Effectiveness of Psidium guajava to increase hemoglobin and hematocrit levels of third trimester in pregnancy

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Abstract. A decrease in one or more parameters of red blood cells: hemoglobin concentrate, hematocrit or the total amount of red blood cells is called anemia. Coverage of iron supplements programme in Indonesia has not reached the goals, so additional supplements are needed to increase hemoglobin and hematocrit levels. Test results showed that on 100 mg red Psidium guajava contained vitamin C as much as 12.3 mg and 79.9 mg on white Psidium guajava. This study used quasi experiment, pre and posttest design. Hemoglobin and Hematocrit levels were analyzed using a photometer automated hematology analyzer, with research carried out for 7 days. The results showed an increase in Hemoglobin levels in respondents given red Psidium guajava at 0.3 gr/dl and in respondents given white Psidium guajava at 0.6 gr/dl. Hematocrit levels in respondents given red Psidium guava decreased by 0.35% and 0.25% in respondents given white Psidium guava. Wilcoxon test shows there is an increase in Hemoglobin levels but there is no effect on Hematocrit levels with responden given red and white Psidium guajava. By using Mann Whitney test, p value of 0.303 was obtained, which means there was no differences in respondents given red and white Psidium guajava. Clinical conclusion is white Psidium guajava is better on improving the value of hemoglobin levels and helps the absorption of iron in pregnant women’s third trimester.

1. Introduction
Anemia is one of the common complications of pregnancy. Hemoglobin concetrate, hematocrit and the total amount of red blood cells are used laboratory to diagnosed anemia[4]. Hematocrit is a blood test that measures the volume percentage of red blood cells with an abnormally low hematocrit may suggest anemia, a decrease in the total amount of red blood cells, while an abnormally high hematocrit is called polycythemia[5,6]. Hemoglobin is a protein in the red blood cells that carries oxygen to the body tissues[7] with normal value > 11g/dL and hematocrit <33% in pregnant women’s according to World Health Organization (WHO)[8].

During pregnancy blood volume rises rapidly. The body needs large amounts of iron for the synthesis of hemoglobin. Iron deficiency can cause anemia thereby reducing oxygen carrying capacity by hemoglobin and resulting in chronic oxygen deficiency in mother and fetus[1]. Pregnant women should get iron supplements at the end of pregnancy to maintain normal physiological needs. Iron is a major component of hemoglobin and myoglobin which is not only involved in the transportation, storage and use of oxygen but also involved in synthesis of cytochrome enzymes, peroxidase enzymes and hormones[2]. Previous studies have shown that anemia occurs in pregnant women with iron deficiency, resulting in chronic fetal hypoxia, premature birth and perinatal fetal death[3].

The 60 iron tablets programme have been integrated into antenatal care services in Health Care Centers but not yet effectively consumed. Setyowati’s study revealed that 96.8% of pregnant women with anemia consume iron tablets the wrong way[9]. To optimize the absorption of iron or ferum (fe)
and minimize the size effects, iron tablets should be consumed by one iron tablet every day for at least 90 days, where iron tablets are taken with water, not with tea, milk or coffee because it can reduce the absorption of iron in the body. iron tablets should also be taken after dinner before bed to reduce nausea and it would be better if taking iron tablets accompanied by eating fruits or vitamin C because it can increase the absorption of iron or ferum (fe) in the body[10]. In 2018 the coverage of iron tablets supplement on pregnant women in Indonesia is 81,42%. These results have not yet reached the 2017 Strategic Plan goal of 90%[17].

Psidium guajava contains vitamins A and C as well as several minerals such as iron, calcium and phosphorus. Manganese is also present in the plant in combination with phosphoric, oxalic and malic acids. The fruit is also rich in phytochemicals such as saponin (combination of oleanolic acid, morin-3-O-α-L-lyxopyranoside dan morin-3-O-α-L arabopyranoside), flavonoids (guaiazavarin dan quercetin)[11, 12].

Researchers conducted laboratory tests on vitamin C contains from red and white Psidium guajava at LPPT UGM Yogyakarta. The test showed that in 100 grams of red Psidium guajava contained vitamin C as much as 12.3 mg and 79.9 mg in white Psidium guajava. Vitamin C will increase the absorption of non-heme iron up to four times (2%-20%). Red Psidium guajava also contains antioxidant compounds (flavonoids and carotenoids) such as beta carotene, lycopene, beta cryptoxanthin and polyphenols[13, 14]. Flavonoids help prevent the bad effects of free radicals. Erythrocyte membrane is one of cell membranes that is vulnerable to free radicals attack. When free radicals attack the erythrocyte membrane, the fluidity of the cell membrane will be disrupted and cause lysis to cell death, causing a decrease in amount of erythrocytes and hemoglobin levels[15]. As an antioxidant, β carotene is useful for capturing free radicals especially peroxyl and hydroxyl radicals and works synergistically with vitamins C dan E[16].

