International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Effect of *Moringa* (*Moringa oleifera*) Biscuit Administration on Hemoglobin Levels of Pregnant Women

Pesta Corry Sihotang[a]*, Putu Candriasih[b], Suleha Amdadi[c]

[a,c]Department of Midwifery, Makassar Health Polytechnic of Ministry of Health
[b]Department of Nutrition, Palu Health Polytechnic of Ministry of Health
[a]Email: corrysihotang.mksr@gmail.com
[b]Email: putucandriasih@yahoo.com
[c]Email: eha_edi@yahoo.co.id

Abstract

This study aimed to analyze the effect of *Moringa* (*Moringa oleifera*) biscuit administration on hemoglobin (Hb) levels of pregnant women. This was a single-blind randomized controlled trial (RCT). The number of subjects in this study were 53 pregnant women for each group (control and treatment). However, at the end of study, the number of respondents decreased to 49 in the treatment group and 44 respondents in the control group. The data were analyzed using independent t-test. The independent t-test results indicated that there was a significant difference in hemoglobin levels between the treatment group and the control group after the intervention ($p \leq 0.05$). After the intervention, some respondents in the treatment group were not suffering from anemia. Administration of five pieces (60 g) of *Moringa* biscuit per day in pregnant women with anemia is recommended as one of the alternatives to overcome the undernutrition problem in pregnant women, especially to increase Hb levels.

Keywords: hemoglobin levels; *Moringa* biscuit; pregnant women.

----

* Corresponding author.

1. Introduction

Pregnant woman is one of the groups prone to undernutrition, either macronutrients or micronutrients. It is due to the increase in nutritional requirement to meet the needs of mothers and fetuses conceived. Wrong dietary pattern in pregnant women has an impact on the occurrence of nutritional disorders such as anemia, low weight gain in pregnant women and intrauterine growth restriction [1].

Basic Health Research (BHC) in 2013 showed that the prevalence of anemic pregnant women in Indonesia was 37.1% [2], meaning that it was considered as moderate health problem [3]. Meanwhile, the prevalence of anemia in pregnant women in Central Sulawesi Province in 2014 was 32.2%, and the prevalence of anemia in Donggala Regency was 32.1% based on reports from regency/municipal nutrition program managers [4].

One of the types of vegetables that has not been widely used but has a high nutritional content is *Moringa* leaf. *Moringa* is dubbed as the mother's best friend and miracle tree because it has high nutrient content and many benefits. *Moringa* leaves can be used as a source of nutrients, and even World Health Organization (WHO) has introduced *Moringa* since 1988 as one of the alternative foods to overcome malnutrition [5].

There is a phenomenon found in Kampili Village, where the pregnant women in the village do not consume *Moringa* leaves due to cultural influences that the leaves may cause miscarriage. *Moringa* leaves contain many elements of micronutrients needed by the pregnant women such as beta carotene, thiamine (B1), riboflavin (B2), niacin (B3), calcium, iron, phosphorus, magnesium, zinc and vitamin C [6].

Food favoured by people has an essential role as a source of nutrients for most of Indonesian people, thereby its nutritional content must be considered. Therefore, *Moringa* leaf flour is used to increase the utilization value of existing resources and increase the nutritional content of biscuits. The *Moringa* biscuit is expected to provide effect on Hb levels and weight gain in pregnant women.

In general, this study aimed to analyze the effect of *Moringa* (*Moringa oleifera*) biscuit administration on Hb levels. The specific objectives of this study were: 1) analyze the content of macronutrients and mineral (Fe) in *Moringa* (*Moringa oleifera*) biscuit, 2) identify the respondents' characteristics (age, education, occupation, income and parity), 3) analyze food consumption adequacy level of the pregnant women, and 4) identify Hb levels of the pregnant women before and after the intervention.

