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Effect of a Local Food–Based Menu Using Mackerel and Moringa Leaves on Hemoglobin Levels in Anemic Pregnant Women

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***Abstract*— *Introduction**: Maternal anemia remains a major public health concern in Indonesia, increasing the risk of pregnancy complications. Utilizing locally available foods offers a sustainable nutritional intervention. To evaluate the effect of a Local Food Based Menu (LFBM) comprising mackerel fish and moringa leaves on hemoglobin (Hb) levels among anemic pregnant women. **Methods**: A quasi-experimental pretest–posttest control group study in South Sulawesi, Indonesia, involved 96 anemic pregnant women purposively selected and assigned to three groups: control group (N = 32, iron–folic acid), mackerel-based diet group (N = 32), and moringa-based diet group (N = 32). Hemoglobin was measured pre- and post-intervention over seven days and analyzed using Wilcoxon and Kruskal–Wallis tests ($p < 0.05$). **Results**: After seven days of intervention, hemoglobin levels increased significantly within all groups (Wilcoxon, $p < .05$). The mackerel-based diet group showed the highest mean increase (1.9 g/dL), followed by the moringa-based diet group (1.4 g/dL), whereas the control group demonstrated only a modest rise (0.6 g/dL). **Analysis**: A Kruskal–Wallis test confirmed significant differences among groups after the intervention ($p < .05$), indicating that local food–based diets were more effective than iron–folic acid supplementation alone. **Discussion**: A local food–based menu using mackerel and moringa leaves effectively improved hemoglobin levels in anemic pregnant women. This approach may serve as an alternative strategy for locally based supplementary feeding programs in primary health care settings.*

***Keywords*—** *Maternal anemia; hemoglobin; pregnant women; local food intervention.*

I. INTRODUCTION

Anemia during pregnancy remains a leading public health problem worldwide, affecting nearly one-third of pregnant women and contributing significantly to maternal and perinatal morbidity and mortality (World Health Organization [WHO], 2021). Recent data show that Asia bears one of the highest burdens globally, with prevalence rates exceeding 35% in several Southeast Asian countries (Zhang et al., 2023). Persistent maternal anemia in Asia is linked to increased risks of preterm birth, low birth weight, impaired neonatal development, and elevated maternal mortality (Kang et al., 2022).

In Indonesia, the prevalence of anemia among pregnant women is alarmingly high, with national health surveys reporting rates of 48–50% in recent years (Kuntari & Supadmi, 2024). South Sulawesi is among the provinces with consistently elevated anemia prevalence, particularly in rural and island communities where access to diverse, iron-rich foods may be limited and reliance on staple grains remains high (Ministry of Health of Indonesia, 2023). Addressing anemia in such regions is critical for achieving national targets to reduce maternal mortality and improve neonatal outcomes.

Conventional iron-folic acid supplementation programs are widely implemented but face challenges such as gastrointestinal side effects, poor adherence, and uneven distribution (Susmita et al., 2023). Locally sourced dietary interventions may represent a more sustainable and culturally acceptable solution. South Sulawesi's coastal ecosystems provide abundant mackerel a rich source of heme iron and protein while Moringa oliefera (moringa) leaves, widely grown in the region, are packed with bioavailable iron, vitamin C, and other micronutrients that enhance iron absorption (Arifin et al., 2023; Setyawati et al., 2024). Combining these local ingredients into a menu intervention has shown promising results in improving nutritional status in pregnant women in other Indonesian settings (Setyawati et al., 2024).

Despite the recognized potential of local food–based approaches, there is a scarcity of controlled studies evaluating their effect on maternal hemoglobin (Hb) levels, especially in resource-limited island areas such as Tomia Timur in Wakatobi District, South Sulawesi. This study. Therefore, his study aimed to evaluate the effect of a Local Food–Based Menu (LFBM) consisting of mackerel fish and moringa leaves on hemoglobin (Hb) levels among anemic pregnant women. Specifically, it sought to: 1) compare changes in Hb levels between pregnant women receiving standard iron–folic acid tablets (control), mackerel-based intervention, and moringa-based intervention, 2) assess the feasibility of using locally sourced foods as an alternative or complementary strategy to improve maternal anemia in South Sulawesi, Indonesia.

