stimulate the production of red blood cells. This study aims to determine the effect of soy milk on haemoglobin levels in pregnant women with anaemia. This research method uses a quasi-experimental research design with a pretest-posttest control group design. The intervention group underwent an initial haemoglobin level check (Haemoglobin 1), followed by a 15-day intervention period by consuming soy milk (250 ml/day) and Fe tablets (2x1/day). On day 16, the haemoglobin level was re-evaluated (Haemoglobin 2). Meanwhile, the control group also underwent an initial haemoglobin level check (Haemoglobin 1) and then received iron tablets (2x1/day), with a follow-up haemoglobin level check on day 16 (Haemoglobin 2). The total sample size was 130 people (65 people in the intervention group and 65 people in the control group). Sampling was purposive sampling, and the data were analysed with a dependent t-test for the intervention group, a Wilcoxon test for the control group, and a Mann-Whitney test. The majority of respondents were between 20 and 35 years old (94.6%), had junior high school education (63.15%), did not work (75.4%), had a had a parity less than 2 (76.9%), and had a had a low knowledge level (70.8%). After the intervention, haemoglobin levels increased by 0.9. Statistical analysis showed a significant difference in the mean haemoglobin levels before and after soy milk consumption ($p = 0.001$). In addition, there was a significant difference in haemoglobin levels between the intervention group and the control group ($p = 0.001$). Soy milk consumption showed a positive effect on haemoglobin levels in anaemic pregnant women. Soy milk consumption (2x250 ml/day) can be an alternative to increasing haemoglobin levels in pregnant women.

Keywords: Soy Milk; Pregnant Women; Anaemia

BACKGROUND

Anemia during pregnancy affects about half of all pregnant women worldwide, making it a serious global health concern. Worldwide.¹ Iron deficiency is responsible for about 41.8% of cases.² Pregnant women's anemia prevalence increased globally from 39.5 percent in 2013 to 40.1 percent in 2016, according to World Bank data. In 2018, it was revealed that 48.7% of pregnant women in Indonesia suffered from iron deficiency anemia.³ Data from the Karawang Regency Health Office indicates a concerning trend, with a 22 percent increase in the number of pregnant women diagnosed with anemia in 2020, followed by a further 26 percent increase in 2021.⁴

According to research done in 2019, there is a four-fold increased risk of anemia during the third trimester of pregnancy compared to the first. In the third trimester of pregnancy, anemia prevalence approaches 67%.² Pregnant women who suffer from iron deficiency anaemia run a higher chance of dying, both for themselves and the unborn child. Pregnant women may have symptoms such as dyspnea, exhaustion, elevated heart rate, difficulty breathing, breathing difficulties, pre-eclampsia, and an increased risk of bleeding. Furthermore, low birth weight (LBW), miscarriage, early delivery, and intrauterine growth retardation (IUGR) are just a few of the adverse effects of anaemia on pregnancy outcomes. Overall, especially in underdeveloped nations, these adverse impacts significantly raise the risk of infant mortality.^{3,5} About 6.5% of infants have iron insufficiency due to maternal iron deficiency, and 42.4% of infants with iron deficiency are produced by mothers who are iron deficient.⁶

Three methods—dietary modifications, nutrient supplementation, and nutrition education—can be

¹ Midwifery Study Program Karawang, Politeknik Kesehatan Kemenkes Bandung, Bandung, Jawa Barat, Indonesia

² Department of Community Education Universitas Pendidikan Indonesia, Bandung, Jawa Barat, Indonesia

³ Undergraduate Program of Midwifery, Politeknik Kesehatan Kemenkes Tasikmalaya, Tasikmalaya, Jawa Barat, Indonesia

