Acacia honey consumption increases hemoglobin level of pregnant women with anemia

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Abstract. Untreated anemia in pregnant women potentially lead to complications of pregnancy and childbirth. Iron deficiency is one of the main causes of anemia. Honey has low pH, so it is expected to increase absorption of iron from Fe tablets consumed by pregnant women. The purpose of this study was to determine the effectiveness of acacia honey consumption in increasing hemoglobin levels of pregnant women with anemia. Acacia honey was produced from the nectar of *Acacia crassicarpa*. The study was a quasi-experiment with pre-post with control group design. The study was preceded by ethical testing and informed consent. The respondents were 30 pregnant women who did antenatal care and checked their pregnancy at Marinir Cilandak Hospital, South Jakarta. Respondents who had hemoglobin levels below 11 g/dL were included in this study. Respondents were further divided into two groups of 15 each. The treatment group consumed one Fe tablet and acasia honey 2×10 mL daily, while the control group consumed one Fe tablet daily. The study was conducted for 14 days. The independent *t*-test showed the hemoglobin levels increased significantly (p=0.031) in the group that consumed honey compared to the control group. Hemoglobin levels in pregnant women who consumed acacia honey and Fe tablets were higher than consumed Fe tablets only.

1 Introduction

Anemia is a blood disorder in which hemoglobin levels are less than normal. In a man, anemia is diagnosed when the blood hemoglobin level is less than 13 g/dL. In a woman, anemia is diagnosed when the blood hemoglobin level is less than 12 g/dL [1, 2]. According to WHO, in pregnant women, anemia is suffered when the blood haemoglobin level is less than 11g/dL, with mild, moderate, and severe anemia with hemoglobin levels of 9.0 - 10.9 g/dL, 7.8 -9.0 g/dL, and <7.0 g/dL, respectively [3, 4].

Anemia is a worldwide problem. Globally, it is estimated that 37% of pregnant women are affected by anemia. In fact, it is estimated that more than 40% of pregnant women

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worldwide suffered from anemia [5]. Indonesian Health Survey in 2023 showed that 27.7% of pregnant women suffered from anemia [6]. Anemia is associated with poor cognitive and motor development in children and work capacity in adults, which affects the economic development of countries [7]. It is even stated that anemia is an indicator of poor health and malnutrition. Anemia in pregnancy is a worldwide health challenge affecting low, middle, and high-income countries with several impacts on health and socioeconomic progress. The iron deficiency is one of the serious challenges and is the most frequently encountered micronutrient deficiency throughout the globe which is one of the major causes of human morbidity [8]. Untreated anemia in pregnant women will result in suboptimal growth and development of the fetus in the womb and potentially lead to complications of pregnancy and childbirth. In greater risk, the baby may not grow to a healthy weight, may be born early (preterm birth), or have a low birth weight. In addition, anemia is associated with increased risks for maternal mortality.

Anemia can be caused by several factors, including nutritional deficiencies through inadequate diet or inadequate absorption of nutrients, infections (e.g. malaria, parasitic infections, tuberculosis, HIV), inflammation, chronic diseases, gynaecological and obstetric conditions, and inherited red blood cell disorders. The most common nutritional cause of anaemia is iron deficiency, although folate, vitamin B12 and A deficiency are also important causes [9]. More than 50% of anemia in pregnant women is caused by the iron deficiency [5]

The Indonesian Government stated that the provision of blood supplementation tablets is an important and effective way to prevent and treat anemia due to iron and/or folic acid deficiency. Blood supplementation tablets (in Indonesia called as *tablet tambah darah* or *tablet Fe*) are given to women of childbearing age and pregnant women. Pregnant women are given blood supplement tablets every day during their pregnancy or a minimum of 90 tablets throughout the pregnancy [10]. Despite the Government efforts, the number of anemia pregnant women remains high [6].

Honey is a natural ingredient valued for its therapeutic abilities since ancient times. Its content plays an important role for human health, with high antioxidant and anti-inflammatory properties. There are different types of honey, depending on the source of nectar: floral and non-floral as well as the type of nectar source plant [11].

Based on the interview on some members of the Indonesian Beekeeping Association, acacia honey is one type of honey produced in Indonesia. Acacia honey is a non-floral honey produced from *Apis mellifera* colonies keeping in *Acacia crassicarpa* or *Acacia mangium* plantations on Sumatera Island. Acacia honey is a relatively new type of honey, found around 12 years ago after *Apis mellifera* colonies and were brought from Java to Sumatera. In the last five years, acacia honey production has been abundant since it does not depend on the flower season. However, acacia honey is less favoured by Indonesia people.

Acacia honey has reddish-brown colour, pH between 3-4, high antioxidant content, secondary metabolites alkaloid, phenolic, flavonoid, terpenoid, saponin, and tannin [12]. Honey is rich in antioxidants. Antioxidant sources in honey can be enzymatic antioxidants and non-enzymatic antioxidants. Enzymatic antioxidants in honey include glucose oxidase, and catalase, while non-enzymatic antioxidants are secondary metabolite compounds such as ascorbic acid, phenolic compounds, flavonoid compounds, phenolic acid compounds, carotenoid derivatives, and organic acids [13].