II. MEHODS

A. Study Design and Setting

This study was a quasi-experimental study with a pretest–posttest control group design. The research was conducted from July to December 2024 at one of the public health centers in South Sulawesi, Indonesia.

B. Participants and Sampling

The study population comprised pregnant women with anemia (Hb < 11.0 g/dL) who were registered at the selected public health center in South Sulawesi. Using the Slovin formula to determine the required population size for a target sample of 96 participants (three groups of 32 each) with a 5%

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margin of error (e = 0.05), the minimum population required was calculated as approximately 126 pregnant women.

C. Sample

The final sample consisted of 96 eligible pregnant women with anemia, allocated equally into three groups (n = 32 per group):

1. Control group – received standard iron–folic acid tablets (Fe) only.
2. Intervention group 1 – received mackerel-based menu daily for 7 consecutive days, in addition to standard care.
3. Intervention group 2 – received moringa leaf–based menu daily for 7 consecutive days, in addition to standard care.

Eligibility criteria included: pregnant women in the second or third trimester, singleton pregnancy, Hb < 11.0 g/dL, no chronic medical conditions (e.g., diabetes, hypertension), no recent blood transfusion, and willingness to provide written informed consent. Participants who developed acute illness during the study or failed to adhere to the intervention were excluded from final analysis.

D. Sample Technique

Participants were identified by purposive sampling from the antenatal registry at the selected Puskesmas to find women who met the inclusion criteria. After obtaining informed consent and confirming eligibility, enrolled participants were randomly assigned to one of the three study groups (32 participants per group) using a simple randomization procedure (computer-generated random numbers)

E. Intervention Details

1. Control group: One standard Fe tablet containing 60 mg elemental iron and 400 µg folic acid per day, following Ministry of Health guidelines.
2. Mackerel menu: ~100 g cooked mackerel per day, prepared using local recipes to ensure acceptability.
3. Moringa menu: ~50 g fresh moringa leaves incorporated into standard dishes per day.

Participants maintained their usual diets apart from the interventions and were instructed to avoid additional iron supplements or fortified foods. Compliance with the assigned intervention was monitored daily, and participants were followed from baseline (day 0) to post-intervention (day 8).

F. Data Collection

Hemoglobin levels were measured using Haemometer devices on day 0 (baseline) and day 8 (post-intervention). Demographic and obstetric data (age, parity, gestational age, and nutritional status) were collected using structured interviews and antenatal records.

G. Ethical Considerations

Ethical approval was obtained from the STRADA Indonesia University Approval No. 000128/EC/KEPK/I/6/2024, 5 Juni 2024. All participants received information sheets and signed informed consent forms. Data confidentiality and the right to withdraw at any stage were guaranteed.

H. Statistical Analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics summarized participant characteristics and Hb levels. Shapiro–Wilk tests assessed normality. Within-group Hb changes were analyzed using the Wilcoxon signed-rank test. Between-group comparisons were analyzed using the Kruskal–Wallis test. Statistical significance was set at $p < .05$.

III. RESULTS

The respondent characteristics in this study included age, gestational age, parity, educational levels, and occupation (Table 1).

TABLE I. Respondent characteristics

Characteristics	Control (N=32)	Mackerel (N=32)	Moringa (N=32)	Total
Age (years)	23-35 (mean 28.4)	22-34 (mean 28.1)	24-26 (mean 28.7)	22-36 (mean 28.4)
Gestational age (weeks)	20-32 (mean 26.8)	21-33 (mean 27.1)	20-34 (mean 27.0)	20-34 (mean 27.0)
Parity				
- Primigravida	8 (25.0%)	14 (43.8%)	11 (34.4%)	33 (34.4%)
- Multigravida	24 (75.0%)	18 (56.2%)	21 (65.6%)	63 (65.5%)
Educational levels				
- Primary	8 (25.0%)	7 (21.9%)	9 (28.1%)	24 (25.0%)
- Secondary	17 (53.1%)	18 (56.3%)	16 (50.0%)	51 (53.1%)
- Higher	7 (21.9%)	7 (21.9%)	7 (21.9%)	21 (21.9%)
Occupation				
- Housewife	20 (62.5%)	21 (65.6%)	19 (59.4%)	60 (62.5%)
- Employed	12 (37.5%)	11 (34.4%)	13 (40.6%)	36 (37.5%)

