

The effect of sugar-free candy made from moringa leaves (Ironella Candy) on hemoglobin levels in students with anemia

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ABSTRACT

Background: The food-based approach strategy is a nutritional intervention that is highly acceptable, effective, and affordable, making it suitable for addressing anemia.

Aim: To assess the effect of sugar-free candy made from moringa leaves (Ironella Candy) on the hemoglobin levels of students with anemia.

Materials and Methods: This study is a randomized controlled trial with a pretest-posttest design with a control group. 35 respondents with moderate and mild anemia were selected. The respondents were then randomized into two groups: the intervention group who received sugar-free candy made from moringa leaves accompanied by anemia education, and the control group who received placebo candy accompanied by anemia education. Hemoglobin levels were measured at three time points: before intervention (pre-intervention), immediately after intervention (post-intervention 1), and one month after intervention (post-intervention 2). Data analysis used the Wilcoxon test and Mann Whitney test.

Results: The Wilcoxon test showed an increase in hemoglobin levels in the intervention group after administration of sugar-free candy made from moringa leaves and anemia education ($p < 0.001$). In contrast, in the control group that received placebo candy and anemia education, the increase in hemoglobin levels was not significant ($p = 0.092$). Although hemoglobin levels increased in the intervention group, the Mann-Whitney test showed no significant difference in hemoglobin levels between the two groups either post intervention 1 ($p = 0.354$) or post intervention 2 ($p = 0.853$).

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Study Limitations: Sugar-free candy made from moringa leaves, accompanied by education about anemia, has been shown to increase hemoglobin levels in students suffering from anemia, although the increase was not significant. Further research with longer intervention periods and additional biomarker measurements is needed to strengthen the evidence of its effectiveness.

KEYWORDS

Dietary Intervention, Functional Foods, Iron Deficiency Anemia, *Moringa Oleifera*, Women of Childbearing Age.

INTRODUCTION

According to WHO 2019, the global prevalence of anemia in women of childbearing age is 29.9%, equivalent to more than half a billion women aged 15-49 suffering from anemia¹. In 2021, the number of anemia cases in women of childbearing age globally was 571,000 cases, while in Indonesia it reached 31.2% or equivalent to 244,000 cases². The WHO estimates that half a billion women aged 15-49 years suffer from anemia worldwide, with Africa and Southeast Asia being the regions with the highest prevalence of anemia, namely around 106 million women with anemia in Africa and around 244 million women with anemia in Southeast Asia³. According to Basic Health Research 2018, the prevalence of anemia among 15-24 year olds in Indonesia reached 32%⁴.

One local food that contains many vitamins and minerals is moringa leaves (*Moringa Oleifera*). Moringa leaves are rich in vitamin A, vitamin C, vitamin B complex, calcium, iron, and easily digestible protein⁵. Consuming moringa leaves is one alternative for addressing cases of malnutrition in Indonesia. Moringa is also a plant that is commonly found in many areas at an affordable price, and we can even cultivate moringa plants ourselves at home.

According to research highlighted that students at 'Aisiyah University Surakarta showed an average hemoglobin level increase of 1.242 g/dL, from 11.034 g/dL before the intervention to 12.276 g/dL after the intervention. The Wilcoxon test results in this study showed that moringa leaf extract had an effect on increasing hemoglobin levels in adolescent girls with a p-value of 0.004 (p-value <0.05)⁶. Research on the nutritional content of chicken liver and moringa flour-based meatballs has also proven effective. This was evidenced by an increase in hemoglobin levels after the samples were given the intervention from 10.35 g/dL to 12.08 g/dL and 10.30 to 11.63 g/dL, respectively, with p-values < 0.05. Although the difference between the two groups was not statistically significant, the effect of chicken liver and moringa flour-based meatballs was greater than that of beef meatballs on hemoglobin levels⁷.

