



Research Article

The Influence of Local Food Interventions in the Form of Goroho Bananas (*Musa acuminata*) and Skipjack Tuna (*Katsuwonus pelamis*) on Hemoglobin Levels of Pregnant Women at Danowudu Health Center

Yulieta Uada¹, Reny Retnaningsih^{2*}

¹ Undergraduate of Midwifery Study Program, Faculty of Health Sciences, Institute of Technology, Science, and Health RS dr Soepraoen, Malang, Indonesia

² Undergraduate of Midwifery Study Program, Faculty of Health Sciences, Institute of Technology, Science, and Health RS dr Soepraoen, Malang, Indonesia

*Correspondence Aauthor: renyretna@itsk-soepraoen.ac.id

Abstract. Anaemia in pregnancy is a significant public health issue that increases the risk of maternal and newborn complications. In addition to iron supplementation, indigenous foods rich in protein, iron, and essential micronutrients may serve as an adjunctive approach to improve haemoglobin levels. Goroho banana (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*) are local foods from North Sulawesi with nutritional properties that support haemoglobin formation. This study aimed to examine the effect of a local dietary intervention using goroho banana and skipjack tuna on haemoglobin levels among pregnant women at Danowudu Primary Health Center. A pre-experimental one-group pretest–posttest design was used. Thirty-two pregnant women were selected through purposive sampling. The study was conducted from March to May 2026. Haemoglobin levels were measured before and after the intervention and analyzed using a Paired Sample t-test with SPSS at a 95% confidence level. Mean haemoglobin increased from 10.13 ± 0.71 g/dL to 11.74 ± 0.75 g/dL, with a mean increase of 1.61 g/dL. The Paired Sample t-test showed a significant improvement ($p < 0.001$). The intervention significantly improved haemoglobin levels and may support anaemia prevention through local food-based nutritional counselling during antenatal care.

Keywords: Anemia; Goroho Banana; Hemoglobin; Local Food; Pregnant Women.

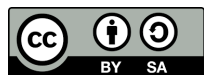
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1. Background

Anaemia in pregnancy constitutes a major global public health concern because to its association with elevated morbidity and mortality rates for both mothers and infants. This disorder is marked by diminished haemoglobin levels, leading to a reduced ability of the blood to convey oxygen to bodily tissues, which may jeopardise the mother's health and the fetus's development (WHO, 2024). It is estimated that over one-third of pregnant women worldwide suffer from anaemia, with a greater frequency in developing nations than in industrialised ones (Stevens et al., 2022; Nurlaela et al., 2024). Anaemia in pregnancy is linked to a heightened risk of preterm birth, low birth weight, foetal development restriction, postpartum haemorrhage, and increased maternal and newborn death (Black et al., 2023).

Anaemia among pregnant women in Indonesia continues to be a significant health concern that necessitates urgent attention, despite the government's implementation of different preventative measures. The findings of the 2023 Indonesian Health Survey reveal that the incidence of anaemia among pregnant women persists at a notably elevated level, serving as a critical indicator in initiatives aimed at enhancing maternal and child health (Ministry of Health of the Republic of Indonesia, 2024). The elevated prevalence of anaemia suggests that the administration of iron supplements tablets has not adequately met the iron requirements throughout pregnancy, unless it is complemented by enhancements in the intake of nutritious and balanced meals (Sari et al., 2021). Consequently, supplementary efforts employing local food sources are necessary to enhance haemoglobin levels in pregnant women (Permatasari et al., 2022; Ringgi et al., 2025).

Haemoglobin levels in pregnant women are affected by multiple factors, such as iron intake, protein, vitamin B12, folic acid, vitamin C, nutritional status, gestational age, compliance with iron supplementation, and the occurrence of concurrent infectious illnesses

(Alem et al., 2023). Iron is the primary constituent in haemoglobin creation, whereas protein is involved in erythrocyte synthesis and iron transit inside the body (Bourre, 2020). Moreover, vitamin C is recognised for its capacity to augment the absorption of non-heme iron in the gastrointestinal system, thus enhancing the availability of iron for erythropoiesis (Abbaspour et al., 2019; Rukmana et al., 2024). Consequently, the intake of meals rich in iron, protein, and vitamins that enhance iron absorption is crucial for sustaining haemoglobin levels during pregnancy (Abdilahi et al., 2024).