Previous study showed that acacia honey increases hemoglobin levels in adolescent girls suffered from anemia [14, 15]. The objective of this study was for determining effectiveness of acacia honey consumption in increasing hemoglobin levels in pregnant women with anemia. The expected results are further serving as a basic proof of the health benefits of acacia honey in general. The study expected that the public would further increasingly embrace acacia honey with its various potentials, especially in treating anaemia.

2 Materials and Methods

2.1 Acacia honey and Fe Tablet

Acacia honey was produced by honey bee colonies *Apis mellifera* which keeping in *Acacia crassicarpa* plantations on Sumatera island, Indonesia. Acacia honey is a non-floral honey.

Fe tablets that were given to the all respondents contained ferrous fumarate by 60 mg and folic acid by 400 mcg.

2.2 Respondents

Respondents in the study were pregnant women who attended antenatal care and pregnancy checkups at Clinic of Obstetrics and Gynaecology Marinir Cilandak Hospital, Jakarta, Indonesia. The selection of pregnant women as respondent was determined by random sampling. In this case, the inclusion criteria include pregnant women with haemoglobin levels below 11 gr/dL, had no chronic diseases and allergy to honey, and willing to become respondents by filling out informed consent after being given an explanation of the research information.

2.3 Data Collection

The study was conducted based on the approval by the ethical clearence on the institution certificate number 13/VII/2023/RSMC. The study was held at the Marinir Cilandak Hospital, Jakarta. The study was a quasi experiment with a pretest-posttest with control group design. The first group was anemia pregnant women who consumed acacia honey and Fe tablets or referred to as the intervention group. The second group was anemia pregnant women who consumed Fe tablets only. The number of pregnant women in each group was 15 people. In the intervention group, respondents consumed 10 mL of honey twice a day in the morning and at night before consuming Fe tablets. All respondents were provided by fourteen Fe tablets, and respondents in the intervention group received 300 mL of acacia honey and a measuring spoon. To ensure that all respondents consumed acacia honey and Fe tablets, researchers created a WhatsApp Group for reminding and monitoring the respondents.

The hemoglobin level of pregnant women was measured with a digital hemoglobin meter (Easy Touch GCHB Model ET-321, IND). The blood was collected in the capillary vein from the tip of the middle finger or ring finger in a sterile and safe procedure according to the hospital's health protocol. Measurement of hemoglobin levels was carried on day 1 and day 15. All data were collected and analysed used Shapiro Wilk normality test, paired sample *t*-test and independent sample *t*-test using SPSS version 25.0.

3 Results

This study involved 30 pregnant women with anemia whose socio-demographic data listed in Table 1.

Table 1. Socio-demographic information of pregnant women with anemia

Variables	Category	Frequency	Percentage (%)
Base and End Line Gestational Age	I (1-12 weeks)	6	20.0
	II (13-28 weeks)	13	43.3
	III (29-36 weeks)	11	36.7
Occupation	Housewife	17	56.7
	Employee	13	43.3
Education	Senior High School	15	50.0
	Under graduate	15	50.0
Age Group	21 – 35 year	17	56.7
	> 35 year	13	43.3
Gravida	Primigravida	8	26.7
	Multigravida	15	50.0
	Grande Multi	7	23.3

Data on hemoglobin levels of pregnant women with anemia before and after consuming acacia honey and tablets Fe in the intervention and control groups based on the paired *t*-test and independent *t*-test of acacia honey effectiveness in increasing hemoglobin levels of pregnant women with anemia are presented in Table 2.

Table 2. Mean hemoglobin levels before and after consumed acacia honey and Fe tablet, *p*-value of paired *t*-test and independent *t*-test

Group	PreTest	PostTest	*p*-value Paired *t*-test
	Mean±SD	Mean±SD	
Acacia honey + Fe Tablet	9.920±0.1781	11.647±0.2588	0.000
Fe Tablet	9.987 ±0.1727	11.447±0.2232	0.000
Mean Difference	0.060	0.200	
***p*-value Independet *t*-test**	0.307	0.031	

The results showed that the mean hemoglobin levels of pregnant women with anemia before and after consuming acacia honey and Fe tablets were almost the same. To determine the effectiveness of acacia honey in both groups, within-group and between-group tests were conducted using Shapiro Wilk nomality test, and the results indicate that the distribution of data are normal (p-value > 0.05) (the results are not showed).

The results of paired *t*-test showed that the mean hemoglobin levels in the intervention group before and after consuming acacia honey and Fe tablets were 9.853 g/dL and 11.680 g/dL respectively. The mean haemoglobin level in the control group before and after consuming Fe tablets was 9.953 g/dL and 11.180 g/dL respectively. The results of paired *t*-test in the both groups have a p-value > 0.05, indicating that there is a significant difference in the increase of hemoglobin levels mean before and after consumed acacia honey and Fe

tablets. The consumption of acacia honey has not shown its effect on increasing hemoglobin levels yet. Therefore, the independent *t*-test was conducted. Results showed no difference mean hemoglobin level in the pretest of both groups (p-value > 0.05). In the posttest results, hemoglobin levels higher in the intervention group compared to the control group (p-value < 0.05). This suggests that the consumption of acacia honey will significantly increase hemoglobin levels compared to pregnant women with anemia who consumed Fe tablets only.