2. Methods

This study is quasi experiment with pretest-posttest without control group design or post test with randomized group of red and white Psidium guajava. Pretest was carried out by measuring the levels of hemoglobin and hematocrit of pregnant women on the first day before being given intervention of iron tablets with red Psidium guajava (experiment group 1) or white Psidium guajava (experiment group 2), while the posttest was carried out by measuring the levels of hemoglobin and hematocrit of pregnant women on the seventh day after being given intervention.

The population in this study were all pregnant women’s third trimester in working area of Kedu Public Health Center in Temanggung Regency on August until September 2018 as many as 50 respondents who were diagnosed with anemia before. The sample was divided into two groups: group 1 (20 respondents given iron tablets and red Psidium guajava) and group 2 (20 respondents given iron tablets and white Psidium guajava). Normality test used Shapiro wilk because total sample is 40 respondents (less than 50) obtained p value>0,05 which means the data are normally distributed on Hemoglobin examination before and after given iron tablets and white Psidium guajava while others have an abnormal distribution. Bivariate analysis is used to examine differences in hemoglobin levels of pregnant women before and after intervention. Hypothesis testing used non parametric test (dependent T test) because data are normally distributed (hemoglobin levels before and after given iron tablets and white Psidium guajava), whereas for data that are not normally distributed use wilcoxon (Hematocrit levels on before and after given iron tablets and white Psidium guajava also Hemoglobin and Hematocrit levels before and after given iron tablets and red Psidium guajava). The Difference of intervention efficacy on hemoglobin and hematocrit levels used mann whitney test obtained $P value < 0,05$ (Ho is rejected). Bivariate analysis calculations are performed using a computerized system[18].
3. Results and Discussion

Respondent characteristics include age and parity, where these characteristics are also effect the occurrence of anemia in pregnancy. Presented in following tables 1 and 2 regarding age and parity pregnant women’s third trimester

| Table 1. Table Age of Pregnant Women’s Third Trimester |
|-----------------------------------------------------|
| Intervention                                      | Not risk | Risk | total |
| Iron tablets and Red Psidium guajava group        | F 15   | 75  | F 5   | 25  | F 20 | 100 |
| Iron tablets and White Psidium guajava group      | F 18   | 90  | F 2   | 10  | F 20 | 100 |
| Total                                              | 33     | 82.5| 7    | 17.5| 40   | 100 |

Table 1 shows the results for the age of pregnant women’s third trimester on both groups are mostly in not risk category 33 respondents (82.5%).

| Table 2. Table Parity of Pregnant Women’s Third Trimester |
|---------------------------------------------------------|
| Intervention                                             | Not risk (parity 1-3) | risk (parity >3) | total |
| Iron tablets and Red Psidium guajava group              | F 17   | 85  | F 3   | 15  | F 20 | 100 |
| Iron tablets and White Psidium guajava group           | F 15   | 75  | F 5   | 25  | F 20 | 100 |
| Total                                                   | 32     | 80  | 8     | 20  | 40   | 100 |

Table 2 shows the results for parity of pregnant women’s third trimester on both groups mostly in not risk category 32 respondents (80%).

3.1 Univariate analysis

Table 3 and 4 presented hemoglobin and hematocrit levels before and after intervention on both groups.

| Table 3. The Difference of Hemoglobin and Hematocrit Levels On Pregnant Women’s Third Trimester Before And After Given Iron Tablets And Red Psidium Guajava. |
|---------------------------------------------------------------|
| Variable            | N | Mean Hb (gr/dl) | Median Ht (%) |
| Pre intervention   | 20 | 11.00           | 31.35         |
| Post intervention  | 20 | 11.00           | 31.70         |

Table 3 shows there is no difference in hemoglobin levels before and after intervention (0.3) with the highest increase is 1.3 gr/dl on 2 respondents while 2 other respondents have decreased hemoglobin levels by 0.4 gr/dl. Laboratory test of Hematocrit shows there is a mean difference in hematocrit levels before and after intervention as much as 0.35% with highest increase is 3.9% on 2 respondents while 2 other respondents have decreased hematocrit levels by 1.6%.
Table 4. The Difference between Hemoglobin and Hematocrit Levels on Pregnant Women’s Third Trimester Before and After Given Iron Tablets and White Psidium Guajava.

| Variable          | N  | Mean Hb (gr/dl) | Median Ht (%) |
|-------------------|----|----------------|---------------|
| Pre intervention  | 20 | 11.1           | 32.05         |
| Post intervention | 20 | 11.7           | 31.80         |

Table 4 shows there is a mean difference in hemoglobin levels before and after intervention (0.6 gr/dl) with the highest increase is 1.3 gr/dl on 4 respondents while 2 other respondents have decreased hemoglobin levels by -0.2 gr/dl. Laboratory test of Hematocrit shows there is 0.25% decrease before and after intervention with the highest decrease is -2.7% on 2 respondents while 2 other respondents have hematocrit increase by 1.1.