Based on the researchers' observations, there have been many moringa-based studies, but there have been no specific studies on sugar-free candy for women of childbearing age or students at the research site. Students today prefer to consume various types of snacks between meals, which are not necessarily healthy. The reason for choosing sugar-free candy in this study is because sugar-free candy is a food commonly consumed by teenagers and women of childbearing age, so it can be used in intervention programs. In addition, sugar-free candy is also more easily accepted and liked by almost all segments of society because it has a pleasant taste and can be used as a snack⁸. Therefore, this study tested sugar-free candy made from moringa leaves (Ironella Candy) on women of childbearing age (in this case, female students) with anemia as an alternative means of increasing hemoglobin levels.

MATERIALS AND METHODS

Study design and population

This type of research is a Randomized Control Trial with a pretest-posttest with Control Group Design. The research was conducted at the Faculty of Public Health, Indonesian Muslim University, from May to July 2025. The population in this study consisted of all active female undergraduate students, totaling 148 individuals. From this population, 30 respondents were selected using a sample calculation formula. To prevent dropouts, the intervention group and control group were increased by 20%, bringing the total sample size to 40 respondents. The sample size for the intervention group and control group was 20 people each. During the study, 5 respondents were excluded from the study because they met the exclusion criteria and dropout criteria, bringing the total sample size to 35 respondents (Figure 1).

Sample collection and preparation

The tools used in this study included written consent forms, respondent characteristic forms, hemoglobin data sheets, compliance monitoring sheets, and hemoglobin measurement

equipment (Easy Touch GCHb). Data collection began with hemoglobin screening to identify participants with mild to moderate anemia, followed by the completion of respondent characteristic forms. The intervention group received sugar-free moringa leaf candy (Ironella Candy) and nutrition education through leaflets for 30 days, while the control group received placebo candy with the same educational materials. After 30 days, hemoglobin levels were remeasured in both groups (post-intervention¹). A follow-up measurement (post-intervention²) was conducted 30 days later to assess the sustained effect of the intervention on hemoglobin levels.

Sugar-free candy formula based on moringa leaves (Ironella Candy)

The selected sugar-free candy formula is the result of previous research by Phitoyo (2025)⁹, namely F3 (80% isomalt + 15% moringa leaf powder + 2.5% lemon + 2.5% ginger 2.5%). One candy weighs 2.5 grams. In this study, 5 candies will be given per day for 30 days. The nutritional content, namely carbohydrates, fats, proteins, iron, and zinc in one sugar-free candy made from moringa leaves in the selected formula (F3) are 2.18 gr, 0.03 gr, 0.14 gr, 0.117 mg, and 0.006 mg, respectively. Top of Form

Implementation of intervention

Samples were taken based on the results of initial screening (pre-intervention), namely respondents suffering from mild and moderate anemia, then randomly divided into two groups, namely the intervention group and the control group (the sample randomization system used a spinning wheel application). Randomization was carried out by researchers before the intervention was given using a simple randomization method. The intervention group was given sugar-free candy made from moringa leaves (Ironella candy) accompanied by education about anemia. Each respondent was given 5 candies per day for 30 days (candies and consumption control cards were given once a week, and respondents filled out the control cards every day; after a week, the remaining candies and completed control cards were returned to the researchers, who then provided new candies and control cards, and so on until the end of the study). Respondents were given consumption reminders twice a week via a WhatsApp group. To calculate the consumption compliance rate, a pill calculation formula was used. The control group was given placebo candies (ginger candies purchased through the Shopee app) accompanied by education about anemia. Each respondent was given 5 placebo candies per day for 30 days (placebo candies were given once a week and were not monitored using a consumption control card, only consumption reminders were sent twice a week via a WhatsApp group).

