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Giving Moringa Soy Milk on Weight Gain and Upper Arm Circumference of Pregnant Women

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Abstract

Moringa oleifera leaves are a potential source of micronutrients and bioactive compounds in functional foods and nutraceuticals. This study aims to determine the effect of moringa soy milk on pregnant women's weight gain and mid-upper arm circumference (MUAC) as indicators of energy and protein nutritional status. This quasi-experimental study was conducted from February to April 2025 in the working area of the Jatibaru Community Health Center, Bima City. It was conducted on 30 pregnant women in their second to third trimesters with a MUAC <23.5 cm. Respondents were divided into two groups: the intervention group accepting 250 ml/day of moringa soy milk for 28 days, and the control group accepting local supplementary food. Data were analyzed using a paired t-test and chi-square tests. The results showed an increase in body weight of 2.00 kg and MUAC of 0.35 cm in the intervention group ($p<0.05$), higher than in the control group. The content of vegetable protein, iron, calcium, and vitamins in moringa soy milk plays a role in improving the nutritional status of pregnant women. These findings suggest that moringa soy milk may be an effective and affordable dietary intervention to prevent Chronic Energy Deficiency (CED) in pregnant women.

Introduction

Pregnancy is one of the most crucial phases in a woman's life cycle. During this period, nutritional needs increase along with the development of the fetus and the physiological changes experienced by the mother. (Ayushree *et al.*, 2020). A critical indicator during pregnancy is adequate maternal weight gain. Weight gain that does not comply with medical recommendations can trigger various pregnancy complications, such as preeclampsia, gestational diabetes, and premature birth (WHO, 2020). Research by Parrettini *et al.* (2020) and Tran *et al.* (2019) Shows that most pregnant women do not meet the recommendations for weight gain and nutritional intake, which can negatively impact the baby's birth weight and increase the risk of pregnancy complications such as preeclampsia, gestational diabetes, and premature birth. Therefore, monitoring the nutritional status of pregnant women is essential in efforts to reduce maternal and infant morbidity and mortality.

Chronic Energy Deficiency (CED) in pregnant women is still a high public health problem in Indonesia and other developing countries. The prevalence of CED in the study in Ethiopia was 28.7% (Dagne *et al.*, 2021), Nigeria 15.4%, Kenya 14.9%, and Gabon 13.4% (Sawadogo *et al.*, 2024). The prevalence of CED in pregnant women in Indonesia is reported to range from 14.8% to 32%, and can even reach 44.4% in some areas. It shows that it is still above the threshold of a public health problem (Izzati and Mutalazimah, 2022). CED in pregnant women is caused by an imbalance in energy and protein intake over a long period, which can increase the risk of pregnancy disorders such

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as anemia, bleeding, abnormal weight gain, and infection (Angraini *et al*., 2023; Harna *et al*., 2024).

Many studies have confirmed that the incidence of Chronic Energy Deficiency (CED) in pregnant women is highly influenced by inadequate nutrition, mainly energy and protein intake (Mahdiah and Tampubolon, 2023). One of the leading indicators for assessing the nutritional status of pregnant women is the Upper Arm Circumference (MUAC). A MUAC of less than 23.5 cm indicates a high risk of CED and is associated with the possibility of giving birth to a baby with low birth weight. In addition to MUAC, weight measurement is also used to assess energy adequacy during pregnancy, because weight gain that is not appropriate for gestational age can be a sign of nutritional problems (Mutalazimah *et al*., 2020).

Maternal nutritional status, especially during pregnancy, plays a crucial role in preventing CED and various health risks to infants (Helmizar *et al*., 2024; Kashyap *et al*., 2023). Research by Wati *et al*. (2024) stated that women of childbearing age who experience CED have a high risk of giving birth to children who also experience CED, and contribute to morbidity, mortality, and low quality of human resources. Meanwhile, Berhe *et al*. (2021) emphasized that maternal nutritional status before and during pregnancy affects the baby's birth weight, with the risk of premature birth or low birth weight (LBW) in mothers with low BMI. Furthermore, Olloqui-Mundet *et al*. (2024) found nutritional needs increase significantly in the second and third trimesters of pregnancy, so access to nutritious food is key to preventing CED.

