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FULL PAPER

The effect of red guava (*Psidium guajava* L.) juice on pregnant women's hemoglobin level

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Abstract

Anaemia in pregnancy has been the main nutritional issue in Indonesia. It is one of the factors that cause pregnant women to end up with death. An alternative to avoid anaemia among pregnant women is consuming fruits with the highest source of iron and vitamin C, such as red guava, which can synthesize haemoglobin. This study aimed to analyze the influence of red guava (*Psidium guajava* L.) juice on pregnant women's haemoglobin levels in Kota Utara Community Health Center, Gorontalo. This pre-experimental research employed a one-group pre-test post-test design. The fruit used was ripe red guava (2.5 months after flowering) with red flesh, soft texture, and sweet taste. As many as 250 mL of guava juice were given to pregnant women in the third trimester for 14 days. Moreover, 60 respondents were selected as the sample using purposive sampling. The data on haemoglobin levels were collected and analyzed in univariate and bivariate analysis with a paired t-test. Cyanmethemoglobin method was performed in the procedure for determining haemoglobin levels, in which the blood was taken and then diluted with Drabkin's diluent solution, resulting in hemolysis of erythrocytes and conversion of haemoglobin to hemiglobincyanide (cyanmethaemoglobin). The resulting solution was then examined with a spectrophotometer (colourimeter), whose absorbance was proportional to the level of haemoglobin in the blood. The results indicated a significant difference in pregnant women's haemoglobin levels before and after consuming red guava juice. In conclusion, consuming red guava juice positively influences the haemoglobin level of pregnant women in the site area. The study recommended consuming 250 mL of red guava juice every day as an alternative to increase pregnant women's haemoglobin levels.

1. Introduction

Anaemia is indirectly contributing to the mortality rate among pregnant women and mostly occurs during delivery. Mortality can be anticipated by regular pregnancy checkups and a healthy diet. The lack of iron in food on account of the low income becomes the primary factor of pregnant women suffering from anaemia. It impacts the disruption of fetal growth, complications during pregnancy and delivery, maternal mortality, prematurity, decreased intelligence, low birth weight, and increased perinatal mortality (Chowdhury and Chakraborty, 2017; Banjari, 2018).

Based on the data from the Health Office of Gorontalo Province in 2017, 899 (25.8%) out of 31,714 pregnant women experiencing anaemia. The highest percentage took place in Boalemo Regency (507 women or 17.9%), followed by Gorontalo City (161 women or 3.8%), Gorontalo Regency (151 women or 0.8%), North Gorontalo Regency (74 women or 3.0%), Bone Bolango Regency (6 women or 0.3%), and Pohuwato Regency (0.0%) as the lowest (Dinas Kesehatan Provinsi Gorontalo, 2019).

The government has made a great deal of effort to overcome anemia by providing Fe tablet as a supplement that is considered effective due to its iron content. To support the absorption of iron in the body, the Fe tablet should be taken with fruits containing vitamin C (ascorbic acid) (Widyaningsih *et al.*, 2017). Ascorbic

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acid is able to bolster the absorption of non-heme iron that goes through the form changes of ferric (Fe^{3+}) to ferrous iron (Fe^{2+}). Ferrous iron is easily absorbed, enabling it to support the process of iron absorption and heal iron deficiency anaemia (Sharma and Shankar, 2010; Abbaspour *et al.,* 2014; Siu, 2015). An example of a fruit with a high content of iron and ascorbic acid is guava (Prasetyanti and Putri, 2017; Barirah *et al.,* 2018).

Each trimester of pregnancy requires a dissimilar amount of iron. The first trimester necessitates less iron than before pregnancy on the ground that pregnant women do not have a menstrual period, and the fetus is yet to need much iron. In the second trimester, they need to have extra iron. Meanwhile, pregnant women have an increasing number of erythrocytes until 35% during the third trimester, so they require 450 mg of iron due to the increase in oxygen needs for the fetus. Iron absorption can be enhanced by ascorbic acid, HCl, and other acid compounds. The acid will reduce ferric to ferrous iron and prevent the formation of Fe complexes with insoluble foods (Abbaspour *et al.,* 2014; Siu, 2015; Namazi, 2018).