A total of 96 pregnant women with anemia participated in the study, divided evenly into three groups of 32 participants each. The women's ages ranged from 22 to 36 years (mean ≈28 years), and gestational ages ranged from 20 to 34 weeks (mean ≈27 weeks). Regarding parity, most participants were multigravida (65.6% overall). The control group had the highest proportion of multigravida women (75.0%), while the mackerel-based diet group had the lowest (56.2%), indicating a greater share of primigravida in the mackerel group (43.8%). In terms of education, over half of the respondents had secondary education (53.1%), while about a quarter had only primary education (25.0%) and 21.9% had higher education. For occupation, the majority were housewives (62.5%), while the rest were employed (37.5%).

TABLE III. Mean Hemoglobin in Pre-test and Post-test

Group	Pre-test (g/dL)	Post-test (g/dL)	Δ Hb	Z	p value
Control	9.2±0.5	9.8±0.5	+0.6	-2.52	0.012
Mackerel	9.1±0.4	11.0±0.6	+1.9	-4.79	<0.001
Moringa	9.0±0.5	10.4±0.4	+1.4	-4.65	<0.001

Between-group comparison (Post-test Hb): Kruskal–Wallis H = 11.45, df = 2, p = 0.003

The mean hemoglobin levels before intervention did not different significantly across the three groups, indicating comparable baseline anemia status. After the seven-day intervention, all groups demonstrated increases in hemoglobin concentration. In the control group (iron–folic acid tablets), mean hemoglobin rose from 9.2 ± 0.5 g/dL at baseline to 10.0

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± 0.6 g/dL post-intervention, representing the smallest increase. The mackerel-based diet group showed the greatest improvement, with hemoglobin increasing from 9.1 ± 0.4 g/dL to 11.0 ± 0.6 g/dL. Similarly, the moringa-based diet group demonstrated a substantial rise from 9.0 ± 0.5 g/dL to 10.4 ± 0.4 g/dL. Wilcoxon tests indicated that the hemoglobin increase within each group was statistically significant ($p < 0.05$). Furthermore, a Kruskal–Wallis test of post-intervention hemoglobin revealed a significant difference between the three groups ($p < 0.001$), confirming that the local food-based interventions particularly the mackerel-based diet were more effective than standard iron folic acid supplementation.

IV. Discussion

A. Baseline Hemoglobin Levels Before Intervention

At baseline, the mean Hb levels of participants in all three groups control, mackerel based, and moringa based fell within the mild anemia range (approximately 9.1-9.7 g/dL). This similarity confirms that participant recruitment and group allocation were balanced, ensuring comparability before the intervention. Establishing equivalent baseline characteristics is essential for quasi-experimental studies to attribute observed effects specifically to the tested interventions rather than to pre-existing differences (Creswell & Creswell, 2023). The high prevalence of anemia observed before the intervention reflects broader regional and global trends. Globally, anemia in pregnancy remains a critical public health issue, with Southeast Asia carrying one of the highest burdens—prevalence rates range between 35% and 50% (World Health Organization [WHO], 2023). In Indonesia, national health data report that 48.9% of pregnant women are anemic, and the problem persists even in areas with access to supplementation programs (Ministry of Health of Indonesia, 2022). In South Sulawesi Province, surveillance data suggest anemia prevalence exceeds 45%, particularly in rural and coastal areas where dietary diversity may be limited (Sulawesi Provincial Health Office, 2023).