2. Materials and Methods

2.1. Study design, time and site

This study was an experimental trial. It was conducted in two stages; i.e. preparation of intervention biscuit in the form of *Moringa* (*Moringa oleifera*) biscuit (first stage), and implementation of the intervention using single-blind randomized controlled trial (RCT) design to analyze the effect of *Moringa* (*Moringa oleifera*) biscuit administration on Hb levels of the pregnant women.The study was conducted from August to September 2017 for the preparation of intervention biscuits and sample screening, while the intervention was conducted from September to November 2017. The study site was in Food Processing and Testing Laboratory, 3-year

Diploma of Nutrition Study Program of Palu Health Polytechnic. The intervention was conducted in Lero Village, Donggala Regency, Central Sulawesi and Kampili Village, Gowa Regency, South Sulawesi.

2.2. Sample size and sampling method

The subjects in this study were pregnant women in Lero Village, Donggala Regency, Central Sulawesi and Kampili Village, Gowa Regency, South Sulawesi with inclusion criteria as follows: 1) Hb levels < 11g/dL, 2) pregnant women with hyperemesis, 3) pregnant women with pregnancy complications, and 4) those who had received an explanation about the study and were willing to sign the informed consent. Based on the calculation, the sample size was 36 pregnant women for each group.

2.3. Data types and collection methods

The data collected in this study were primary data covering the subjects' characteristics (age, education and occupation), anthropometric data, nutritional status, health status, food consumption and compliance regarding the consumption of intervention biscuits, and Hb levels measured at the beginning and the end of intervention. The instruments used in this study were questionnaire (respondent characteristics data), 2x24-h food recall questionnaire and food frequency questionnaire (food consumption data), form and logbook (the data on the compliance rate of biscuit consumption). Hb levels were measured using cyanmethemoglobin method.

During the intervention, the researchers were assisted by Posyandu (integrated service station) cadres in Lero Village, Donggala Regency, Central Sulawesi and Kampili Village, Gowa Regency, South Sulawesi. Intervention biscuits were distributed every week to the coordinator of Posyandu cadres, which were then distributed to several Posyandu companion cadres. The biscuits were delivered directly to the respondents twice a week by the companion cadres. Along with biscuit distribution, each cadre helped the researchers monitor and record the amount of biscuits consumed and not consumed to observe the respondent's compliance in consuming the intervention biscuits. Besides that, the respondents were provided with nutrition education or counseling, introduction of the intervention biscuits, and reward at the beginning of the study to improve the compliance and maintain the continuity of participation in the research activities.

2.4. Data processing and analysis

Data processing included several stages; i.e. editing, coding, processing and cleaning. Data normality was analyzed by Shapiro-Wilk test. Characteristic differences between the treatment and the control groups were analyzed using Mann-Whitney test. The differences in intake of energy and nutrients, as well as Hb levels between the treatment and the control groups before and after the intervention were analyzed using independent t-test.

3. Results

3.1. Nutrient content of Moringa biscuit

The content of macronutrients and micronutrients in *Moringa* biscuit per 100 g were 480.44 kcal energy, 58.67

g carbohydrates, 13.07 g protein, 3.535 mg vitamin C and 7.39 mg iron (Table 1).

Table 1: Nutrient contents of *Moringa* (*Moringa oleifera*) biscuits

Nutrient analysis	Composition
Energy (Cal/100 g)	480.44
Water content (% wet weight)	8954.5
Ash content (% dry weight)	563.12
Protein content (g)	13.07
Fat content (g)	23.82
Carbohydrate content (g)	58.67
Iron content (mg)	7.39
Vitamin C (mg)	3.535

3.2. Subjects' characteristics

Table 2 showed that most of the respondents in the treatment group (84.91%) and in the control group (83.02%) were 20-35 years old.

Most of them were in the third trimester gestation period (25-34 weeks); i.e. 49.06% in each group. The results of Mann-Whitney test showed no differences in characteristics (age and gestation period) between the two groups (p>0.05).