Ascorbic acid can be found in various fruits, including red guava (*Psidium guajava* L.) which contains more than 200 mg of vitamin C. Besides, papaya and kiwi have 94 mg and 84 mg of vitamin C, respectively. Guava is a fruit that accommodates the most vitamin C compared to other fruits, containing six times more vitamin C than oranges, ten times more than papayas, 17 times more than rose apples, and 30 times more than bananas (Sinaga, 2016; Prasetyanti and Putri, 2017).

A previous study by Fitri (2017) showed that guava juice increased the haemoglobin level of pregnant women during the third trimester in Polindes Krebet Bululawang Malang. At first, 57.1% of the women had a normal haemoglobin level, and 42.9% had a low one. After drinking 250 mL of guava juice for seven days, 11 pregnant women (78.6%) had increased their haemoglobin levels (Fitriani and Panggayuh, 2018).

Haemoglobin level serves as a measure of the respiratory pigment in the erythrocytes. Haemoglobin is a compound that transports oxygen in the erythrocytes. It can be measured chemically, and the amount of haemoglobin/100 mL of blood can be used as the capability index of transporting oxygen in the blood (Oliveira and Rocha, 2014; Namazi, 2018). The purpose of this study was to explore the effect of red guava (*Psidium guajava* L.) juice on the haemoglobin level of pregnant women in Kota Utara Community Health Center, Gorontalo.

2. Materials and methods

This research employed a pre-experimental method with the one-group pretest-posttest design and was conducted from January to April 2020 in Kota Utara Community Health Center, Gorontalo. Independent and dependent variables comprised red guava (*Psidium guajava* L.) juice and haemoglobin level, respectively, with 97 pregnant women in the second and third trimester of pregnancy involved as the population. Moreover, the sample was selected by using purposive sampling with the following inclusion criteria: 1) pregnant women suffering from anaemia based on the results of anamnesis, physical examination of the midwives, and laboratory examinations (haemoglobin level < 11 g/dL), 2) pregnant women who did not take other supplements beside Fe tablet, 3) pregnant women who consumed Fe tablet regularly. On the other hand, the exclusion criteria included: 1) pregnant women with infections and other complications, 2) pregnant women with a low compliance level of Fe tablet consumption. Finally, 60 samples met the inclusion criteria. Moreover, the study has been approved by The Health Research Ethics Commission (KEPK) of Health Polytechnic, Ministry of Health of Gorontalo, with the registered number of LB.01.01/KEPK/03/2020.

The process of conducting this study was started by collecting data on prospective respondents. The data consisted of the results of anamnesis, physical examinations of the midwives, and the results of the examination of haemoglobin levels. Respondents who had fulfilled the inclusion criteria were explained the research process and signed a letter of informed consent. Respondents also were asked not to eat dinner before the juice was brought home for consumption. Following the stage was the intervention performed by providing 250 mL of guava juice every night for 14 days. Afterwards, the post-test was done on the 15th day. The haemoglobin level was measured using the cyanmethaemoglobin method before and after drinking red guava juice.

Measurement with the cyanmethemoglobin method was started by taking blood from the respondent. The blood then was diluted with Drabkin's diluent solution so that erythrocyte hemolysis would occur, and the conversion of haemoglobin became haemiglobincyanide (cyanmethaemoglobin). The resulting solution was examined with a spectrophotometer (colourimeter), whose absorbance was proportional to haemoglobin levels in the blood. Tools and materials comprised spectrophotometer, spectrophotometer cuvette, test tube, test tube rack, 0.2 mL blood pipette, drabkin diluent solution, and comparison solution (Tantono, 2017). Further, the results of pre-and post-test, as well as

respondents' characteristics, were recorded in the observation sheet.

