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A comparison between extract *Moringa oleifera* and iron tablet on prevention low birth weight in pregnant mothers in Makassar, Indonesia☆

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Abstract
Objective: Compare the effect of *Moringa oleifera* (MO) leaf extract and iron tablets on pregnant women on low birth weight.
Methods: This study used a Randomized Double-Blind design controlled by using a sample of non-anemic pregnant women. Birth weight was measured using a digital scale electrically after delivery. Analysis of data using two independent samples *t*-test.
Results: Overall, there were no significant different between intervention and control group in terms of birth weight (3104.57 ± 52 vs. 3022.29 ± 53 g), birth length (48.06 ± 2.4 vs. 48.68 ± 2.6 cm), and head circumference (33.72 ± 1.50 vs. 33.55 ± 1.47 cm). The number of low birth weight infants in the intervention group of 8.6% and 11.4% of control. There is no difference in birth weight between the intervention with the control group (p = 0.365).
Conclusion: M. oleifera (MO) leaf extract supplement has similar effect to iron folate supplement in terms of low birth weight incidence. It is recommended for the government to use MO supplement, as local source supplement, replacing iron-folic supplement in improving pregnancy outcomes. A further study is necessary to see the effect of MO supplement to other pregnancy outcomes, including maternal and child mortality.

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Introduction

Pregnancy is an inflammatory condition that shows a high susceptibility to oxidative stress. The pregnancy process causes an increase in oxidation pressure resulting in an increase in oxidation results, such as *malondialdehyde* (MDA). MDA levels in pregnant women are higher compared to normal women. MDA levels in pregnant women are higher compared to non-pregnant women. Increased MDA levels increase with gestational age, i.e. from the first, second, and third trimesters.[1] Increased MDA as a sign of oxidative pressure can lead to DNA damage, pregnancy disorders such as preeclampsia (PE) and fetal growth barriers or *intrauterine growth restriction*/IUGR.[2]

DNA damage has been investigated in association with late pregnancy abnormalities such as preeclampsia (PE) and fetal growth disorders or *intrauterine growth restriction*/IUGR Genomic damage can cause inhibition of cell division, cell cycle slowdown, and excessive apoptosis or cell death causing disruption to trophoblast invasion and abnormal placenta.[3] A study showed that 8-OHdG levels as biomarkers of DNA damage are significantly higher in low birth weight babies.

Moringa leaves have the potential for substantial nutrients, contain a number of essential amino acids, and various kinds of important micronutrients, such as vitamin A, vitamin C, vitamin E, iron in sufficiently high amounts. Several studies have reported on the benefits of Moringa leaf extract against anemia prevention and genome health and nutritional status of pregnant women. Giving Moringa leaf extract can reduce the level of 8-OHdG as a marker of DNA damage in pregnant women in Gowa district, South Sulawesi. Intervention of Moringa leaf extract in addition to preventing DNA damage, can also prevent anemia and improve the nutritional status of pregnant women non-informal workers in Makassar City.[4] Other studies have shown that pregnant women who often consume vegetables such as Moringa leaves have higher antioxidant levels.[5] Previous studies have not reported the effect of Moringa leaf extract intervention on pregnancy outcomes. This study aimed to determine the effect of giving Moringa leaf extract to pregnant women on pregnancy outcomes.

Methods

Type and design

This study was an experimental study using *Randomized Double-Blind Controlled* design. Pregnant women who meet the inclusion criteria are divided into two groups randomly (*simple random sampling*). Pregnant women who received Moringa leaf extract were included into intervention group, while those received iron folate supplement (60 mg iron and 0.25 mg folate) were included into control group. The intervention was given for 12 weeks.

Population and sample

The population of this study were all pregnant women in the coastal area of Makassar City. The coastal area of Makassar City is divided into five sub-districts, namely Ujung tanah District, Tallo, Biringkanaya, Mariso and Tamalate. The participants were the second trimester pregnant women selected based on inclusion criteria as the following: 5–6 months gestational age, Hb levels >10.5 g/dl (not anemia), and no smoking.

Data collection

Data obtained in this study were demographics, nutritional intake, and infant anthropometric measurements at birth, such as weight, length, and head circumference (HC). Maternal nutrient intake during pregnancy was collected by the 24-h recall form. Children were weighed shortly after birth using Sigma digital electric scale. Birth length was measured using a length board, while HC was measured using tape.

Processing, analysis and presentation of data

Nutritional intake data was analyzed using NutriSurvey databases. Data analysis was carried out by univariate and bivariate. Data analysis was performed by comparing the mean of measurement result between treatment groups using the *t*-test.