One of the intervention approaches taken to overcome CED is the provision of additional food based on vegetable protein. In recent years, the consumption of vegetable protein sources like soybeans has increased significantly due to their high protein content and low saturated fat. Soy milk contains fiber, vitamins, and essential minerals such as calcium, magnesium, and vitamin B complex that support fetal growth and maternal health. Soy milk is also a necessary alternative for pregnant women who are lactose intolerant or at risk of obesity (Ariesthi *et al*., 2021; De and Goswami, 2022).

However, although soy milk has high nutritional value, its protein and micronutrient content can be further improved through fortification. One of the potential food ingredients as a fortifier is moringa leaves (Moringa oleifera). Moringa leaves contain high protein, essential amino acids, iron, calcium, and vitamins A and C. Previous studies have shown that consuming moringa can improve the nutritional status of children and improve protein intake in vulnerable groups (Srikanth *et al*., 2023; Chabibah *et al*., 2023). The combination of soy milk and moringa is a nutritional innovation used in nutritional recovery programs, including for pregnant women.

Providing Supplementary Feeding of biscuits often does not deliver optimal results, due to problems such as nausea and vomiting in pregnant women, irregular distribution, and lack of social support (Rahmiati, 2023). Therefore, alternative nutritional interventions that are highly nutritious, organoleptically acceptable to pregnant women, and producible locally are needed. Efforts to modify biscuit formulas, for example, by adding local ingredients such as purple sweet potatoes, cowpea sprout flour, sorghum, or anchovies and moringa leaves, have been shown to increase nutritional content, taste variation, and acceptability, so that it is expected to reduce boredom and improve the effectiveness of interventions (Picauly *et al*., 2023).

Several studies have shown that pregnant women's consumption of Moringa oleifera leaves is generally safe and does not cause significant side effects. Dantas *et al*. (2024) found that supplementation of Moringa leaf flour in pregnant rats did not cause weight disorders, abortions, or mutations in their offspring, and instead supported children's cognitive development. In a study by Ofulue and Ebomoyi (2023), the acute toxicity test of Moringa leaf alkaloid extract also showed no deaths or pregnancy disorders, and pregnancies continued normally in the treated group. In addition, several human studies outlined that Moringa leaves can increase hemoglobin levels and nutritional status of pregnant women without significant gastrointestinal side effects

(Ashfaq *et al*., 2024; Hadju *et al*., 2020; Usman *et al*., 2025; Yuliastuti and Kurnia, 2022). Thus, Moringa leaves have the potential to be an alternative food supplement that is highly nutritious and well-tolerated by pregnant women, especially for those who experience problems when consuming other supplements (Hadju *et al*., 2020; Hajar *et al*., 2024).

Previous studies have shown that moringa soy milk-based interventions in toddlers can significantly increase body weight and nutritional status (Chabibah *et al*., 2023). It opens opportunities to develop similar products for pregnant women with special needs as an alternative to supplementary feeding. In addition, moringa soy milk has advantages in terms of sustainable raw materials and low production costs, so that it can be integrated sustainably into community nutrition programs. Until now, few studies have specifically examined the effect of moringa soy milk on pregnant women's weight and upper arm circumference. Monitoring these two indicators is crucial to assessing the effectiveness of nutritional interventions in the short term. This study aims to determine the effect of moringa soy milk on increasing pregnant women's weight and MUAC size as a representation of energy and protein nutritional status.