The fruit used was ripe red guava (2.5 months after flowering) with red flesh, soft texture, and sweet taste (Hadiati and Apriyanti, 2015). A total of 120 g of red guava added with 200 mL of water were processed, becoming 250 mL of juice. It was then given to 60 respondents every day for two weeks (Widyaningsih *et al.*, 2017; Barirah *et al.*, 2018). The juice was consumed 30 mins before dinner to ease the absorption of nutrients in the fruit. The juice contains 217.5 mg of vitamin C, 2.75 mg of iron, and other minerals (Adriani and Wirjatmadi, 2016; Widyaningsih *et al.*, 2017). The juice was made and distributed every day by researchers, and the distribution was also assisted by the enumerator. All respondents were asked to finish drinking the juice in front of the researchers or the enumerator. The juice was consumed 30 minutes before dinner. Besides, the respondents also took Fe tablets based on dosage and recommended time, one tablet prior to bedtime. Before conducting the study, all respondents had been required not to have dinner before consuming the juice. The results of homogeneity and normality tests revealed that the data were homogeneous with a significance level of <0.05, indicating that the data were normally distributed. Thus, the used test was a paired t-test.

3. Results

Table 1 illustrates that most of the pregnant women in the category of safe age are 80%, the third trimester with 33-37 weeks of pregnancy is 73.3%, multiparity is 50.0%, low education is 76.7%, and being unemployed is 56.7%.

Table 1. Characteristics based on age, gestational age, parity, education, and job status.

Variables	Categories	Fi	iPerP%
Age	Risky	12	20.0
	Safe	48	80.0
Gestational Age	28-32 weeks	16	26.7
	33-37 weeks	44	73.3
Parity	Primiparity	24	40.0
	Multiparity	30	50.0
	Grand Multiparity	6	10.0
Education	Low	46	76.7
	High	14	23.3
Job status	Employed	26	43.3
	Unemployed	34	56.7
Total		60	100

Source: Primary Data (2020)

The analysis utilized to observe the distribution and percentage of the independent variable is the influence of guava juice with the dependent variable of haemoglobin level in Kota Utara Community Health Center.

Table 2 shows that 60 respondents (100%) have a low haemoglobin level (anaemia) before consuming guava juice. Meanwhile, 50 respondents (83.3%) have a normal haemoglobin level after taking the juice, and 10 respondents (16.7%) get a low haemoglobin level.

Table 2. Hemoglobin level before and after consuming guava juice.

Juice consumption	Hemoglobin Level	N	%
Before consuming the juice	Normal	0	0.0
	Anemia	60	100.0
After consuming the juice	Normal	50	83.3
	Anemia	10	16.7

Source: Primary Data (2020)

The bivariate analysis is useful to determine the comparison before and after treatment in the haemoglobin level. Such an analysis is carried out through the paired t-test.

Table 3 indicates that the average haemoglobin level of pregnant women experiences an increase before and after drinking guava juice for 14 days with an average difference = 1.183 g/dL and p-value = 0.001. The p-value < 0.05 means an increase in haemoglobin level of pregnant women with anaemia before and after consuming the guava juice for 14 days. The synthesis of haemoglobin takes approximately 7-14 days to become mature and ready to be distributed throughout the body with red blood cells (erythrocytes), where haemoglobin levels are in erythrocytes, and the life span is the same as the life span of erythrocytes, which is about 20 days (Guyton and Hall, 2011).

Table 3. The effect of consuming guava juice on pregnant women's hemoglobin level.

Hemoglobin Level			
Measurement			
Before	After	Average Difference	P-value
Mean±SD	Mean±SD		
10.013±0.422	11.197±0.539	1.183	0.001

4. Discussion

The result reveals that the consumption of red guava juice influences the increase in pregnant women's haemoglobin levels. After consuming 250 mL of red guava juice every day for two weeks, 83.3% of respondents' haemoglobin levels are increased on averagely 11.197 g/dL with a p-value of 0.001.