Education about anemia in this study was provided through a series of planned and structured activities to ensure that all respondents received consistent information in line with the

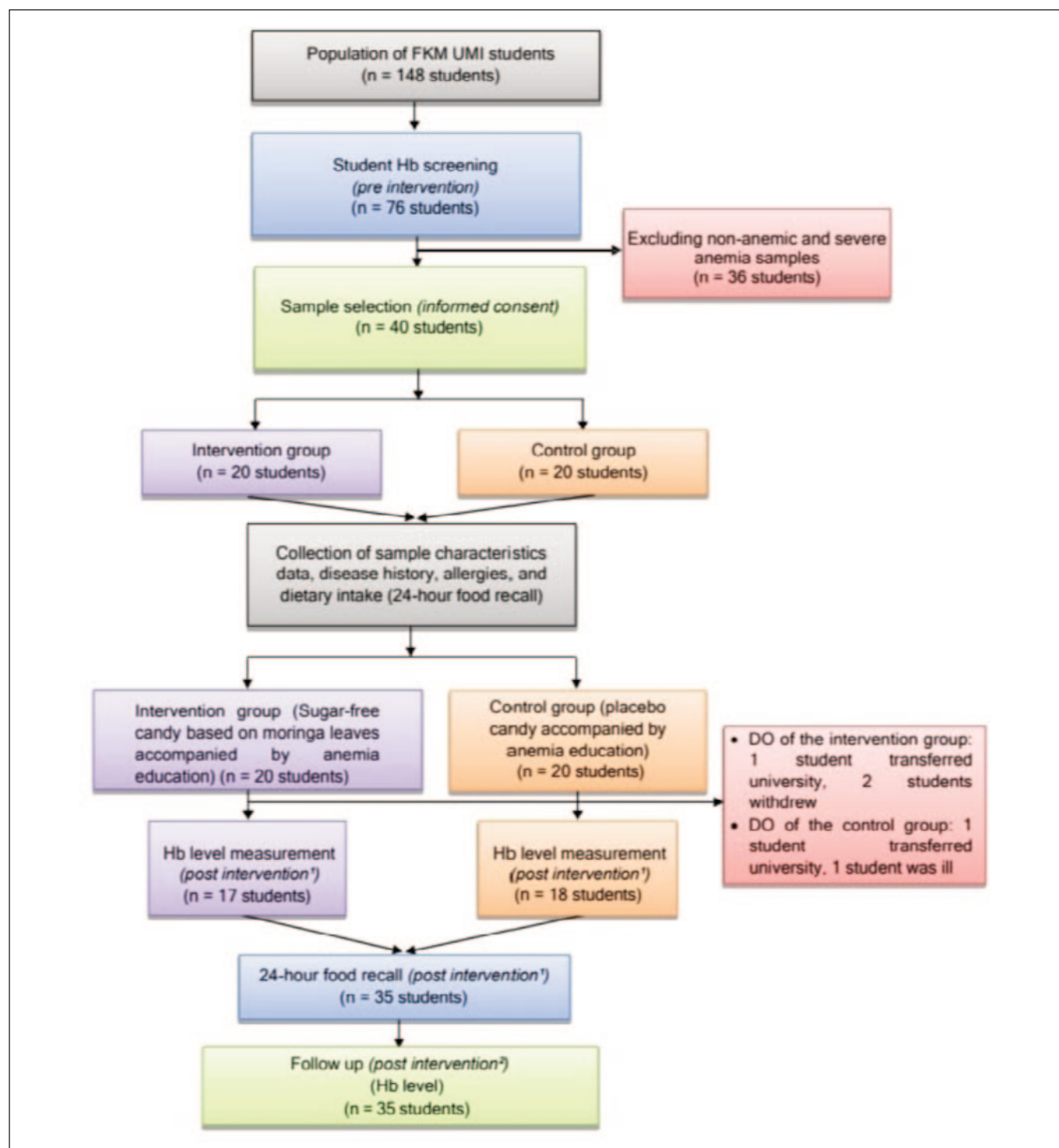


Figure 1. Flow chart

intervention objectives. In the initial stage, the researchers explained the objectives, benefits, and steps of the study, then requested written consent from each respondent. After the respondents met the inclusion criteria, the researchers set a mutually agreed time and place for the education session.