Numerous studies indicate that local food-based interventions can effectively enhance haemoglobin levels in at-risk populations, including pregnant women. Animal protein sources, such as fish, are recognised for their ability to elevate haemoglobin levels due to their heme iron content, which is absorbed more efficiently than non-heme iron from plant sources (Costa et al., 2023). Skipjack tuna (*Katsuwonus pelamis*) is a fishery commodity abundant in protein, iron, vitamin B12, and vital amino acids, which contribute to the development of red blood cells (Mamuaja et al., 2020). Gorocho bananas (*Musa acuminata*) are a regional delicacy in North Sulawesi, rich in carbohydrates, vitamin C, and numerous minerals that facilitate haemoglobin synthesis and improve iron absorption in the body (Koni et al., 2019). The amalgamation of these two food constituents may have a synergistic effect in elevating haemoglobin levels in pregnant women (Abdilahi et al., 2024).

While numerous studies have demonstrated the efficacy of iron supplementation and specific dietary intake in enhancing haemoglobin levels, research assessing the synergistic effects of gorocho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*) as a localised food-based intervention remains significantly scarce. Prior research has predominantly concentrated on pharmaceutical supplementation, food fortification, or the utilisation of a singular food type to mitigate anaemia throughout pregnancy (Rahmawati et al., 2021). Moreover, scientific evidence about the utilisation of a mix of native food sources characteristic of North Sulawesi to enhance haemoglobin levels in pregnant women has not been extensively documented in national or international scientific literature (Permatasari et al., 2022; Verisca et al., 2024). The research gap signifies the necessity for additional investigations into the efficacy of combining these two food sources as a practical and sustainable nutritional intervention alternative (Costa et al., 2023).

The operational zone of the Danowudu Health Center possesses a plentiful availability of gorocho bananas and skipjack tuna, readily accessible to the population, hence serving as viable local food supplies to bolster anaemia prevention initiatives for pregnant women (Bitung City Health Office, 2024). To date, no research has precisely assessed the impact of the combination of these two food ingredients on the haemoglobin levels of pregnant women in the region (Bitung City Health Office, 2024). This study seeks to evaluate the effects of local food interventions, specifically gorocho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*), on the haemoglobin levels of pregnant women at the Danowudu Health Center, thereby providing a foundation for the development of effective, economical, and sustainable local food-based nutritional strategies to prevent anaemia during pregnancy.

2. Research Method

Design

This study employs a pre-experimental design utilising a one-group pretest-posttest methodology. This design aims to assess the impact of local food interventions involving gorocho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*) on the haemoglobin levels of pregnant women by measuring levels before and after the intervention. All participants underwent identical therapy without a control group, and haemoglobin levels were assessed at the study's commencement (pretest) and following the intervention's conclusion (posttest).

Location and Time Research

The study was carried out in the Danowudu Health Center in Bitung City, North Sulawesi Province, from March to May 2026. The research area was chosen due to the presence of pregnant women as subjects and the accessibility of native food sources, including gorocho bananas and skipjack tuna, readily available to the population.

Population and Sample

The study population included all pregnant women receiving prenatal checkups at Puskesmas Danowudu throughout the research period. The research sample comprised 32 pregnant women recruited through purposive sampling methods based on established criteria. The inclusion criteria comprise pregnant women in their second trimester, individuals wanting to participate in the study, those capable of consuming the provided intervention, and participants who can adhere to the complete research protocol until its conclusion. Exclusion criteria encompass pregnant women with significant pregnancy difficulties, those

afflicted with chronic conditions that may influence haemoglobin levels, or individuals who do not complete the intervention program by the study's conclusion.

Variable

The independent variable in this study is the local food intervention, namely the intake of goroho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*), whereas the dependent variable is the haemoglobin level of pregnant women, quantified in grams per decilitre (g/dL). Furthermore, data regarding respondent characteristics were obtained, encompassing age, gravida, gestational age, education, occupation, weight, height, body mass index (BMI), adherence to the intervention consumption, and complaints during the research implementation.

Instrument

This study utilised a respondent characteristic sheet, an intervention consumption compliance monitoring sheet, and a haemoglobin testing tool to assess haemoglobin levels pre- and post-intervention. Data on respondent characteristics were acquired through interviews and records from the cohort book of pregnant women, whereas compliance data were collected via monitoring sheets completed during the intervention period.