The increased level of haemoglobin after consuming red guava juice in pregnant women is due to the vitamin C intake contained in guava (300-400 mg), a fruit with the highest vitamin C. Vitamin C plays a major role in the absorption of iron that can enhance the haemoglobin, and can also improve four times the absorption of non-

heme iron. 400 mg of vitamin C will improve iron absorption by 50% (Safyanti and Andrafikar, 2018; Putri, 2017). For such a reason, consuming red guava juice will bolster the absorption of iron in pregnant women (Fitriyani and Panggayuh, 2017; Apriyanti and Andriani, 2019).

Similar studies were also conducted by Herdiani (2019) and Barirah *et al.* (2018), determining that guava juice influenced the increased haemoglobin level and erythrocytes (Prasetyanti and Putri, 2017; Barirah *et al*., 2018). It was because guava contents can increase haemoglobin levels in erythrocytes. Every 100 mg of guava contains 49 calories, 0.9 g of protein, 0.3 g of fat, 12.2 g of carbohydrate, 14 mg of calcium, 28 mg of phosphor, 1.1 mg of iron, 25 IU of vitamin A, 0.05 mg of vitamin B1, and 86 g of water. Vitamin C in guava enhances iron absorption so that the body can absorb it optimally and increase the haemoglobin level (Apriyanti and Andriani, 2019; Hunter, 2014; Herdiani et al., 2019).

Iron is a mineral required to carry oxygen throughout the body. The lack of iron in the body can lower immunity which will also lead to anaemia (Abbaspour *et al.*, 2014; Ratih, 2017; Namazi, 2018).

Red guava juice is able to increase the haemoglobin level of pregnant women. This kind of intervention highly supports the faster absorption process. Consuming fruit juice will accelerate the absorption process in the digestive system for approximately 20 mins. Conversely, eating whole fruits instead of juicing needs about 18 hours of the absorption process. Fruits processed into juice will not reduce the nutritional value compared to other processed forms (Rahmana, 2014). Compounds in guava include Fe, ascorbic acid, vitamin A (retinol), Cu, and phosphor which are beneficial in increasing the haemoglobin level in erythrocytes (Rahayu, 2014). Iron serves as a microelement that is vital for the body. Fe is needed in hematopoiesis (blood formation), and in the synthesis of haemoglobin. Fe in pregnant women is helpful to form and maintain erythrocytes (Keswara and Hastuti, 2017; Banjari, 2018; Namazi, 2018).

The result suggests that red guava juice can enhance the haemoglobin level of pregnant women. Prior to intervention, the respondents have already taken the Fe tablet since the second trimester, yet they still suffer from anaemia. Taking a Fe tablet along with red guava juice is more effective in increasing the pregnant women's haemoglobin level than only taking a single dosage of Fe tablet.

Hemodilution in pregnant women is often found with an increase in plasma volume, blood cells, and haemoglobin. Hemodilution helps to ease the work of the heart. The occurrence of hemodilution from the second trimester to the end of the third trimester will decrease the haemoglobin level. Consequently, pregnant women will experience anaemia, although they already take Fe tablets (Onyeneho *et al.*, 2016; Namazi, 2018). This corresponds to a previous study discovering that consuming Fe tablets with vitamin C affected the haemoglobin level of pregnant women (Rosmiyati, 2018). In the same tune, similar research indicated that pregnant women who took Fe and vitamin C would have higher haemoglobin levels than those who were given a single dosage of Fe tablet (Wirawan and Nuriyansari, 2015; Putri and Rokhanawati, 2015).