*Correspondence: enengsolihah@upi.edu

used to treat nutritional anemia.⁷ In accordance with the WHO's advice to employ a food-based approach to iron supplementation worldwide, prior research has demonstrated that pregnant women would benefit more from eating foods high in iron than using iron supplements.^{8,9} Foods high in iron, including those derived from plants like legumes and animal sources like red meat and shellfish, can be used as sources of iron supplementation. Mung and soy beans, in particular, are recognised for having a high iron content.¹⁰ A 2020 literature analysis found that soybeans, one of the primary sources of vegetable protein, have a notable protein content of approximately 36-38%. With an average iron concentration of 2.47 mg/100 g, or 18.01% of the required daily requirement, soy beans are also high in iron.¹¹ Soya beans' high protein content is crucial for the metabolism of haemoglobin, which is linked to bodily function. As a protein in the blood that carries oxygen, haemoglobin is essential for distributing oxygen throughout the body.¹²

Globally, the use of plant-based protein has increased in recent decades as an alternative to animal sources. One such is soy juice, a plant-based beverage made from soy, a stable emulsion of protein, water, and oil, and high in protein. Because soya includes all nine essential amino acids, it is regarded as a complete diet with excellent nutritional value.^{13,14} Since soya does not include starch like animal milk does, the process of creating milk from soya is easier. Compared to cow's milk, soy milk has a benefit because it is high in phytochemicals such as phytoestrogens and isoflavones and has no cholesterol. There are notable concentrations of certain phytochemicals, such as 2.22 g of phytoestrogen and 10 mg of isoflavones per 100 g of constituent weight. In addition, soy milk is easier to make, requires less energy to produce, has less fat, no cholesterol, and is lactose-free).¹⁵ Soy milk, which is made from soybeans, has considerably more nutrients than animal milk.¹⁶ The mixture of soy milk combined with ginger and consumed up to twice a day (250 ml) for 15 days in a row sets it apart from the earlier study. The study's conclusions support those of numerous earlier investigations. The average haemoglobin level was 9.36 g/dl prior to drinking soy milk, and it rose to 9.76 g/dl after a 7-day intake of soy milk (1x200 ml).¹⁷

It is imperative to treat iron deficiency anaemia in light of the urgency of this study and the high occurrence of anaemia that may endanger the health of expectant mothers, new mothers, and postpartum women. Increasing iron consumption is one strategy that can be used, either by taking supplements or eating foods high in iron, like soy-based products that are processed into soy milk. It is anticipated that pregnant women who drink soy milk will raise their haemoglobin levels, which will help solve the anaemia issue. The researcher was motivated to investigate "The effect of soy milk on haemoglobin levels of pregnant women with anaemia in Karawang Regency" in light of this backdrop.

MATERIALS AND METHODS

The Bandung Polytechnic Health Research Ethics Commission has granted this study a certificate of ethical feasibility (No. 30/KEPK/EC/VII/2021). Applying a pretest-posttest control group design in conjunction with a quasi-experiment design. Two groups were chosen at random for this design. Two groups function as an intervention group and a control group, respectively. Both groups underwent a pretest (01) and an intervention. Following the conclusion of the intervention, both groups underwent a posttest (02).

After the haemoglobin level (Hb 1) was checked, the intervention group drank soy milk (2x250 ml/day) and 2x1/day Fe tablets for 15 consecutive days. On day 16, the HB level (Hb 2) was measured. Fe pills were taken after lunch and at night before bedtime, while soy milk was consumed before lunch and in the afternoon. Before the intervention, the Hb levels of the control group were also measured, but they were only given two Fe pills every day for 15 days. On day 16, Hb levels were measured (Hb 2)