Procedure

The research commenced with an elucidation to the potential respondents concerning the study's objectives and methodologies, alongside the execution of the consent form to participate as respondents. Subsequently, data collection regarding respondent characteristics and initial haemoglobin levels (pretest) was executed. Following the initial measurement, participants received an intervention involving the consumption of goroho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*) in accordance with the predetermined parameters throughout the research duration. Consumption compliance was frequently assessed via a monitoring sheet. Upon the conclusion of the intervention period, a follow-up haemoglobin level assessment (posttest) is performed utilising the identical methodology as the first examination. All acquired data were subsequently documented and organised for the analytical process.

Data Analysis

Data analysis was performed with the Statistical Package for the Social Sciences (SPSS) software. Univariate analysis is employed to delineate the attributes of respondents and haemoglobin levels through frequency distribution, percentage, mean, and standard deviation. Bivariate analysis assesses the impact of the intervention on the haemoglobin levels of pregnant women by comparing haemoglobin values pre- and post-intervention. The statistical method employed is the Paired Sample t-test with a 95% confidence level ($\alpha = 0.05$). Results are deemed significant if a p-value of less than 0.05 is achieved.

3. Results And Discussion

Results

Characteristics Respondent

The attributes of the respondents are delineated to furnish an overview of the profile of pregnant women who are the subjects of the study. The examined attributes encompass age, educational attainment, profession, and gravida status. Table 1 illustrates the distribution of the respondents' attributes.

Table 1. Characteristics of Research Respondents (n = 32).

Characteristics	n	%
Age		
< 20 years	5	15,6
20–35 years	22	68,8
> 35 years	5	15,6
Education		
High School	19	59,4
Bachelor's Degree	13	40,6
Occupation		
Housewife	13	40,6
Private employe	14	43,8
Civil Servants	5	15,6
Status gravida		
Primigravida	10	31,2
Multigravida	22	68,8

Description of Respondents' Anthropometric Status

The anthropometric status of the respondents was assessed to offer an overview of the physical condition of pregnant women prior to the intervention's implementation. The

examined characteristics encompass weight, height, and body mass index (BMI). The analysis findings are displayed in Table 2.

Table 2. Description of Respondents' Anthropometric Status (n = 32).

Variable	Mean $\pm$ SD	Minimum	Maximum
Body weight (kg)	60,28 $\pm$ 4,39	53,00	69,00
Height (cm)	159,22 $\pm$ 3,06	154,00	165,00
Body Mass Index (kg/m ²)	23,78 $\pm$ 1,66	20,76	27,55

According to Table 2, the mean weight of the respondents is 60.28 $\pm$ 4.39 kg, with a minimum weight of 53.00 kg and a maximum weight of 69.00 kg. The mean height of the respondents is 159.22 $\pm$ 3.06 cm, with a height range of 154.00 cm to 165.00 cm. The respondents' average body mass index (BMI) is 23.78 $\pm$ 1.66 kg/m², with a minimum of 20.76 kg/m² and a high of 27.55 kg/m². The results reveal that most respondents had an anthropometric status within the normal to mildly overweight range, suggesting that their dietary condition prior to the intervention is adequate to facilitate the research implementation.

Overview of Intervention Implementation

The intervention's execution was examined to assess the local food consumption patterns, respondent compliance levels, and complaints encountered during the intervention process. The findings of the intervention implementation analysis are displayed in Table 3.

Table 3. Description of Intervention Implementation in Respondents (n = 32).

Variable	n	%
Frequency of goroho banana consumption		
1 time/day	11	34,4
2 times/day	14	43,8
3 times/day	7	21,9
Frequency of skipjack tuna consumption		
1 time/day	30	93,8
2 times/day	2	6,2
Adherence to the intervention		
85%	9	28,1
90%	1	3,1
95%	15	46,9
100%	7	21,9
Complaints during the intervention		
No complaints (0%)	7	21,9
Mild complaints (5%)	15	46,9
Moderate complaints (10%)	1	3,1
Higher complaints (15%)	9	28,1

According to Table 3, the predominant consumption pattern among respondents is twice daily, with 14 individuals (43.8%) partaking in goroho bananas. In contrast, 11 individuals (34.4%) take them once daily, while 7 individuals (21.9%) consume them thrice daily. The majority of respondents, 30 individuals (93.8%), consume skipjack tuna once daily, whereas only 2 individuals (6.2%) consume it twice daily. The majority of respondents exhibited a 95% adherence rate, with 15 individuals (46.9%), followed by 85% adherence with 9 individuals (28.1%), 100% adherence with 7 individuals (21.9%), and 90% adherence with 1 individual (3.1%). During the intervention's implementation, most respondents reported only modest complaints, shown by a complaint score of 5%, corresponding to 15 individuals (46.9%). Simultaneously, 7 individuals (21.9%) reported no problems, 1 individual (3.1%) encountered mild complaints, and 9 individuals (28.1%) indicated complaints with a score of 15%.