The education sessions were delivered by the researchers. The education was delivered using leaflets containing material on the definition of anemia, its causes, symptoms, the impact of anemia on health, and how to prevent anemia through a nutritious diet and healthy lifestyle. During the ed-

ucation process, the researchers ensured that the material was delivered interactively, gave respondents the opportunity to ask questions, and ensured understanding by explaining again or confirming the information provided. In addition, the researchers gave respondents the opportunity to ask questions if there was anything they did not know about anemia through a WhatsApp group, which was also used to monitor and remind them to consume sugar-free candy made from moringa leaves (Ironella Candy). With this procedure, it is hoped that the education provided can increase respondents' knowledge about anemia and support changes in eating habits to become healthier.

Statistical analysis

Descriptive statistics were used to summarize the characteristics of respondents and hemoglobin measurements. Data normality was tested using the Shapiro–Wilk test. Because the research data were not normally distributed, nonparametric tests such as the Wilcoxon signed-rank test and Mann–Whitney test were used. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) software version 25.0, with a significance level of $p < 0.05$.

Ethical approval

This research protocol has received official ethical approval from the Health Research Ethics Committee (KEPK) of the Faculty of Public Health, Hasanuddin University (No. 647/UN4.14.1/TP.01.02/2025). Prior to enrollment, all participants received a detailed explanation of the research objectives, procedures, and their right to withdraw at any time, followed by the provision of written consent.

RESULTS

Characteristics of the study participants

Table 1 shows that most participants in the intervention group were 19 years old (58.8%), while most participants in the control group were 20 years old (72.2%). All participants in both groups had completed high school (100%). None of the respondents had a history of infectious disease in the last three months (100%). Most people in the intervention group had no history of allergies (88.2%), while all people in the control group had no history of allergies at all (100%).

Anemia status

Based on Table 2, in the intervention group, most respondents were classified as having moderate anemia, with 10 respondents (58.8%) before the intervention, 5 respondents (29.4%) after the intervention¹, and 0 respondents after the intervention². This data shows that there was an improvement in hematological status to mild anemia and normal. In the control group, the anemia status variable showed that the majority of respondents were in the mild anemia category, with 11 respon-

Table 1. Characteristics of study participants

Characteristic	Group			
	Intervention		Control	
	n (17)	%	n (18)	%
Age (years)				
19	10	58.8	3	16.7
20	5	29.4	13	72.2
21	0	0	1	5.6
22	2	11.8	1	5.6
Respondents' highest level of education				
Elementary School	0	0	0	0
Junior High School	0	0	0	0
Senior High School	17	100	18	100
History of infectious diseases in the last 3 months				
Yes	0	0	0	0
No	17	100	18	100
Allergy history				
Yes	2	11.8	0	0
No	15	88.2	18	100

Source: Primary Data, 2025.

dents (61.1%) before the intervention, 10 respondents (55.6%) after the intervention¹, and 9 respondents (50%) after the intervention². These data show that the prevalence of mild anemia improved hematological status to non-anemia or normal. Based on this prevalence data, it can be concluded that there was a change in the prevalence of anemia among respondents, or in other words, there was an increase in hemoglobin levels in both groups after the intervention. Based on the results of the Pearson Chi-square test analysis, the p -value was > 0.05 , meaning that the anemia status in the intervention group and the control group was not statistically different. Although the analysis showed no statistically significant difference, an increase in hemoglobin levels was expected in both groups.

Differences in pre-intervention and post-intervention¹ haemoglobin levels

Table 3 shows that the Wilcoxon test results for the intervention group had a p -value of $< 0.001 < 0.05$, indicating that sugar-free candy made from moringa leaves (Ironella Candy)

Table 2. Distribution of anemia status in both groups

Anemia Status	Group				P value
	Intervention		Control		
	n (17)	%	n (18)	%	
Pre Intervention					
Normal	0	0	0	0	0.318*
Mild Anemia	7	41.2	11	61.1	
Moderate Anemia	10	58.8	7	38.9	
Post Intervention ¹					
Normal	2	11.8	4	22.2	0.687*
Mild Anemia	10	58.8	10	55.6	
Moderate Anemia	5	29.4	4	22.2	
Post Intervention ²					
Normal	10	58.8	9	50.0	0.600*
Mild Anemia	7	41.2	9	50.0	
Moderate Anemia	0	0	0	0	