Diagram 1. Intervention Group

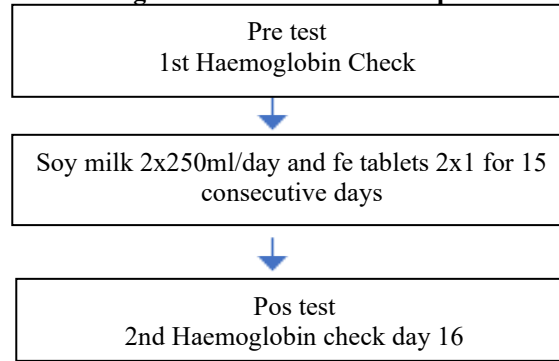


Diagram 2 . Control Group

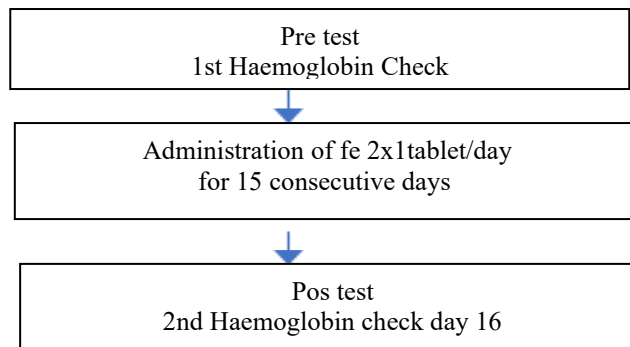
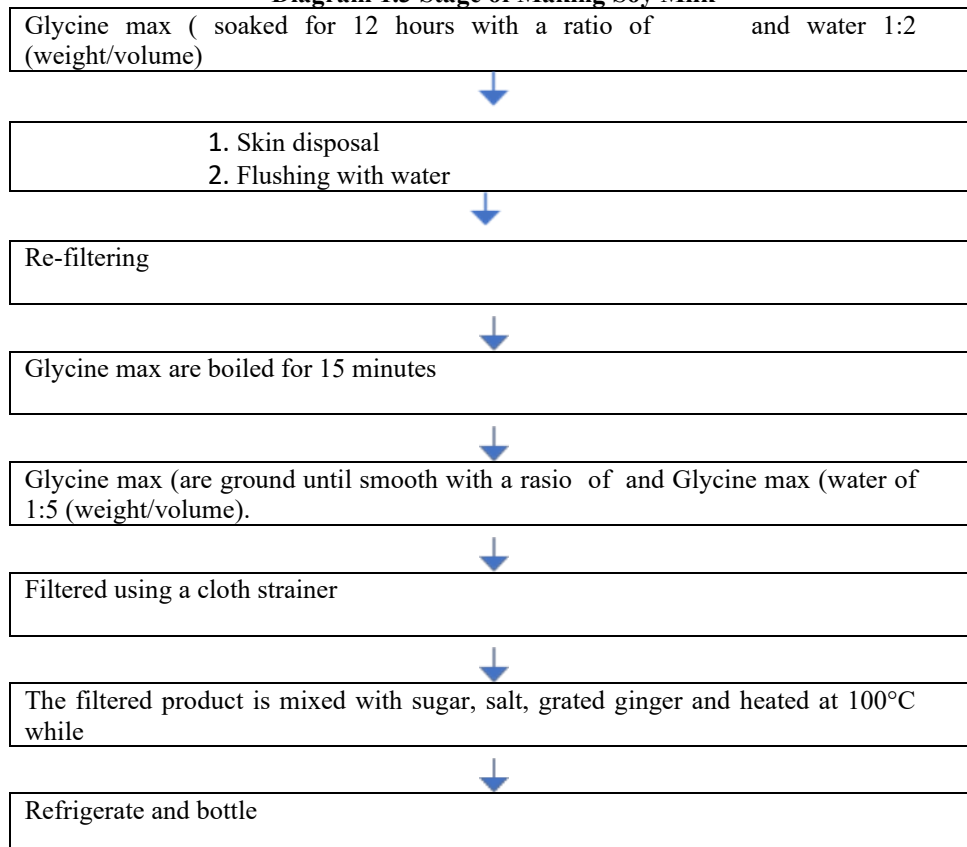


Diagram 1.3 Stage of Making Soy Milk



Researchers made soy milk using Glycine max, sugar, salt, ginger, and mineral water. Every day of soy milk production, with the help of village midwives and cadres, Every three days, the ingredients for soy milk are acquired to guarantee consistency in quality, particularly to avoid discoloration of the glycine max.

The consumption of Fe tablets and soy milk was monitored through video chat and WhatsApp. The graphic below shows the steps involved in making soy milk and designing the research project.

From January to December 2021, the study was carried out in the Karawang Regency Health Centre's workspace. Pregnant women with anemia made up the study's population. There were 65 respondents in the intervention group and 65 respondents in the control group. The study's inclusion criteria included being willing to participate in research, being pregnant in the third trimester, having a haemoglobin level of less than 11 grammes, and wanting or liking to drink soy milk. Exclusion criteria: Haemoglobin formation disorders (e.g., thalassemia, hereditary hemolytic anaemia, sickle cell anaemia) are present in pregnant women with problems such as preeclampsia/eclampsia, placenta previa, etc.