Ethical considerations

This research was carried out after obtaining approval from the Ethics Commission of the Faculty of Medicine, Hasanuddin University. Before the implementation of measurements and interviews will be given an explanation of the actions to be taken for each respondent (pregnant women). After the explanation, the respondents were asked for approval to participate in this study by signing an *informed consent*.

Results

Table 1 shows the nutrient intakes of the participants. There was no significant different of nutrient intakes between intervention and control groups.

Table 2 shows the mean of anthropometric measurements of the participant. No differences were found between intervention and control group for weight, height, and mid upper arm circumference (MUAC).

Table 3 describe the result of anthropometric measurements of infant born to mother supplemented with MO (intervention group) and iron-folic acid (control group). There was no significant difference of birth weight, birth length, and head circumference between these groups.

Fig. 1 illustrates the prevalence of low birth weight (<2500 g) in intervention and control group. There was no significant difference between intervention and control group (8.6% vs. 11.4%).

Discussion

The focus of this study was to provide evidence regarding the effect of MO extract compared to iron-folic supplement. The finding of this study showed that low birth weight (LBW) in both groups was statistically not differed but indicated

Table 1 Nutrient intake of pregnant women.

Nutrients	Nutrients intake (mean ± SD)		p
	Intervention	Control	
Energy (kcal)	2096 ± 543	2077 ± 371	0.864
Protein (g)	68 ± 19	71 ± 20	0.434
Vitamin A (ug)	1075 ± 690	1315 ± 1570	0.409
Vitamin D (ug)	10 ± 6.7	11 ± 8.2	0.450
Vitamin E (eq)	6.4 ± 2.7	6.0 ± 2.8	0.576
Vitamin B1 (mg)	0.64 ± 0.21	0.65 ± 0.15	0.860
Vitamin B2 (mg)	0.92 ± 0.21	0.88 ± 0.40	0.674
Folate acid (ug)	154.6 ± 71.0	173.1 ± 82.2	0.318
Vitamin B12 (ug)	3.23 ± 1.58	4.41 ± 7.23	0.393
Vitamin C (mg)	46.84 ± 34.25	42.14 ± 31.56	0.551
Calcium (mg)	385.1 ± 1	383.7 ± 275.5	0.983
Phosphor (mg)	948.7 ± 287	1032 ± 279	0.219
Iron (mg)	7.1 ± 2.9	8.7 ± 3.95	0.57
Zinc (mg)	6.75 ± 2.26	8.69 ± 3.96	0.185

Table 2 Nutritional status pregnancy women.

Anthropometric size	Intervention	Control	p-Value
Weight (kg)	53.40 ± 9.791	51.09 ± 11.127	0.359
Height (cm)	151.06 ± 5.728	151.60 ± 5.672	0.696
MUAC (cm)	25.72 ± 3.300	25.13 ± 3.032	0.438

Table 3 Size of infant anthropometric of each group intervention.

Anthropometric size	Group	Mean ± SD	p Value
Birth weight (grams)	Intervention vs control	3104.57 ± 523022.29 ± 53	0.365[a]
birth body length (cm)	Intervention vs control	48.06 ± 2.4 48.68 ± 2.6	0.298[b]
Head circumference (cm)	Intervention vs control	33.72 ± 1.50 33.55 ± 1.47	0.637[b]

[a] Mann–U Whitney.
[b] Independent samples T-test.

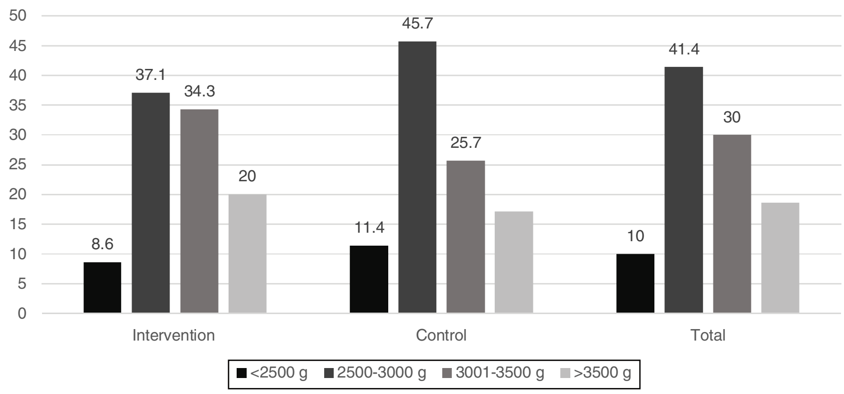

Figure 1 Birth weight categories.