Description of Hemoglobin Levels Before and After Intervention

Haemoglobin levels were measured before to (pretest) and following (posttest) the implementation of local dietary treatments involving goroho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*). A descriptive analysis was performed to examine the alterations in respondents' haemoglobin levels prior to and during the intervention. The analysis findings are displayed in Table 4.

Table 4. Description of Hemoglobin Levels Before and After Intervention (n = 32).

Measurement Time	Mean $\pm$ SD (g/dL)	Minimum	Maximum
Before intervention	10,13 $\pm$ 0,71	8,90	11,50
After intervention	11,74 $\pm$ 0,75	10,20	13,10

According to Table 4, the average haemoglobin level of pregnant women prior to the local food intervention including goroho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*) was 10.13 $\pm$ 0.71 g/dL, with a minimum of 8.90 g/dL and a maximum of 11.50 g/dL. Post-intervention, the mean haemoglobin level rose to 11.74 $\pm$ 0.75 g/dL,

with a minimum of 10.20 g/dL and a maximum of 13.10 g/dL. The results indicate a rise in the average haemoglobin level of 1.61 g/dL following the intervention, signifying an enhancement in haemoglobin status among pregnant women over the research period.

The Influence of Local Food Interventions on Hemoglobin Levels in Pregnant Women

Bivariate analysis was performed to assess the impact of local food interventions, specifically goroho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*), on the haemoglobin levels of pregnant women. The Paired Sample t-test was employed for the analysis as the data consisted of two paired measures from the same respondents. The outcomes of the statistical analysis are displayed in Table 5.

Table 5. Results of the Paired Sample t-test Analysis of Hemoglobin Levels Before and After Intervention (n = 32).

Variable	Mean $\pm$ SD (g/dL)	Selisih Mean	Nilai <i>t</i>	<i>p</i> -value
Before intervention	10,13 $\pm$ 0,71			
After intervention	11,74 $\pm$ 0,75	1,61	10,253	<0,001

According to Table 5, the average haemoglobin level of pregnant women rose from 10.13 $\pm$ 0.71 g/dL prior to the intervention to 11.74 $\pm$ 0.75 g/dL subsequent to the intervention, reflecting an average rise of 1.61 g/dL. The analysis employing the Paired Sample t-test yielded a t-value of 10.253 and a p-value < 0.001, indicating a statistically significant difference in haemoglobin levels before and after the intervention involving local food, specifically goroho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*). The results demonstrate that the intervention implemented effectively elevated haemoglobin levels in pregnant women at Puskesmas Danowudu.

Discussion

The research findings indicate that local food interventions involving goroho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*) can markedly elevate the haemoglobin levels of pregnant women. The mean haemoglobin level rose from 10.13 $\pm$ 0.71 g/dL prior to the intervention to 11.74 $\pm$ 0.75 g/dL subsequent to the intervention, reflecting an average rise of 1.61 g/dL ($p < 0.001$). The findings suggest that the intake of locally abundant nutritious foods may facilitate haemoglobin synthesis during pregnancy. The rise suggests that local food-based interventions may function as a supplementary alternative to iron tablet supplementation, which has been the primary strategy for preventing anaemia in pregnant women. The community-centric food approach is deemed more feasible to execute as it employs locally available food ingredients, potentially enhancing adherence to consumption compared to programs reliant purely on supplements (Daru et al., 2020).

The elevation in haemoglobin levels in this study aligns with other prior studies indicating that local food-based nutritional interventions can enhance the haemoglobin status of pregnant women. Gernand et al. (2021) demonstrate that elevated intake of animal protein during gestation correlates with enhanced haemoglobin levels and a diminished likelihood of anaemia. A study conducted by Ahmed et al. (2022) demonstrated that integrating nutrition education with the intake of iron-rich foods produced superior outcomes compared to exclusive reliance on iron supplementation. Research in Indonesia demonstrates that the incorporation of local foods as nutritional treatments correlates with elevated haemoglobin levels following the consumption of protein-, iron-, and vitamin-rich foods that enhance iron absorption. The congruence of these findings underscores that the utilisation of local foods might serve as an effective approach to meet nutritional requirements during pregnancy (Ahmed et al., 2022; Gernand et al., 2021).