Prior to doing statistical tests. Skewness was used in this study to perform a normality test, and the skewness value was divided by the skewness standard error. A result is considered normal if it falls between -2 and +2. The dependent t test was the statistical test employed in the intervention group based on the findings of the normality test, which indicated that the data were normally distributed; in the control group, the Wilcoxon test was used because it was known that the distribution of the data was not normal. The data were not normally distributed, according to the findings of the normality test conducted after the soy milk and FE (pos test). The Mann Whitney statistical test was employed.

RESULTS

Respondent Characteristics

Table 1.1 Characteristics Distribution of Pregnant Women with Anemia

Characteristics	Intervention Group	Control Group
	n (%)	n (%)
Age		
- Risk (<20years>35years)	10 (15.42)	6 (9.2)
- No risk (20-35years)	55 (94.6)	59 (90.8)
Education		
- Elementary School	5 (7.7)	2 (3.1)
- Junior High School	41 (63.1)	33 (50.8)
- High School	17 (26.2)	30 (46.1)
- College	2 (3.1)	-
Profession		
- Work	27 (41.5)	16 (24.6)
- Housewife	38 (58.5)	49 (75.4)
Parity		
- >2	20 (30.8)	42 (64.6)
- <2	45 (69.2)	23 (35.4)
Knowledge		
- Low (< mean)	24 (36.9)	39(70.8)
- High (\geq mean)	41(63.1)	26(29.2)

Table 1.1 shows that 94.6 percent of respondents in the intervention group and 90.8 percent of respondents in the control group were in the non-risk age group (20–35 years old). Additionally, 63.1 percent of respondents in the intervention group had junior high school education, while 50.1 percent of respondents in the control group had the same education level. In the intervention group, 58.5 percent of workers did not report for work, compared to 75.4 percent in the control group. 73.8 percent of the intervention group and 63.1 percent of the control group had a majority parity of less than two. The majority of participants in the intervention group (63.1%) had high knowledge, while the majority of participants in the control group (70.8%) had low knowledge.

Anaemia levels in the control and intervention groups both before and after ingesting Fe

Table 1.2 Distribution of Anaemia Levels in Intervention and Control Groups

Group	Pre Test			Pos Test		
	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
	Mild Anaemia	Moderate Anaemia	Severe Anaemia	Normal	Mild Anaemia	Moderate Anaemia
Intervention	65 (100)	-	-	46(70.8)	19 (29.2)	-
Control	61(93.8)	4(6.2)	-	23(35.4)	41(63.1)	1 (1.5)

Table 1.2 shows that before the intervention with soymilk and fe, 100 percent of respondents had mild anaemia, and after the intervention, it decreased to 29.2 percent. In the control group, 93.8 percent of respondents had mild anaemia before consuming FE and 63.1 percent after consuming E. Respondents not experiencing anaemia were greater in the intervention group at 70.8 percent.

Haemoglobin levels of Intervention and control groups

Table 1.3 Haemoglobin levels of intervention and control groups

Grups	Haemoglobin Levels					
	Pre Test			Pos Test		
	Mean/median	Min	Max	Mean/median	Min	Max
Interventin	10.3	9.4	10.9	11.2	10.0	11.8
Control	10.0	6.5	10.9	10.8	8.8	11.4

Table 1.3 shows that the intervention group's mean hemoglobin level was 10.3 g/dl before receiving soy milk and fe, and it increased to 11.2 g/dl after that. Prior to receiving fe 2x1 pills, the control group's median was 10.0; however, after receiving fe 2x1, it increased to 10.8.