that birth weight of infants born to mother received MO extract were 84 grams higher than in control group. Similarly, although the statistical test showed no significant difference in LBW prevalence, MO group tended to be lower than control group, meaning that at least MO extract may be potentially replacing iron supplement. Moringa leaves contain a number of essential amino acids that are very useful for the formation of fetal tissue growth and contain a number of micronutrients such as vitamin A, vitamin B complex, vitamin C, calcium, phosphorus, magnesium, copper.[6] Giving MO extract may help the pregnant women meet their nutritional needs improving their nutritional status. Previous studies have shown that MO extract can reduce stress levels and increase the size of MUAC in informal workers of pregnant women.[4] The weight growth of pregnant women who consumed MO extract experienced a significant increase in the last three months of pregnancy and did not differ from the weight of pregnant women who were intervened with iron folate capsules. Pregnant women who have good nutritional status especially in the last three months of pregnancy tend to give birth to babies with normal birth weight.

In this study, LBW prevalence is similar to the result of National Basic Health Research data survey in 2013 (10.2%) and slightly lower than prevalence in South Sulawesi (12.4%) and Makassar City (13.3%).[7] The occurrence of LBW is probably be related to high oxidative stress during pregnancy, which can be indicated from high level of Malondialdehyde level in the urine. Oxidative stress during pregnancy makes free radicals and other oxidative molecules are in the higher level than the amount of antioxidants in the body, affecting the growth and development of the fetus. Excessive free radicals in the blood will inhibit the ability of the process of signal vasodilation. Thus, it causes vasoconstriction (constriction and contraction of blood vessels) and reduce the blood circulation from mother to the fetus, leading to premature birth, preeclampsia and IUGR.[8]

Increased oxidative stress caused DNA damage which was marked by increasing the 8-OHdG level in both groups. DNA damage, especially those that occur during placental formation can inhibit fetal growth. The results of the regression analysis showed a significant correlation between BBL and 8-OHdG levels (before intervention). This result is in line with the results of previous studies which reported that the lower birth weight was found to be an 8-OHdG level in the increasingly umbilical cord.[9] The same finding was reported by Kim (2005) where 8-OHdG and MDA levels of pregnant women were negatively correlated with infant birth weight. The higher the level of 8-OHdG and MDA in the mother's urine, the lower the birth weight of the baby.[10]

MO extract containing rich vitamin A, vitamin C, vitamin E and some other micronutrients is known as the source of antioxidants. Antioxidants from MO leaves have a very strong ability to fight against free radicals, thus preventing hosts from oxidative damage and DNA damage. For pregnant women, antioxidants are needed to reduce the number of reactive compounds formed as the residue of metabolism, especially in late gestation periode.[11] MO intervention showed an increase in the nutritional status indicators of pregnant women in the intervention group similar to those received iron folate.[12] Free radicals in the form of *Reactive oxygen species* (ROS) formed during pregnancy will inhibit fetal growth. ROS that is not resolved during pregnancy can cause obstacles to fetal growth in the uterus, especially in the second trimester of pregnancy. Oxidative stress can inhibit fetal growth in the uterus, due to an increase in production carbonyl. The production of carbonyl can destroy proteins resulting in not fulfilling protein requirements so that eventually it causes Intrauterine Growth Restriction (IUGR) and DNA damage.[13]

Several previous studies carried out using the intervention of Moringa leaves showed an increase in nutritional status in children under five. Giving Moringa leaf flour in the diet of toddlers can increase the weight of malnourished children in Burkina Faso. Another study conducted in India reported an increase in nutritional status of malnourished children given MO powder. Likewise, in vitro research in mice showed that administration of MO flour for 30 days could increase levels of prealbumin, albumin, transferrin and retinol binding protein. Intervention of MO biscuit could increase weight, upper arm circumference in malnourished pregnant women. The results of this study indicate that the use of Moringa leaves can improve the nutritional status of the mother so that it can prevent the birth of low birth weight in infants. Moringa leaves can be used to increase nutrient intake to meet the antioxidant needs of pregnant women who can prevent IUGR and LBW.

Conclusion

The administration of MO extract in pregnant women has a similar effect to iron folate supplement in terms of preventing low birth weight. Therefore, MO extract can be used as an alternative to improve the pregnancy outcomes. A further study in investigating the effect of MO on other pregnancy outcomes is necessary including on mortality among mothers and neonates.

Conflict of interests

The authors declare no conflict of interest.

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