Table 2: Distribution of respondents based on characteristics (age and gestation period)

Characteristics	Treatment		Control		p-value
	n	%	n	%	
Age					
<20 years	5	9.43	4	7.55	0.25
20-35 years	45	84.91	44	83.02	
>35 years	3	5.66	5	9.43	
Total	53	100.00	53	100.00	
Gestation period					
First trimester (0-12 weeks)	10	18.87	9	16.98	0.18
Second trimester (13-24 weeks)	17	32.07	18	33.96	
Third trimester (25-34 weeks)	26	49.06	26	49.06	
Total	53	100.00	53	100.00	

3.3. Energy and nutrient intakes

Table 3 showed that before the intervention, mean energy intakes of the respondents were 2218.2±131.7 kcal (treatment group) and 2190.9±117.4 kcal (control group), mean protein intakes were 56.8±12.5 g (treatment group) and 55.6±10.2 g (control group), mean vitamin C intakes were 67.2±10.6 mg (treatment group) and 63.8±12.2 mg (control group), and mean iron intakes were 10.5±3.2 mg (treatment group) and 9.6±3.8 mg (control group).

The independent t-test results indicated that there were no differences in intakes of energy and nutrients (protein, vitamin C and iron) between the two groups (p>0.05).

Table 3: Distribution of respondent based on intake of energy and nutrients before the intervention

Energy and nutrients	Mean intake (Mean±SD)		p-value
	Treatment	Control	
Energy (kcal)	2218.2±131.7	2190.9±117.4	0.11
Protein (gr)	56.8±12.5	55.6±10.2	0.23
Vitamin C (mg)	67.2 ±10.6	63.8±12.2	0.31
Iron (mg)	10.5±3.2	9.6±3.8	0.15

Table 4 indicated that after the intervention, mean energy intakes of the respondents were 2853.1±154.2 kcal (treatment group) and 2429.4±157.2 kcal (control group), mean protein intakes were 77.8±10.3 g (treatment group) and 56.8±9.9 g (control group), mean vitamin C intakes were 88.9±20.1 mg (treatment group) and 69.7±12.5 mg (control group), and mean iron intakes were 32.9±6.5 mg (treatment group) and 23.8±8.1 mg (control group).

The independent t-test results showed that there were differences in intake of energy and nutrients (protein, vitamin C and iron) between the two groups (p<0.05), in which the treatment group had higher intake of energy and nutrients (protein, vitamin C and iron) than the control group.

Table 4: Distribution of respondents based on intake of energy and nutrients after the intervention

Energy and nutrients	Mean intake (Mean±SD)		p-value
	Treatment	Control	
Energy (kcal)	2853.1±154.2	2429.4±157.2	0.00
Protein (gr)	77.8±10.3	56.8±9.9	0.00
Vitamin C (mg)	88.9±20.1	69.7±12.5	0.00
Iron (mg)	32.9±6.5	23.8±8.1	0.00

3.4. Adequacy level of energy and nutrients

Table 5 showed that before the intervention, most of the respondents in the treatment group (77.36%) and in the control group (77.36%) had energy adequacy levels classified as mild deficient (80-89% RDA). Most of them (83.02% in each group) also had protein adequacy levels classified as mild deficient.

Most of the respondents in the treatment group (88.68%) and the control group (86.79%) had deficient vitamin C adequacy levels. Most of them also had deficient iron adequacy levels; 88.68% in the treatment group and 84.91% in the control group.

Table 5: Distribution of respondents based on adequacy levels of energy and nutrients before intervention

Energy and nutrients	Treatment		Control	
	n	%	n	%
Energy (kcal)				
Moderate deficiency (70-79% RDA)	5	9.43	7	13.21
Mild deficiency (80-89% RDA)	41	77.36	41	77.36
Normal (90-199% RDA)	7	13.21	57	9.43
Protein (g)				
Moderate deficiency (70-79% RDA)	5	9.43	7	13.21
Mild deficiency (80-89% RDA)	44	83.02	44	83.02
Normal (90-199% RDA)	4	7.55	2	3.77
Vitamin C (mg)				
Deficient (<77% RDA)	47	88.68	46	86.79
Adequate (≥77% RDA)	6	11.32	7	13.21
Iron (mg)				
Deficient (<77% AKG)	47	88.68	45	84.91
Adequate (≥77% AKG)	6	11.32	8	15.09

Table 6 showed that after the intervention, most of the respondents in the treatment group (89.80%) and in the control group (54.55%) had normal energy adequacy levels (90-199% RDA). Most of them had normal protein adequacy levels; i.e. 91.84% in the treatment group and 47.73% in the control group. Most of the respondents in the treatment group had adequate vitamin C and iron intakes with a percentage of 93.88% for each nutrient adequacy level category. Meanwhile, most of the respondents in the control group had deficient vitamin C and iron intakes with percentages of 54.55% and 59.09%, respectively.