4 Discussion

An increase hemoglobin levels in anemia pregnant women who consumed honey to normal levels were also observed in other studies, but the type of honey was unknown [16, 17, 18]. Some researchers suggested that the increased hemoglobin levels in pregnant women with anemia who consumed honey is because honey contains various elements that could increase hemoglobin levels such as iron, vitamins, enzymes, minerals, amino acids, hormones, antibiotics and aromatic ingredients [18, 19, 20].

The effect of honey consumption in increasing haemoglobin levels in anemia people is not easy to explain because the levels of nutritional components in honey are dominated by many types of carbohydrates and water. Food data central - USDA notes that in 100 grams of honey there are 82.1 grams carbohydrates in total various types of sugar (sucrose, glucose, fructose, maltose, galactose), 17.1 gram of water, 0.3 g of protein, 0.2 g of ash, 0.2 g of fibre, 6 mg of calcium, 0.42 mg of iron, 4 mg of phosporus, 52 mg of potassium, 4 mg of sodium, 0.22 mg of zinc, 0.036 mg of copper, 0.08 mg of manganese, 0.8 µg of selesnium, 7 µg of fluoride, 0.5 mg of vitamin C, 0.251 - 0.3 mg of other vitamins, 2 µg of folate, and total of 18 type of amino acid by 0.226 g, while folic acid, vitamin E, vitamin D, vitamin K are not found [21]. Thus, it would be difficult to claim that the increase hemoglobin levels due to honey being a source of iron as well as other nutrients that honey contained.

The need for iron in pregnant women is quite high. Pregnant women need additional iron during pregnancy of approximately 1000 mg, which is needed for fetal growth, placenta and bleeding during childbirth which releases an average of 250 mg of iron [10]. During pregnancy, a woman needs iron supplementation which ranges from 30 mg to 60 mg of elemental iron. A total of 60 mg of elemental iron is equivalent to 300 mg of ferrous sulfate heptahydrate or 500 mg of ferrous gluconate or 180 mg of ferrous fumarate [6]. For this reason, it is very crucial to understand the mechanism of iron absorption in the body.

There are two types of iron found in food, those are heme and nonheme. Heme iron only presents in animal products such as meat, fish, and poultry, while nonheme iron is found in fruits, vegetables, dried beans, nuts, grain products, and meat. Heme iron is absorbed with better efficiency in the intestines than nonheme iron. In other words, iron absorption is highly dependent on the physical state of iron as oxidised ferric Fe^{3+} and ferrous Fe^{2+}. Nonheme iron in the diet is mainly in the oxidised form or ferric Fe^{3+} [2].

Honey has a low acidity or low pH, due to the presence of organic acids. These acids contribute to honey's flavour and antimicrobial activity, as well as the stability of food matrix [22]. Various types of organic acids from honey have been determined and there are 22 organic acids present in honey, namely Glycolic acid, 3-Hydracrylic acid, 3-Hydroxychloric acid, and 3-Hydroxychloric acid, Propanedioic acid, Succinic Acid, Tartronic acid, Malic acid, α-Ketoglutaric acid, DL-Tartaric acid, trans-Aconitic acid, Shikimic acid, D-(-)-Quinic acid, D-Gluconic acid, L-(+)-lactic acid, Oxalic acid, Benzoic acid, Fumaric acid, Adipic acid, DL-Pyroglutamic acid, DL-3-Phenyllactic acid, Suberic acid, Azelaic acid, Citric acid. Acacia honey have all of the organic acid [23]. In Addition, there is also formic acid, pyruvic acid, and acetic acid in honey [22].

Research shows that iron must be dissolved before it is absorbed. Iron dissolution is supported by the acidic pH in the stomach [24]. Ferric iron is precipitated in solutions with pH higher than 3. Therefore, ferric iron must first be solubilised and chelated in the stomach to be absorbed in less acidic proximal intestine [25]. The chelation process occurs rapidly by other components in the diet as iron is released in the intestinal lumen. These chelators can be enhancers and inhibitors that affect iron absorption through iron solubility [26].

Honey contains 0.57% organic acids. It is known that organic acids regulate both the bioavailability and absorption of non-heme iron. The molecular docking study of honey on iron bioaviobility selected 53 honey-derived ligands for assessment of docking behaviour of human Ferritin, Transferrin, and Hepcidin using PatchDock method. Results showed that all 53 ligands from honey were modulators of human Ferritin, Transferrin, and Hepcidin [27]. For this reason, according to the researcher's assumption, it is thought that honey can increase hemoglobin levels because honey with a low pH creates a lower gastric atmosphere and makes iron from Fe tablets and other foods consumed anemia pregnant women more soluble and easily absorbed the jejenum and duodemum.

5 Conclussion

Hemoglobin levels in pregnant women who consumed acacia honey and Fe tablets were higher than consumed Fe tablets only. Acacia honey help to increase hemoglobin levels in pregnant women with anemia.

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