Differences in mean pre and post haemoglobin levels in each group

Table 1.4 Distribution of Average Haemoglobin Levels Based on Pre and Post Test Results in the Intervention Group and Control Group in the Karawang Health Center Working Area in 2023

Haemoglobin Levels							
Group	n	Pre Test		Pos Test		Difference	p- Value
		Mean/Median	SD	Mean/Median	SD		
Intervention	65	10.3	0.4	11.2	0.5	0.9	0,0001
Control	65	10.0	0.7	10.6	0.5	0.6	0,0001

Before receiving soy milk and fe, the intervention group's mean hemoglobin level was 10.3, but after receiving them, it increased to 11.2. Based on the t-dependent known value of p = 0.0001 statistical test, it may be inferred that the intervention group's mean hemoglobin levels differ from each other. In the control group, the mean hemoglobin level before receiving Fe supplementation was 10.0, which increased to 10.6 after supplementation. The Wilcoxon statistical test findings showed a p-value of 0.0001, indicating a significant difference in the mean hemoglobin level in the control group

Mean Haemoglobin Levels in Intervention and Control Groups

Table 1.5 Distribution of Mean Haemoglobin Levels in the Intervention and Control Groups in the Karawang Health Center Working Area in 2023

Kelompok	n	Mean	SD	p-value
Intervensi	65	11.2	0.5	0.0001
Kontrol	65	10.6	0.6	

In the intervention group, the mean hemoglobin level was 11.61 with a 0.5 standard deviation, whereas in the control group, it was 10.6 with a 0.6 standard deviation. It is evident that the average difference in hemoglobin levels between those given soy milk is 0.6. The Mansfield-Whitney statistical test yielded a significant difference in the mean hemoglobin levels between the intervention and control groups, with a value of $p = 0.0001$ at alpha 5%.

DISCUSSION

Respondent Characteristics

Pregnancy planning should consider physiological factors that may affect the mother and fetus. According to the research, 94.6% of pregnant women with anemia fell within the healthy reproductive age range of 20 to 35. These findings corroborate those of several other studies that showed anemia in pregnant women could develop 64.0% of the time in a healthy reproductive age range of 20 to 35 years.^{18,19,20,21} The results of this study, however, refute the hypothesis that anemia will result from a pregnancy in a very young or very elderly woman under circumstances requiring a high iron intake. Ages under 20 and over 35 are categorized as too young, and between 20 and 35 is deemed safe for pregnancy because it is the age range at which a person is both psychologically and physically prepared to get pregnant.²² This runs counter to the findings of the research, which indicate that pregnant women at risk age (35 years) are 4.125 times more likely to have anemia than pregnant women at non-risk age.²³

The most likely age group for pregnancy and childbirth is between 20 and 35 years old. Many factors interact with each other, it is possible that even at a mature age for pregnancy, aged 20–35 years, the incidence of anemia is much higher. A mother should experience pregnancy at this age, even though she is at a mature and optimal age in mental and emotional maturity and does not always think maturely about her needs, one of which is in the decision to intake iron to prevent anemia in pregnancy.

There were differences in the increases in hemoglobin levels before and after the intervention group compared to the control group.

The study found that after receiving up to 250 milliliters of soy milk daily for 15 consecutive days, the subjects' hemoglobin levels increased by 0.9. Statistical testing revealed that the average hemoglobin levels in the intervention groups differed from each other.

This finding is reassuring, as meat, fish, and poultry contain amino acids that can bind to iron and To aid its absorption, consuming heme and non-heme iron together can increase the absorption of non-heme iron. The type of food ingested affects the body's absorption of iron, especially non-heme iron of plant origin. Meat, fish, poultry, and vitamin C can increase iron absorption. A large amount of plant food is required to meet iron requirements, and soya milk is one of the supplement drinks that can meet and maintain the daily iron requirements of the respondents in this study. The respondents' daily food consumption was closely related to foods sourced from animal meat, especially fish and chicken, as these aided iron absorption when consuming soymilk.

Consuming both hemo and non-heme iron together can increase the absorption of non-heme iron, as meat, fish, and chicken contain amino acids that can bind to iron and aid its absorption. The absorption of iron in the body, especially non-heme iron of plant origin, is influenced by the type of food consumed. Vitamin C, meat, fish, and poultry can increase iron absorption, In this study, the consumption of food consumed by respondents daily is inseparable from foods sourced from animal meat, especially fish and chicken, so that it helps the absorption of iron when consuming soymilk. Therefore, a large amount of plant-based food is needed to meet iron needs, soymilk is one of the supplement drinks that can meet iron needs and can keep the body in shape so that it is not susceptible to disease.