Source: Primary Data, 2025; Post Intervention¹: After Intervention; Post Intervention²: 1 Month After Intervention; * Pearson Chi-square Test.

accompanied by education about anemia can increase hemoglobin levels between pre-intervention and post-intervention¹. This can be seen from the average hemoglobin levels of the intervention group, which were 10.57 ± 1.01 g/dL before the intervention and increased to 11.17 ± 0.61 g/dL after the intervention¹, with an increase of 0.6 ± 0.4 g/dL. Meanwhile, in the control group with a p-value of $0.092 > 0.05$, there was no effect of placebo candy accompanied by education about anemia on hemoglobin levels. This can be seen from the average hemoglobin level of the control group during the pre-intervention, which was 10.89 ± 1.00 g/dL, then increased during the post-intervention¹ to 11.32 ± 1.09 g/dL with an increase of 0.43 ± 0.09 g/dL. Based on the Mann Whitney test on pre-intervention and post-intervention¹, there was no significant difference in the average hemoglobin levels between the two groups, with p-values of 0.186 and 0.354, respectively, meaning that the effect of Ironella candy was not superior to that of the placebo.

Differences in post-intervention¹ and post-intervention² haemoglobin levels

Table 4 shows that the Wilcoxon test results for the intervention group had a p-value $< 0.001 < 0.05$, indicating a difference in hemoglobin levels at post-intervention¹ and hemoglobin levels at post-intervention². This can be seen from the average hemoglobin level of the intervention group at post-intervention¹ of 11.17 ± 0.61 g/dL, which then increased

Table 3. Analysis of hemoglobin level differences before and after intervention¹

Hemoglobin (g/dL)	Pre Intervention	Post Intervention ¹	Δ (Post ¹ -Pre)	p value*
	Mean $\pm$ SD (g/dL)	Mean $\pm$ SD (g/dL)	Mean $\pm$ SD (g/dL)	
Intervention (n=17)	10.57 $\pm$ 1.01	11.17 $\pm$ 0.61	0.6 $\pm$ 0.4	<0.001
Control (n=18)	10.89 $\pm$ 1.00	11.32 $\pm$ 1.09	0.43 $\pm$ 0.09	0.092
p value**	0.186	0.354		

Source: Primary Data, 2025; * Wilcoxon Test; ** Mann-Whitney Test; Post Intervention¹: After Intervention.

Table 4. Analysis of hemoglobin level differences after intervention¹ and after intervention²

Hemoglobin (g/dL)	Post Intervention ¹	Post Intervention ²	Δ (Post ² - Post ¹)	p value*
	Mean $\pm$ SD (g/dL)	Mean $\pm$ SD (g/dL)	Mean $\pm$ SD (g/dL)	
Intervention (n=17)	11.17 $\pm$ 0.61	11.93 $\pm$ 0.34	0.76 $\pm$ 0.27	<0.001
Control (n=18)	11.32 $\pm$ 1.09	11.83 $\pm$ 0.60	0.51 $\pm$ 0.49	0.004
p value**	0.354	0.853		

Source: Primary Data, 2025; * Wilcoxon Test; ** Mann-Whitney Test; Post Intervention¹: After Intervention; Post Intervention²: 1 Month After Intervention.

at post-intervention² to 11.93 ± 0.34 g/dL, with an increase of 0.76 ± 0.27 g/dL. Similarly, in the control group, the p-value was $0.004 < 0.05$, indicating a difference in hemoglobin levels between post-intervention¹ and post-intervention². This can be seen in the average hemoglobin level of the control group after intervention¹ of 11.32 ± 1.09 g/dL, which then increased after intervention² to 11.83 ± 0.60 g/dL with an increase of 0.51 ± 0.49 g/dL. This indicates the possibility of a strong influence from the anemia education provided or other uncontrolled factors. Based on the Mann Whitney test on post-intervention¹ and post-intervention², there was no significant difference in the average hemoglobin level between the two groups, with p-values of 0.354 and 0.853, respectively.