Table 6: Distribution of respondents based on adequacy levels of energy and nutrients after the intervention

Energy and nutrients	Treatment		Control	
	n	%	n	%
Energy (kcal)				
Moderate deficiency (70-79% RDA)	1	2.04	5	11.36
Mild deficiency (80-89% RDA)	4	8.16	15	34.09
Normal (90-199% RDA)	44	89.80	24	54.55
Protein (gr)				
Moderate deficiency (70-79% RDA)	0	0.00	4	18.18
Mild deficiency (80-89% RDA)	4	8.16	19	43.18
Normal (90-199% RDA)	45	91.84	21	47.73
Vitamin C				
Deficient (<77% RDA)	3	6.12	24	54.55
Adequate (≥77% RDA)	46	93.88	20	45.45
Iron (mg)				
Deficient (<77% AKG)	3	6.12	26	59.09
Adequate (≥77% AKG)	46	93.88	18	40.91

3.5. Hemoglobin levels

Table 7 indicated that before the intervention, most of the respondents in the treatment group (86.79%) and in the control group (88.68%) had mild anemia (8-10 g/dL). Independent t-test results showed that there was no difference in Hb levels between the two groups, because most of the respondents in both groups had adequacy levels of energy and nutrients (protein, vitamin C and iron) that were classified as deficient (Table 5).

Table 7: Distribution of respondents based on Hb levels before the intervention

Hb levels (g/dL)	Treatment		Control		p-value
	n	%	n	%	
Severe anemia (<8)	7	13.21	6	11.32	0.07
Mild anemia (8-10)	46	86.79	47	88.68	
Normal (≥11)	0	0.00	0	00.00	
Total	53	100.00	53	100.00	

Table 8 showed that there was a decrease in the number of respondents in each group because some of them had bleeding and abortion, thereby could not continue participating in the intervention until the fourth week. After the intervention, most of the respondents in the treatment group (75.51%) and in the control group (88.64%) still had mild anemia (8-10 g/dL). However, the respondents in the treatment group tended to have an increase in Hb levels. It was indicated by the decreased percentage of respondents who had mild anemia, from 86.79% before they were given *Moringa* biscuits (Table 7) to 75.51% (Table 8). Independent t-test results showed that there was a difference in Hb levels between the treatment and the control groups, in which there was a change of anemia status to normal in 24.49% of respondents in the treatment group after they were given *Moringa* biscuits.

Table 8: Distribution of respondents based on Hb levels after the intervention

Hb levels (g/dL)	Treatment		Control		p-value
	n	%	n	%	
Severe anemia (<8)	0	0.00	1	2.27	0.00
Mild anemia (8-10)	37	75.51	39	88.64	
Normal (≥11	12	24.49	4	9.09	
Total	49	100.00	44	100.00	

4. Discussion

The results of this study showed that most of the respondents were at age with low risk factors in pregnancy. According to Ministry of Health of Republic of Indonesia, ages considered as risk factors in pregnancy are age less than 20 years and more than 35 years [7]. Besides that, respondents at that age are in the productive period for working and mostly involved in social and religious activities in community that may drain their energy, thus the mothers are less concerned about their pregnancy conditions.

Pregnant woman needs to consume adequate energy and nutrients to sustain the growth and health of the fetus and herself. Many changes occur in the body during pregnancy such as increased blood volume, increased size and strength of uterus, more flexible muscles to prepare for birth, swollen feet due to increased concentration of estrogen that is required to hold water and help prepare the uterus for labor, enlarged and changing breasts to prepare for breastfeeding. Meanwhile, there are intrauterine growth and development in the mother's body. These changes need to be accompanied by the help of nutritious food, regular physical activity and adequate rest [8].