The synthesis of hemoglobin, which is necessary for the body's organs to receive oxygen and energy, depends on iron. Iron deficiency during pregnancy might cause compromised immune system function and reduced cognitive development in the fetus. One of the key sources of iron for expectant mothers is soy. Nutrient-rich meals are essential for pregnant women to consume in order to have a healthy pregnancy. Therefore, in order to prevent obesity, it is advised that pregnant women limit their intake of meals high in fat or sugar and give priority to foods high in protein and iron, including meat, cereals, and beans.

These results corroborate the findings of many previous studies that homemade soymilk drinks have been shown to successfully increase the hemoglobin levels of pregnant women.^{24,25} Another study found a considerable increase in hemoglobin levels after consuming 200 cc of soymilk daily for 7 days. After starting

with 10 grams per deciliter, the haemoglobin level increased to 10.6 grams per deciliter, indicating an increase of 0.6 grams.¹⁷

This is encouraging because soy milk can serve as an excellent substitute for iron enrichment with the goal of lowering the risk of anemia. A necessary mineral for the synthesis of hemoglobin is iron. In addition, iron is necessary for the synthesis of collagen, a protein present in bone, cartilage, and connective tissue, as well as myoglobin, a protein that carries oxygen to the muscles. Iron is also necessary for the immune system and the operation of enzymes.

The high iron and protein content of soya can stimulate the production of red blood cells. In addition, soya is easy to find and can be processed into various types of food. Processed soybean products such as tempeh, tofu, soy sauce, soy milk, and bean sprouts have an important role in the consumption patterns of the Indonesian people, especially as a source of protein that is economical and available to various groups.¹⁴ The nutrients in soy milk derived from soybeans are far more beneficial than those in animal milk.¹⁶

Previous research data indicates that the consumption of soy milk has a noteworthy effect on the levels of hemoglobin. Adolescent females' average hemoglobin level was 12.7 g/dl prior to the soy milk intervention, but it increased to 13.7 g/dl following the intervention.^{26,27} As an alternate approach for the treatment of anemia, the use of tempeh and soy milk is advised. The incidence of anemia and soybean consumption are significantly correlated.²⁴ Previous studies on the use of components derived from soybeans have demonstrated that tempeh milk improves the hemoglobin levels of pregnant women in their third trimester. It has been demonstrated that consuming tempeh milk throughout the third trimester of pregnancy raises a woman's hemoglobin levels.²⁸

Soy milk has a disadvantage in terms of aroma, which is sometimes considered unpleasant, especially the aroma referred to as "langu". Based on the literature, the strong aroma in soymilk is caused by the enzymatic reaction of lipoxygenase. However, the addition of ginger may reduce the aroma and possibly improve the acceptability of soymilk.²⁹

Ginger, as a natural source rich in polyphenols, has the potential to be a supplement to iron oral therapy in addressing iron deficiency anemia, as well as being part of a dietary approach that supports the prevention of deficiency anaemia.^{30,31,32} Studies on acute and subacute toxicity in rats given enriched ginger extract (8% gingerol) showed that at a dose level of 2000 mg/kg there were no deaths or clinical signs of toxicity (LD 50 > 2000 mg/kg). Repeated administration of ginger extract for 28 days to rats at a dose of 1000 mg/kg also showed no observable toxic effects, and the no observable adverse effect level (NOAEL) was calculated as 1000 mg/kg daily. Researchers added 3cm of ginger to soya milk. Daily consumption of up to four grams of ginger is considered a safe level to consume.³³

Variation in the rise in hemoglobin levels between the intervention and control groups

The results showed that there was a significant difference in the mean hemoglobin levels between the intervention group and the control group. There are several possible explanations for this result. The intervention group had a higher increase in hemoglobin levels compared to the control group.