Fe tablet will be more effective if consumed with other vitamins in raising haemoglobin count rather than taking a single dosage of the aforementioned tablet. Therefore, the Fe tablet should be accompanied by other vitamins such as vitamins A and C, in supporting the absorption of iron in the body. When iron is consumed with vitamin C, it will form soluble ferrous ascorbate complexes which are easily absorbed by one's body (Wirawan and Nuriyansari, 2015; Rahmawati *et al.*, 2019). HCl and vitamin C in food can change the gastric acid, making it easier for the non-heme iron or ferric (Fe^{3+}) to turn into ferrous iron (Fe^{2+}). Vitamin C functions to increase gastric acid which can accelerate the absorption of Fe by 30% (Siu, 2015; Banjari, 2018). In order for the Fe absorption process to be optimal, it is better if one takes the Fe tablet at mealtimes and eats fruits with high vitamin C. It is not recommended to drink tea, milk, and coffee as the absorption of Fe tablets may be disrupted (Namazi, 2018; Keswara and Hastuti, 2017). Having a Fe tablet with vitamin C contained in vegetables and fruits is able to increase the haemoglobin level of pregnant women (Barirah *et al.,* 2018; Olii, 2020).

As many as ten respondents (16.7%) did not experience an increase in haemoglobin even though they had consumed red guava juice. It is assumed that the haemoglobin level did not increase due to the characteristics of the respondents. Respondents with an early third trimester of pregnancy (28-34 weeks), respondents included in the risk age group, and parity grand multipara did not experience an increase in haemoglobin levels despite consuming red guava juice. Pregnant women at an age at risk are susceptible to developing anaemia. This is due to physical and psychological factors; the immune system begins to decline and is susceptible to various infections during pregnancy (Herawati and Astuti, 2010; James *et al*., 2010; Barirah *et al*., 2018). The results of this study are supported by research by Astriana (2017) that there is a

significant relationship between age and the incidence of anaemia in pregnant women.

Hemodilution could decrease haemoglobin levels. It occurs from 10 weeks of gestation and reaches its peak at 32-36 weeks of gestation. As a result, haemoglobin levels in pregnant women often decrease in the third trimester of pregnancy (James *et al.,* 2010; Banjari, 2018; Dinas Kesehatan Provinsi Gorontalo, 2019). This indicates a relationship between gestational age and the incidence of nutritional anaemia in pregnant women (Herawati and Astuti, 2010).

In the same tune, a similar study showed that there is a significant relationship between parity and the incidence of anaemia in pregnant women (Astriana, 2017). Parity is related to the occurrence of anaemia as the more often women give birth, the greater the risk of blood loss and the impact on the decrease in haemoglobin levels. A woman who has given birth more than three times, her health condition will begin to decline, and she often experiences anaemia (Olii and Abdul, 2019; Olii, 2020). This is in line with Astriana's research (2017), which stated that there is a significant relationship between parity and the incidence of anaemia in pregnant women.

Further, the low level of education of pregnant women affects the acceptance of information so that knowledge about anaemia and related factors, as well as knowledge about the importance of iron is limited (Olii and Abdul, 2019).

It is much better to eat red guava to raise the amount of haemoglobin and improve immunity. Red guava is also great for the circulatory system, digestion, relieving stress, and eliminating toxins in the blood. Red guava has a lot of Fe, organic acid, protein, and minerals, such as K, Mg, Ca, and Vitamin C. Accordingly, it is suggested that pregnant women consume this fruit to prevent anaemia (Fitriani and Panggayuh, 2017; Putri, 2017; Herdiani *et al.,* 2019). A high amount of Fe and vitamin C in guava can increase the amount of haemoglobin. The impact of anaemia can be anticipated if one has a normal haemoglobin level. Vitamin C in red guava is able to bolster the process of Fe absorption, blood formation, as well as maintain stamina and immunity (Hunter, 2014; Apriyanti and Adriani, 2014). This theory strengthens the findings that drinking 250 mL of red guava juice every day for two weeks positively influences the increased haemoglobin level of pregnant women.

Some ways to increase the pregnant women's haemoglobin level and prevent anaemia are taking Fe tablets regularly (following the dosage), and eating vegetables and fruits with high Fe and vitamin C, including red guava. One can eat the whole fruit of red guava or process it into juice, smoothie, jelly, iced fruit, and cake.

5. Conclusion

Consuming 250 mL of red guava juice every day for two weeks positively influences the increase in haemoglobin level. It is suggested that midwives continuously monitor and encourage pregnant women to regularly take Fe tablets along with red guava juice and fruits containing vitamin C.

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