3.2 Bivariate Analysis

Table 5 shows that there is a significant effect of iron tablet with red or white Psidium guajava intervention on Hemoglobin levels of pregnant women’s third trimester with p value < 0.05. Meanwhile, there is no significant effect of iron tablets with red or white Psidium guajava intervention on Hematocrit levels with p value >0.05.

Table 5. Effect of Iron tablets with Red or White Psidium guajava on hemoglobin and hematocrit levels of pregnant women’s third trimester

| Intervention                     | Hemoglobin | P-value pre and post | Hematocrit | P-value pre and post |
|----------------------------------|------------|-----------------------|------------|-----------------------|
| Iron tablets and Red Psidium guajava | 0.032      | 0.231                 |            |                       |
| Iron tablets and White Psidium guajava | 0.020      | 0.736                 |            |                       |

To find out the efficacy of iron tablets with red or white Psidium guajava on Hemoglobin levels of pregnant women’s third trimester, Mann whitney test was used and obtained p value 0.303 which means there is no difference efficacy on both groups. So statically red or white Psidium guajava are both good for increasing Hemoglobin levels of pregnant women’s third trimester, but clinically red Psidium guajava more effective to help the absorption of iron (fe) in the body.

Consumption of iron tablets with other micronutrients, namely vitamin A and C will be more effective in improving iron status compared to consuming only iron in the form of a single dose[19]. Vitamin C is an excellent agent to increase iron absorption in cases of iron deficiency anemia[22]. Iron deficiency anemia is associated with higher cases of Preterm birth rates, Low Birth Weight (LBW) and newborns with Small Gestational Age (SGA). Iron deficiency in pregnant women affects the concentration of iron in cord blood[20]. Iron deficiency in fetus until neonatal causes hearing loss in baby’s memory which reflects its impact on the developing of hippocamus[21].

Previous studies showed that anemia respondents who given iron tablets and vitamin C had an increase in hemoglobin levels of 0.91 gr% and the cases of anemia is decreased to 42.86% from 80.95%[23]. Intervention of red guava juice 3 cc/kg/day for 7 days resulted on erythrocytes blood increasing[24]. Red guava contains antioxidant compounds namely flavonoids and carotenoids such as beta carotene, lycopene, beta cryptoxanthin, polyphenols and vitamin C which can increase the absorption of non-heme iron up to four times (2% -20%) [25,26].

Clinically known that white guava is better than red guava to increase the absorption of iron in the body.

Amino acids and vitamin C in Psidium guajava will help reduce ferrette (Fe +++) to ferrous (Fe ++) so that iron is easily absorbed. Vitamin C will also remove iron from transferrin in plasma to join the ferritin tissue. The dietary needs of young women every day for protein are 48-62 g, iron 19-26 mg, vitamin B6 1,25 mg and vitamin C 60 mg. Fe is an important element in the formation of hemoglobin.
A healthy human body contains ± 3.5 g Fe which is almost entirely in the form of complex bonds with proteins, mostly 70% Fe in the body fuctions and the remaining 30% is not. Fuctional/essence of fe is present in 66% of hemoglobin, myoglobin 3%, enzymes for transfer electrons (cytochromoxidase, succinyl dehydrogenase, xanthine oxidase) as much as 0.5% and transferrin 0.1%. Iron as a reserve in the form of ferritin and hemosiderin as much as 25% and in parenchymal tissue around 5%. Iron that has been absorbed in the form of ions will be converted into ferries in mucosal cells which will then be inserted with the helps of transferrin plasma, then ferritin will be converted and stored in the intestinal mucosa. Vitamin B6 together with enzyme aminolevulenate converts Succinyl-CoA and glycine to become Aminolevulenic Acid (ALA). Furthermore ALA will be condensed by ALA dehydratase enzyme to form 2 water molecules and 1 porphobilinogen molecule. This porphobilinogen is synthesized into protoporphyrin 3. The involvement of iron in hemoglobin synthesis is in final stages of heme formation, where the incorporation of iron to protoporphyrin 3 is catalyzed by enzyme ferroketalase[27].

4. Conclusions and Suggestions

Provision of iron tablets and Psidium guajava with sufficient doses can increase iron reserves in the body, so it can increase hemoglobin levels needed in pregnancy. Bone marrow also requires precursors such as iron, vitamin C, vitamin B12, cobalt and hormones for the formation of red blood cells and hemoglobin so it can increas amount of erythrocytes and hematocrit levels. Therefore, pregnant women are expected to continue consuming iron tablets regularly and apply combination therapy of red or white Psidium guajava to improve hemoglobin levels in blood red cells as prevention of anemia during pregnancy.

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