In line with previous research, it is known that there is an effect of soy milk on increasing hemoglobin levels in pregnant women with anemia.¹⁷ There was an increase in hemoglobin levels in the group given soy milk, these results corroborate previous findings that there was an increase of 0.68 haemoglobin levels in pregnant women with anaemia after being given Fe tablets for 30 days³⁴ and an increase in hemoglobin levels of 0.6 g/dL after being given 200ml of soy milk for 7 days.³⁵ Meanwhile, the group given Fe tablets for 30 days experienced an increase in hemoglobin levels of 0.7g/dL.³⁴

It is possible that soy milk contains iron and protein high enough to increase hemoglobin levels in anemic pregnant women. In addition, the benefits of soy milk are healthy because it does not contain cholesterol but contains phytochemicals such as pterioleiclinoleic and linolenic and is easily digested.³⁶ In accordance with the results of the current study, it is explained that the group given soy milk with the basic ingredients of the formula using iron in non-heme form is able to provide an increase in haemoglobin levels. Previous research emphasizing the importance of dietary iron comes in two varieties: hem iron and non-hem iron. Because hemoglobin and myoglobin are essential for the body's oxygen transport, hemoglobin has a higher nutrient availability and is commonly found in meat, poultry, and fish.³⁷ On the other hand, the primary providers of non-hem iron include cereals, legumes, and dark green leafy vegetables.³⁸ Meat-containing diets account for around 25% of iron absorption, but the availability of non-hem iron and an individual's iron status are two factors that affect non-hem iron absorption.³⁹ The absorption of non-hem iron

is also aided by other elements like zinc, folate, and protein. The usual range of estimates for non-hem iron absorption from diet is 5–15%.^{39,24}

The formation of haemoglobin is not only influenced by the availability of Fe as a constituent of heme, but also by other factors such as protein. This is in accordance with Leader's theory, which explains that protein plays an important role in iron transport in the body. Therefore, a lack of protein intake will cause iron transport to be inhibited, resulting in iron deficiency and deficient haemoglobin levels.⁴⁰ Transferrin is a glycoprotein synthesised in the liver. This protein plays a central role in the body's iron metabolism because transferrin transports iron in the circulation to places where it is needed, such as from the gut to the bone marrow, to form new haemoglobin. Ferritin is another protein that is important in iron metabolism. Under normal conditions, ferritin stores iron that can be retrieved for use as needed.⁴¹

Due to the increase in haemoglobin levels due to the consumption of Fe, it can be assumed that the importance of awareness and compliance with taking iron tablets is an important factors in preventing anaemia in mothers. Adherence to the dose, method, and timing of daily iron tablet consumption is key. Prevention of anaemia can be done effectively through the use of iron tablets containing folic acid. The use of iron tablets is considered effective because they contain iron and folic acid. This finding was reported by Arief that taking iron tablets regularly for 30 days can increase haemoglobin levels by 1 gram per deciliter.⁴² Women with anemia who were pregnant participated in this study. Thus, in accordance with Ministry of Health guidelines, iron pills were administered to both the intervention and control groups at a dose of two tablets per day. Two pills were given to anaemic individuals every day until their hemoglobin levels stabilized.⁴³ Iron pills provide 400 mcg of folic acid and 60 mg of iron. Folic acid, sometimes referred to as folate, is a vital component needed for the development and maturation of red blood cells.⁴⁴ Folic acid ingestion and hemoglobin levels were significantly correlated. There was a significant association between folic acid consumption and haemoglobin levels.^{45,46}

This study confirms that iron intake has an important role for haemoglobin formation, Iron intake that is less than the RDA will not directly affect haemoglobin levels because the body still has iron reserves in the liver. After this iron reserve is depleted, it will cause a decrease in haemoglobin levels which begins with a decrease in ferritin levels. Iron has several essential functions in the body, namely as an oxygen carrier from the lungs to body tissues, an electron carrier in cells and as an integrated part of various enzyme reactions in body tissues.⁴⁷ Giving Fe tablets and soy milk can increase the haemoglobin level of anaemic pregnant women, because of the iron and protein content contained in it.

CONCLUSIONS

There is an effect of soy milk consumption on haemoglobin levels in anaemic pregnant women. Soy milk consumption of 2x250ml/day is an alternative in increasing haemoglobin levels.

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