Intake of energy and nutrients (protein, vitamin C and iron) in the treatment group increased after they were given the intervention, in the form of five pieces (60 g) of *Moringa* biscuits that had to be consumed by the respondents every day. It signified that *Moringa* biscuit administration could help increase intake of energy and nutrients (protein, vitamin C and iron) in pregnant women, where every 100 g *Moringa* biscuit contained 480.44 kcal energy, 13.07 g protein, 3.535 mg vitamin C and 7.39 mg iron. If compared to beef, the iron content of *Moringa* (28 mg) is higher than the beef (2 mg) [9]. In addition, *Moringa* leaves contain iron three times higher than spinach and vitamin C seven times higher than oranges [10].

If a person consumes nutrients less than his nutritional requirement, then the person will be undernourished [11]. If the mother suffers from undernutrition during pregnancy, it will cause problems to the mother and fetus. Undernutrition in pregnant women may cause risk and complications in the mother, such as anemia, bleeding, maternal weight does not increase normally and having infectious diseases.

Anemia in pregnant women is caused by the decreased Hb and hematocrit (Ht) levels in the first and second trimesters, as a result of increased plasma volume that occurs earlier than the production of red blood cells [12]. Anemia during pregnancy may result in the mother giving birth to preterm infants, low birth weight (LBW) infants, bleeding at the time of delivery and maternal death [13]. It is supported by the previous study suggesting that low Hb levels that persist during pregnancy may pose a risk of giving birth to LBW infants [14].

Hb synthesis is closely related to the adequacy of energy, protein and iron [15]. The process of red blood cell formation requires the availability of adequate energy. To transport oxygen, protein must bind to iron to form myoglobin in muscle fibers, and then form enzymes that play a role in energy formation in cells. If the availability of energy in the cells is sufficient, the protein and iron that bind each other will form Hb and transport oxygen to the blood. Therefore, the Hb level will be an indicator of anemia status. Thus, the protein and iron intakes must be fulfilled during pregnancy because they play an essential role in Hb synthesis.

Besides high in iron, *Moringa* biscuit also contained high amount of protein. Protein is one of the nutrients that play a role in improving iron bioavailability [16]. *Moringa* leaves have high-quality and easily-digested protein that is influenced by the quality of the amino acids. In addition, the vitamin C content in *Moringa* leaves are quite high and it plays a role in increasing iron bioavailability [17]. Vitamin C can act as an enhancer of iron absorption at non-heme sources [18]. It can improve non-heme iron absorption up to four fold. Vitamin C and iron form ferrous-ascorbate complexes that are soluble and easily absorbed, thereby fresh vegetables and fruits containing lots of vitamin C are good to consume to prevent anemia. It may not only be due to the large amount of iron contained in the foodstuffs, but also the vitamin C content that facilitates iron absorption because the factors that determine absorption are more important than the amount of iron in the foodstuffs in certain cases [19].

5. Conclusion and Recommendation

Respondents' characteristics (age and gestation period) between the treatment and the control groups were not significantly different. There was no differences in energy and nutrient intakes between the treatment and the control groups before the intervention. Energy and nutrient intakes of the respondents in the treatment group increased after the intervention. Prior to the intervention, most of the respondents – either in the treatment group or the control group – had mild anemia and none of them had normal Hb levels. After the intervention, some respondents did not suffer from anemia. Therefore, administration of five pieces (60 g) of *Moringa* biscuits per day in anemic pregnant women is highly recommended as one of the alternatives to overcome undernutrition problem in pregnant women, especially to improve Hb levels.

References

[1] S. Fatimah, V. Hadju, B. Bahar, Z. Abdulah. "Pola konsumsi dan kadar hemoglobin pada ibu hamil diKabupaten Maros, Sulawesi Selatan (Consumption pattern and haemoglobin levels in pregnant women in Maros Regency, South Sulawesi)". Makara Kesehatan, vol. 15, pp.1-6, 2011.

[2] Kemenkes RI (Ministry of Health, Republic of Indonesia). Riset Kesehatan Dasar 2013 (2013 Basic Health Research). Jakarta: Kementerian Kesehatan Republik Indonesia (Ministry of Health, Republic of Indonesia), 2013.