Several factors likely contributed to the low Hb levels before intervention. Nutritional deficiencies, especially inadequate intake of heme iron, are a primary determinant. In many communities in South Sulawesi, diets are heavily based on rice and cassava with minimal consumption of animal protein. Cultural dietary practices that restrict certain protein sources during pregnancy may further reduce iron intake (Rahman et al., 2022). Parasitic infections such as hookworm, frequent pregnancies with short birth intervals, and increased iron requirements during pregnancy exacerbate the problem (Ahmed et al., 2021). Limited socioeconomic resources and low health literacy may also delay the recognition and treatment of anemia.

The comparable baseline Hb levels are critical for validating the intervention results. They indicate that post-intervention improvements are more likely to be attributable to the mackerel-based and moringa-based diets rather than differences in initial health status. Additionally, the widespread mild anemia observed highlights the urgent need for food-based interventions that are locally available, culturally acceptable, and nutritionally rich. Mackerel, a common fish in Sulawesi, provides bioavailable heme iron, whereas moringa leaves are rich in non-heme iron, vitamin C, and other micronutrients that support iron absorption and erythropoiesis (Widyaningsih et al., 2023).

These findings align with previous studies demonstrating the effectiveness of locally sourced food in improving maternal nutrition and suggest that local food–based strategies may complement or even enhance standard iron–folic acid supplementation programs. From a public health perspective, screening for anemia during antenatal visits should remain a priority, particularly in high-prevalence areas like South Sulawesi. Programs should integrate nutrition education, food security initiatives, and culturally tailored dietary recommendations to address the multifactorial causes of anemia among pregnant women in Indonesia and similar contexts.

B. Post Intervention Hemoglobin Levels

After seven days of intervention, all three groups demonstrated significant increases in hemoglobin levels (Wilcoxon, $p < .05$). The mackerel-based diet group showed the highest mean increase (1.7 g/dL), followed by the moringa-based diet group (1.6 g/dL), while the control group (iron–folic acid tablets) had the smallest increase (0.7 g/dL). The Kruskal–Wallis test ($p < .05$) confirmed significant differences among groups after the intervention, suggesting that local food–based diets were more effective than supplementation alone.

Mackerel's efficacy is linked to its nutrient profile. It contains heme iron (≈1.3–1.7 mg/100 g) with high bioavailability (15–35%), vitamin B12 (8–12 µg/100 g) for erythropoiesis, and high-quality protein (19–21 g/100 g) to support hemoglobin synthesis (Rahman et al., 2022; U.S. Department of Agriculture [USDA], 2023). Mackerel is also rich in omega-3 fatty acids (EPA and DHA), zinc, and selenium, which enhance iron metabolism and maternal immune function, making it a potent local food option for addressing anemia.

The moringa-based diet also significantly increased hemoglobin levels. Moringa leaves contain abundant non-heme iron, vitamin C (enhancing iron absorption), and antioxidants that stimulate red blood cell formation (Widyaningsih et al., 2023). Similar studies in Kupang and Riau showed hemoglobin increases of 1–1.7 g/dL after moringa interventions (NHS Journal, 2023; Widyaningsih et al., 2023). Similar research found that moringa leaves was effective in increasing hemoglobin levels in postpartum women ($p = .001$), (Astutik, et., al, 2025).

The smaller increase in the control group may be related to adherence issues associated with iron–folic acid tablets, such as gastrointestinal discomfort or inconsistent use (WHO, 2023). Integrating mackerel and moringa-based meals into antenatal programs may improve compliance, leverage culturally accepted foods, and provide diverse micronutrients. This approach could strengthen maternal nutrition strategies and contribute to anemia reduction in South Sulawesi.

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V. CONCLUSION

This quasi-experimental study confirmed that mackerel- and moringa-based diets significantly increased hemoglobin levels in anemic pregnant women compared with iron–folic acid tablets alone. The mackerel group achieved the highest mean increase, followed closely by the moringa group, whereas the control group showed only modest improvement. These findings highlight the potential of local food–based interventions as culturally acceptable and sustainable strategies to address maternal anemia in South Sulawesi, Indonesia. Recommendations for further research – Larger-scale and longer-term studies across different regions are recommended to evaluate the sustainability, cost-effectiveness, and broader maternal–child health outcomes of local food–based interventions.

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