Method

This study employs a quasi-experimental design with a pretest-posttest approach and a control group. The study took place at the Jatibaru Health Center, Bima City, from February to April 2025. The study population consisted of all pregnant women recorded in the Antenatal Care (ANC) visit book in August 2024. A sample of 30 respondents was selected non-probably through a purposive sampling technique, which was divided into two groups: the intervention and the control groups. Each group consisted of 15 respondents. The inclusion criteria in this study included pregnant women in the second and third trimesters, MUAC <23.5 cm, and willingness to participate in the entire series of studies. The exclusion criteria included pregnant women in the first trimester, having chronic diseases, taking certain medications or supplements, or refusing to follow the research protocol. Respondents who were not compliant or experienced conditions that prevented them from continuing were categorized as dropouts.

The intervention group was given 250 ml of moringa soy milk daily for 28 days. This milk is formulated from 33 g of dried soybeans, 3.5 g of moringa flour, 10 g of sugar, and 250 ml of water. Meanwhile, the control group only received local supplementary food from the health center program during the same period. Before and after the intervention, body weight and MUAC were measured using a Scale brand digital scale with an accuracy level of 95–98%. To monitor compliance, researchers provided daily reminders via WhatsApp and periodic home visits, and asked respondents to fill out a 24-hour food recall sheet daily. The respondents' families also assisted in monitoring milk consumption as quality control participants.

This study has obtained ethical approval from the Health Research Ethics Committee of the Faculty of Public Health, Hasanuddin University, Makassar, with protocol number 13125092014. Data was analyzed univariately to describe the characteristics of respondents and bivariately to assess the effectiveness of the intervention. The chi-square test was used to compare characteristics between groups, and the paired t-test was used to measure changes in the same group before and after the intervention.

Result and Discussion

This study used moringa soy milk that had been measured for nutritional content in the Food Chemistry Laboratory of the Faculty of Animal Husbandry, Hasanuddin University. The results found that protein was 5.75 mg, fat was 0.25 g, and carbohydrates were 25.62 g in 250 ml of moringa soy milk (Table 1). Other studies that have developed soy and moringa-based drinks have also shown that adding moringa leaves to soy milk can significantly increase protein, fat, and carbohydrate content, depending on the proportion of moringa used. A study by Matabura and Rweyemamu (2022) found that the increase in protein, fat, and carbohydrate levels can reach 49.77%, 8.59%, and 114.56% as the amount of moringa leaves added to soy milk increases. The increased protein, fat, carbohydrate, and mineral content

Table 1. Results of Macronutrient and Micronutrient Measurements of Moringa Soy Milk per 250 ml

Nutrition	Total Content
Macronutrients	
Protein	5.75
Fat	0.275
Carbohydrate	25.625
Micronutrients	
Calcium (mg)	131.93
Phosphorus (mg)	231.4
Iron (mg)	3.65
Sodium (mg)	73.19
Potassium (mg)	253.81
Copper (mg)	0.62
Zinc (mg)	1.32
Vitamin B1 (mg)	0.18
Vitamin B2 (mg)	0.03
Vitamin B3 (mg)	0.61

Source: Primary Data, 2025

Table 2. Respondent Characteristics (n=30)

Respondent Characteristics	Intervention (Provision of Moringa Soy Milk) (n=15)		Control (Provision of Local Supplemental Food) (n=15)		p-value*
	n	%	n	%	
Education					
Junior High School	0	0	3	10	
Senior High School	9	30	10	33.33	0.800
Bachelor	6	20	2	6.67	
Age					
<20 or >35 Years	3	10	3	10	0.674
20-35 Years	12	40	12	40	
Job					
Civil Servant	3	10	2	6.67	
Self-Employed	4	13.3	3	10	0.754
Housewife	8	26.67	10	33.33	
Gravida					
Primigravida	7	23.33	6	20	0.500
Multigravida	8	26.67	9	30	

* Chi-Square Test

Source: Primary Data, 2025

Table 3. Effect of Giving Moringa Soy Milk on Increasing Body Weight and Upper Arm Circumference of Pregnant Women

Variables	Mean ± SD		Increase	p-value*
	Pre Test	Post Test		
Weight				
Intervention (n=15)	43.86 ± 1.736	45.86 ± 1.818	2.00	0.000
Control (Local Supplemental Food Provision) (n=15)	43.21 ± 2.615	44.75 ± 2.361	1.54	0.000
MUAC				
Intervention (n=15)	21.87 ± 0.934	22.23 ± 0.938	0.35	0.000
Control (Local Supplemental Food Provision) (n=15)	21.42 ± 1.130	21.57 ± 1.170	0,14	0.318