DISCUSSION

Based on Table 1 on age characteristics, the majority of respondents in this study were in the age range of 19 years (58.8%) in the intervention group and 20 years (72.2%) in the control group. This age range is the reproductive or fertile age in women (from the first menstruation to the cessation of menstruation), during which their iron requirements increase significantly due to rapid physical growth. Women of childbearing age are prone to anemia. This is because they experience bleeding or menstruation every month and have poor eating habits, such as a tendency to consume foods low in nutrients¹⁰.

Based on the characteristics of their highest level of education, all respondents in this study were in the high school category, namely 17 respondents (100%) in the intervention group and 18 respondents (100%) in the control group. Education level is one of the elements that can influence a person's ability to receive and understand the information obtained. A higher level of education has an impact on deeper knowledge and understanding of nutritional information compared to individuals with a lower level of education¹¹.

Based on the characteristics of the history of infectious diseases in the last 3 months, both the intervention group and the control group had no history of infectious diseases in the last 3 months (100%). Anemia caused by acute infection has various causes. For example, in someone infected with malaria, the main cause of anemia is the destruction of red blood cells by parasites. Or someone infected with hookworms may experience chronic iron and blood loss in the intestines, often leading to morbidity. Women of childbearing age, in particular, are at the highest risk of iron deficiency anemia due to hookworms because of low iron reserves and an unbalanced diet. A study with interventions to treat hookworm infection has shown a significant increase in hemoglobin levels¹².

Research on women of childbearing age in Central Ethiopia also mentions that intestinal parasite infections are significantly associated with anemia. This is because intestinal parasites

have a detrimental effect on the intestinal mucosa, which affects the absorption of iron and other micronutrients. Theoretically, worm infections are also associated with anemia. This is because parasitic worms use blood and nutrients from food as a source of energy, causing sufferers to become malnourished and anemic. Worm infections can cause long-term malnutrition because they interfere with the absorption of nutrients¹³.

Based on allergy history characteristics, the majority of the intervention group had no history of allergies (88.2%). In the control group, all respondents had no history of allergies (100%). Allergies are a form of hypersensitivity reaction, which is an excessive immune response to foreign substances or allergens. Previous studies have shown that allergies are often associated with low hemoglobin levels and a high incidence of anemia. Examples include atopic diseases such as atopic dermatitis, allergic rhinitis, and asthma. In individuals with these conditions, immune reactions and iron deficiency can lead to anemia caused by problems with iron balance. Research on women of childbearing age (>18 years) in Korea found a relationship between a history of atopic diseases such as atopic dermatitis, allergic rhinitis, and asthma and the incidence of anemia (< 0.001). The increase in the prevalence of anemia is in line with the increase in the number of atopic diseases, which supports the research hypothesis that inflammation due to atopic diseases is associated with a high risk of anemia. Although the study did not establish causality between allergic diseases and anemia, a significant association is presumed¹⁴.

The percentage of anemia in both groups shows that anemia remains a significant health problem among students, especially in the medical faculty environment at one of the universities in Makassar (Table 2). In addition, the researchers conducted brief interviews with respondents before the intervention to find out whether they had been exposed to material about anemia in their lectures, and almost all respondents answered that they had been exposed to such material, including the definition of anemia, its symptoms, causes, and effects. However, after blood sampling, the results showed that many of them still suffered from anemia, either mild or moderate.

Factors such as an unbalanced diet, behavioral awareness, and a busy schedule and college assignments could be the main causes of the high percentage of anemia in this region. Therefore, a food-based intervention approach, including nutrition education and dietary data collection, is relevant to address this problem. A study of midwifery students found that 21 students (50%) suffered from anemia. This was due to a low iron intake (p-value 0.000) and the habit of drinking tea, with an average consumption of 5-6 times a week of 200 ml and sweet tea once a week¹⁵. This condition is similar to the situation of several respondents in this study who had low iron intake and the habit of drinking tea while eating.