The efficacy of the intervention in this study is presumed to be associated with the nutritional profile of skipjack tuna (*Katsuwonus pelamis*), which provides high-quality animal protein and is rich in heme iron, vitamin B12, vitamin B6, and numerous essential amino acids. Heme iron exhibits a superior absorption rate compared to non-heme iron from plants, facilitating its utilisation in erythropoiesis. Moreover, protein is crucial to the synthesis of the globin chain, which constitutes the primary component of haemoglobin. Proper protein availability facilitates the production of new erythrocytes, thereby enhancing haemoglobin concentration physiologically. Consequently, the consistent intake of skipjack tuna throughout the intervention period is presumed to be a contributing factor to the elevation of haemoglobin levels in the participants (Camaschella, 2021; Stoffel et al., 2020).

Besides skipjack tuna, goroho bananas (*Musa acuminata*) are also thought to enhance haemoglobin levels. Goroho bananas provide complex carbs for energy, vitamin C, potassium, and several micronutrients that facilitate metabolic processes during pregnancy. Vitamin C is recognised for its significant role in improving the absorption of non-heme iron by reducing ferric ions to ferrous ions, hence facilitating absorption in the small intestine. Despite having a lower iron level than animal protein sources, goroho bananas are thought to improve the absorption of iron from both dietary sources and supplementation in pregnant

women due to their vitamin C content. The amalgamation of skipjack tuna, providing heme iron and protein, with goroho bananas, which supply vitamins that enhance iron absorption, is hypothesised to create a synergistic effect on elevating haemoglobin levels (Lynch et al., 2021; Hurrell & Egli, 2020).

The attributes of the responders are also considered to influence the efficacy of the intervention. The majority of respondents are within a healthy reproductive age, possess an adequate nutritional state as indicated by body mass index, and demonstrate a high degree of adherence to the intervention consumption. These settings facilitate optimal nutrition metabolism, hence promoting haemoglobin synthesis. The significant adherence among responders during the trial is a crucial feature that elucidates the rise in haemoglobin levels. Numerous studies indicate that the efficacy of nutritional interventions is determined not only by the kind of the food ingested but also by the regularity of consumption during the intervention period. Increased adherence to the intervention program among respondents correlates with a higher likelihood of improving haemoglobin status (Sunuwar et al., 2022).

This study, despite yielding strong results, possesses some drawbacks. The study employed a pre-experimental one-group pretest-posttest design, without a control group for comparative analysis. The increase in haemoglobin levels cannot be exclusively ascribed to the intervention, as other factors, like daily food habits, compliance with iron tablet intake, or physiological alterations during pregnancy, may also exert effect. The research was conducted at a single community health center with a small respondent pool, hence the findings cannot be generalised to a wider population. Nonetheless, the substantial rise in haemoglobin levels observed suggests that local food-based treatments had considerable potential to be established as a supplementary program within antenatal services, particularly in regions with ample local food resources. It is advisable to conduct additional research utilising a quasi-experimental design or randomised controlled trial with an expanded sample size and extended intervention duration to acquire more robust scientific evidence concerning the efficacy of the combination of goroho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*) in elevating haemoglobin levels in pregnant women (WHO, 2024).

4. Conclusion And Suggestions

This study demonstrates that local dietary interventions involving goroho bananas (*Musa acuminata*) and skipjack tuna (*Katsuwonus pelamis*) significantly enhance haemoglobin levels in pregnant women at the Danowudu Health Center. The data suggest that including indigenous foods abundant in protein, iron, and essential micronutrients may serve as an adjunctive approach in the prevention and control of anaemia in pregnancy. The accessibility and alignment with community consumption patterns of these two food ingredients may enhance the iron tablet supplementation initiative in antenatal care, thereby sustainably improving the nutritional status and health of pregnant women. Consequently, healthcare professionals are anticipated to incorporate teaching on the utilisation of local cuisine in nutritional counselling throughout pregnancy. Future research should employ a study design that includes a control group, utilise a larger sample size, and assess the intervention's effects on additional maternal and neonatal outcomes, thus yielding more comprehensive scientific evidence on the efficacy of local food interventions for pregnant women.

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