* Paired t Test
Source: Primary Data, 2025

in soy milk and moringa can help overcome the problem of malnutrition (Ponka *et al*., 2022). The characteristics of the respondents in this study, both intervention and control groups, were homogeneous. Most respondents were aged 20–35, had a high school education, worked as housewives, and were multigravida. The Chi-Square test on age, education, occupation, and parity showed a p-value > 0.05, indicating no significant difference between groups, thus both groups could be compared equally in further analysis (Table 2).

This study showed a significant increase in body weight and MUAC in the intervention group after being given moringa soy milk, with a weight gain of 2.00 kg and MUAC of 0.35 cm ($p < 0.05$). Meanwhile, the control group also experienced an increase in body weight of 1.54 kilograms ($p < 0.05$), but the rise in MUAC of 0.14 cm was not significant ($p > 0.05$). The greater increase in the intervention group indicates the effectiveness in improving pregnant women's nutritional status (Table 3). It is in line with Matabura and Rweyemamu (2022) who found that moringa-soy drinks containing 30% and 40% moringa leaves can provide an estimated average requirement (EAR) for protein. Pregnant and lactating women can get an EAR for zinc of around 62% and 35% when drinking 600 and 800 ml/day, respectively. Several substances affect body weight. According to a study by Yunita *et al.* (2023), Carbohydrates, protein, and fat are energy sources from food needed to carry out activities. Carbohydrate intake produces energy used by the body in its metabolic processes. A lack of carbohydrates, protein, and fat can cause reduced energy needs. If this continues, the body will become thin, leading to chronic energy deficiency (CED).

The effectiveness of moringa soy milk in improving the nutritional status of pregnant women can be attributed to the high dietary content of soybeans and moringa leaves, such as protein, iron, calcium, and vitamins. Other studies have also shown that moringa-based products, such as yogurt or moringa leaf powder, can increase the content of protein, iron, and other minerals, vital for growth and development, and prevent anemia in pregnant women (Rotella *et al*., 2023). In addition, moringa supplementation during pregnancy is safe and has no side effects, so it can be an alternative, affordable, and easily accessible nutritional intervention, especially in areas with high levels of malnutrition (Ponka *et al*., 2022). Studies in Kenya (Attia *et al*., 2022) and Indonesia (Basri *et al*., 2022) also support the idea that moringa supplementation increases breast milk output, improves blood profiles, and reduces the prevalence of stunting in children born to mothers who received the intervention during pregnancy.

This study find that giving moringa soy milk can increase the weight of pregnant women according to the recommendations set by the Institute of Medicine (IOM) in 2009. Based on IOM guidelines, weight gain during pregnancy is adjusted to the mother's initial nutritional status based on the WHO classification, where underweight mothers are recommended to experience a total weight

gain of 12.5–18.0 kg, normal weight mothers 11.5–16.0 kg, overweight mothers 7.0–11.0 kg, and obese mothers 5.0–8.0 kg. Additionally, in the second and third trimesters, the recommended weekly weight gain ranges from 0.17 to 0.58 kg, depending on the nutritional status category. Giving moringa soy milk contributed to achieving weight gain within the recommended range, thus can help prevent the risk of complications such as fetal growth retardation, low birth weight, premature birth, and increased neonatal morbidity and mortality (Adeoye *et al*., 2023).