Most respondents experienced moderate anemia (29.4%) after intervention¹, and no respondents experienced moder-

ate anemia (0%) after intervention² (Table 2). This means that there was a decrease in the severity of anemia in the group that received the intervention. Anemia that was initially moderate shifted to a milder or normal category. This shows that the intervention had a positive impact on increasing hemoglobin levels. In other words, the longer the duration of the intervention, the better the anemia status in the group that received the intervention.

The intervention group obtained a p-value of $< 0.001 < 0.05$, indicating a significant effect on hemoglobin levels after administration of sugar-free candy made from moringa leaves (Ironella Candy) accompanied by education about anemia. Meanwhile, the Wilcoxon test results in the control group showed a p-value of $0.092 > 0.05$, indicating no significant effect on hemoglobin levels after administration of placebo candy accompanied by education about anemia (Table 3). This shows that the combination of placebo candy administration accompanied by education about anemia had no significant effect on hemoglobin levels.

In addition to containing iron, which is essential for hemoglobin formation, moringa leaves are also rich in various nutrients and other bioactive compounds that help increase hemoglobin levels. One important nutrient is vitamin C (*Ascorbic Acid*). Vitamin C functions physiologically to increase the absorption of non-heme iron in the small intestine by converting Fe^{3+} to Fe^{2+} , which is more easily absorbed by the intestinal lining. Based on previous studies, consuming vitamin C together with plant-based iron sources can increase iron absorption by two to three times compared to without vitamin C, thereby accelerating the increase in hemoglobin levels^{16,17}.

Moringa leaves that have been processed into moringa powder can be used as a substitute for iron tablets as a treatment for anemia. The high protein content in moringa leaves (about 25–30% of dry weight) makes them a source of plant-based protein that supports the process of red blood cell formation. In addition to vitamins and protein, moringa leaves also contain many natural antioxidants such as flavonoids, polyphenols, and beta-carotene. These compounds work to protect erythrocytes from damage caused by oxidative stress, thereby prolonging the life of red blood cells and maintaining stable hemoglobin levels in the body¹⁸.

Although there was a significant effect on hemoglobin levels in the intervention group, the Mann-Whitney test results showed a p-value of $0.354 > 0.05$, indicating no difference in mean hemoglobin levels between the two groups after the intervention¹. In terms of hemoglobin level increase, there was a tendency for the intervention group to experience a higher increase in hemoglobin levels compared to the control group, although the increase was not significant. This can be seen in Table 3, which shows an increase in hemoglobin levels of 0.6 g/dL in the intervention group after receiving sugar-free candy made from moringa leaves accompanied by

education. Meanwhile, the control group experienced an increase in hemoglobin levels of 0.43 g/dL after receiving placebo candy accompanied by education. This shows that education can strengthen the effectiveness of sugar-free candy made from moringa leaves in increasing hemoglobin levels in students with anemia.

Nutritional interventions accompanied by health education or education show better results than interventions without education. Improvements in cognitive and behavioral aspects directly support the success of physiological interventions, such as increased hemoglobin levels¹⁹. When individuals realize the benefits of the intervention provided (such as consuming moringa candy to increase hemoglobin levels), they are more likely to comply with the intervention, increase consumption frequency, and maintain a healthy lifestyle for a longer period of time.

Based on previous research on the effects of administering iron supplements once and twice a week on hemoglobin levels in female students in Tangerang City who were anemic, it was found that in the control group, 10% of them had mild anemia. This study provided moringa leaf extract and nutrition education, which resulted in an improvement from mild anemia to a normal status. Meanwhile, in the treatment group, before the intervention, all 30 individuals (100%) had mild anemia. After the intervention, 26 individuals (87%) showed normal hemoglobin levels, and 4 individuals (13%) still had mild anemia, although there was an average increase of approximately 1.53 g/dL in these four subjects²⁰.

Education not only enhances the effectiveness of interventions but also plays a role in preventing the return of old behaviors after the intervention ends. According to the book *Health Behavior: Theory, Research, and Practice*, behavioral changes based on understanding and awareness are more likely to be sustained in the long term than changes caused by passive interventions alone²¹. Although education-based intervention programs can have positive effects, the results also depend heavily on how well participants can absorb and apply the information provided in their daily activities^{22–24}.