[3] WHO (World Health Organization).Nutrition Landscape Information System (NLIS), Country Profile Indicators, Interpretation Guide. Geneva: World Health Organization, 2010.

[4] Dinas Kesehatan Provinsi Sulawesi Tengah (Health Office of Central Sulawesi Province), Profil Kesehatan Provinsi Sulawesi Tengah Tahun 2014 (Health Profile of Central Sulawesi Province in 2014). Palu: Dinas Kesehatan Provinsi Sulawesi Tengah (Health Office of Central Sulawesi Province), 2015.

[5] Broin. Growing and Processing Moringa Leaves. France: Imprimerie Horizon, 2010.

[6] A. Khuzaimah, V. Hadju, S. As'ad, N. Abdullah, B. Bahar, D.S. Riu. "Effect of honey and Moringa oleifera leaf extracts supplementation for preventing DNA damage in passive smoking pregnancy". International Journal of Sciences: Basic and Applied Research, vol. 24, pp. 138-145, 2015.

[7] DEPKES RI (Ministry of Health, Republic of Indonesia). Buku Acuan Pelayanan Kesehatan Maternal dan Neonatal (Reference Book of Maternal and Neonatal Health Services). Jakarta: Departemen Kesehatan Republik Indonesia (Ministry of Health, Republic of Indonesia), 2005.

[8] S. Almatsier, S. Soetardjo, M. Soekatri. Gizi Seimbang dalam Daur Kehidupan (Balanced Nutrition throughout Life Cycles). Jakarta: PT Gramedia Pustaka Utama, 2011.

[9] L. Gopalakrishnan, K. Doriya, D.S. Kumar. "Moringa oleifera: A review on nutritive importance and its medicinal application". Food Science and Human Wellness, vol. 5, pp. 49–56, Jun. 2016.

[10] S. Winarti. Makanan Fungsional (Functional Food). Jakarta: Gramedia Pustaka Utama, 2010.

[11] A. Khomsan, F. Anwar. Sehat itu Mudah (Healthy is Easy). Jakarta: Hikmah, 2008.

[12] Darlin. Faktor-Faktor yang Berhubungan dengan Kejadian Anemia Gizi pada Ibu Hamil di Kota Bogor, Provinsi Jawa Barat (Factors Associated with Incidence of Nutritional Anemia in Pregnant Women in Bogor City, West Java Province). Jakarta: Papas Sinar Sinanti, 2003.

[13] S. Muslimatun. "Weekly supplementation with iron and vitamin a during pregnancy increases hemoglobin concentration but decreases serum ferritin concentration in Indonesian pregnant women". Journal of Nutrition, vol. 131, pp. 85-90, Jan. 2001.

[14] L.H. Allen. "Anemia and iron deficiency: effects on pregnancy outcome". American Journal of Clinical Nutrition, vol. 71(5 suppl), pp. 280S-284S, May 2000.

[15] S. Sayogo. Gizi Ibu Hamil (Nutrition for Pregnant Women). Jakarta: Faculty of Medicine, University of Indonesia, 2007.

[16] C. Beck, S. Hertel, A. Rediger, R. Lehmann, A. Wiegard, A. Kolsch, et al. "Daily expression pattern of protein-encoding genes and small noncoding RNAs in synechocystis sp. strain PCC 6803". Applied and Environmental Microbiology, vol. 80, pp. 5195-5206, Sep. 2014.

[17] K.M. Nair, V. Iyengar. "Iron content, bioavailability and factors affecting iron status of Indians". Indian Journal of Medical Research, vol. 130, pp. 634-645, Nov. 2009.

[18] S. Pavord, B. Myers, S. Robinson, S. Allard, J. Strong, C. Oppenheimer. "UK guidelines on the management of iron deficiency in pregnancy". British Journal of Haematology, vol. 156, pp. 588-600, Jan. 2012.

[19] D. Briawan. "Efikasi Suplementasi Besi-Multivitamin terhadap Perbaikan Status Besi Remaja Putri (Efficacy of Iron-Multivitamin Supplementation on Iron Status Improvement in Female Adolescents)". Dissertation, Bogor Agricultural University, Bogor, 2008.