In this study, giving moringa soy milk to pregnant women effectively increased body weight as recommended weight gain during pregnancy. This finding shows more optimal results compared to several previous studies that assessed the effectiveness of the Supplemental Food Program in the form of biscuits for pregnant women with Chronic Energy Deficiency (CED). Research by Riandha Feliza *et al*. (2023) and Setyawati *et al*. (2024) showed that even though PMT biscuits had been given, there were still cases of CED pregnant women and insignificant weight gain. The significant increase in MUAC in the intervention group indicates an improvement in energy reserves and nutritional status of pregnant women, which are very important to support fetal growth and prevent pregnancy complications due to malnutrition (Derbo and Debelew, 2024). MUAC is a sensitive indicator for assessing the nutritional status of pregnant women, so this increase indicates the success of the intervention in meeting the mother's dietary needs (Febriza and Idrus, 2023). In terms of composition, moringa soy milk contains high-quality vegetable protein, fiber, and essential micronutrients such as iron and calcium, which play a role in the formation of red blood cells and bone health. The antioxidant content in moringa can also help increase the immune system of pregnant women and support optimal fetal development (Brar *et al*., 2022).

The nutritional content of Moringa leaves can meet ideal dietary needs, improve nutritional status, and support the body's anabolism, so that weight gain occurs (Islam *et al*., 2021). Moringa leaves do not contain harmful substances, so they are safe for consumption by children and adults. Pathophysiologically, weight gain due to consumption of Moringa leaves is mainly caused by increased protein and micronutrient intake that accelerates new tissue synthesis, improved nutritional status that supports optimal growth and development, and the anabolic effects of bioactive content that will enhance body metabolism and increase the efficiency of nutrient utilization (Kashyap *et al*., 2022). Local food-based interventions improve nutritional status and community food security. Zakaria *et al*. (2024) demonstrated that Plumeria rubra ointment effectively relieves mastitis pain in postpartum mothers, highlighting the potential of local herbal ingredients in improving maternal health. Azinar *et al*. (2018) emphasized the importance of local food-based nutrition education for pregnant women to improve consumption behavior during pregnancy, using the Prenatal Class Plus model. From the perspective of health workers, Putri *et al*. (2023) highlighted the role of preparedness of officers in rural areas in supporting the success of local nutrition intervention programs, such as the provision of moringa preparations. Rahman *et al*. (2024) also demonstrated that the consumption of local ingredients such as avocado extract positively impacts community nutritional status, similar to the role of moringa in this study. Furthermore, Tulak *et al*. (2018) emphasized the importance of adapting interventions to local geographic and social conditions for program effectiveness.

Consumption of moringa leaves in capsule, extract, or processed form, such as biscuits, has increased energy and macro and micro nutrient intake in vulnerable groups like pregnant women and children. This increase in nutrient intake supports protein synthesis and body tissue repair, thus contributing to increased muscle mass and subcutaneous fat tissue in the upper arm, as reflected by an increase in upper arm circumference (MUAC) (Fitriahadi *et al*., 2024; Frianti *et al*., 2022). Moringa leaves also increase hemoglobin levels and iron status, which improves oxygen transport to body tissues and supports cell metabolism, including muscle growth (Nur *et al*., 2020). The effect of increasing MUAC from consuming moringa leaves occurs because its

complete nutritional content improves energy intake, protein status, and body metabolism, thus supporting the growth of muscle and fat tissue in the upper arm (Nur *et al*., 2022).

Conclusion

Moringa soy milk is a promising nutritional intervention in improving the nutritional status of pregnant women, especially in cases of Chronic Energy Deficiency (CED). The combination of soybeans and moringa leaves produces a drink with high vegetable protein, iron, calcium, and vitamin content, and is safe to consume during pregnancy. Giving 250 ml of moringa soy milk daily for 28 days showed a significant increase in body weight and upper arm circumference of pregnant women, two important indicators of nutritional status. This effectiveness makes moringa soy milk an alternative supplementary food, which is highly nutritious, affordable, and well-accepted organoleptically by pregnant women. Furthermore, its widespread use in community nutrition programs has great potential to support the achievement of maternal and neonatal health targets, especially in areas with high CED prevalence. However, larger-scale and long-term intervention trials are needed to ensure the safety and sustainability of its benefits. Moringa soy milk appears to be a strong candidate for developing functional food products that support healthy pregnancies and a better quality of life for future generations.

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