There was a difference in hemoglobin levels after the first and second interventions² with a p-value < 0.001 in the intervention group. The results showed an increase in hemoglobin levels after the second intervention², as seen in the average difference of 0.76 ± -0.27 g/dL in the intervention group (Table 4). This indicates that the average increase in hemoglobin levels was higher after the second intervention compared to after the first intervention. This means that even though they no longer received the intervention, the iron reserves in the study group's bodies were still high enough for hemoglobin production to continue, accompanied by anemia education. This study is in line with research on the intervention of snack bar provision on hemoglobin levels in adolescent girls, which also used the method of measur-

ing hemoglobin levels post-intervention² or one month after the intervention ($p = 0.000$)²⁵.

The results of the analysis of the difference in hemoglobin levels at post-intervention¹ and post-intervention² showed a p -value of 0.004 in the control group. The results show an increase in hemoglobin levels in post-intervention², as seen in the average difference of 0.51 ± 0.49 g/dL in the control group. This indicates that the average increase in hemoglobin levels is higher in post-intervention² compared to post-intervention¹. Although the control group also showed an increase in hemoglobin levels, the increase was much lower than that of the intervention group. However, the variation in this increase was higher, so the impact was not as strong and homogeneous as in the intervention group. These results show that both the intervention and control groups experienced an increase in hemoglobin levels from post-intervention¹ to post-intervention². However, the increase in the intervention group was more significant and stable.

This could also be due to other factors, such as an increase in nutritional intake in the respondents' daily diets after the intervention, as the respondents were female students who happened to be on semester break during the period between post-intervention¹ and post-intervention². Although the researchers did not measure the respondents' nutritional intake, they made the initial assumption that during the semester break, these female students were not burdened with a busy class schedule and assignments, as well as pressure to achieve academic targets, so they spent more time at home and relaxing. In addition, the respondents lived with their parents, and female students who lived with their parents had better eating habits than those who did not live with their parents. Respondents who lived with their parents had the habit of eating three regular meals a day, which was certainly healthier because the food was prepared or cooked themselves without preservatives. This assumption was also supported by previous studies.

A qualitative study examining the eating patterns of students in Jakarta states that the eating patterns of students who live with their parents are mainly influenced by family eating habits, because the amount of food consumed and the types of food they eat are always monitored by their mothers. Almost all respondents in this study often ate with their families at home during semester breaks. However, there were also those who had a habit of eating alone or students who cooked their own meals because their mothers were busy working all day²⁶. Unlike when they were still actively attending college, most students have irregular eating patterns, unhealthy diets, poor nutrition, and low fruit and vegetable consumption, so they prefer to buy fast food or simply buy snacks to fill their stomachs for convenience and flexibility. This shows that access also plays an important role in shaping healthy eating patterns among female students^{27,28}.

In addition, compared to lunch and dinner, students who actively attend lectures often skip breakfast, which is very important because it is considered the key to starting the day well and preventing blood sugar spikes at lunchtime due to combining breakfast and lunch. By starting the morning with the right nutrients, the body can operate more optimally, thereby increasing efficiency and concentration. Furthermore, a nutritious breakfast can help maintain weight, as we tend not to overeat at subsequent meals. Consuming foods rich in fiber, protein, and healthy fats can also support stable blood sugar levels, which is important for avoiding sudden energy spikes and fatigue. Individuals who choose a healthy breakfast tend to have more regular blood sugar levels, which can reduce the risk of diabetes and other health issues²⁹.

CONCLUSION

Sugar-free candy made from moringa leaves (Ironella Candy), accompanied by education about anemia, has been shown to increase hemoglobin levels in students suffering from anemia, making this product a potential alternative intervention for anemia. Although no additional interventions were provided after the intervention², hemoglobin levels continued to increase in both groups, which was most likely a long-term effect of the education provided during the intervention. This study is limited by its small sample size and short intervention duration, so the observed effects tend to be limited. This study is also limited to health students, so the results cannot be generalized to non-health students. Methodological differences between the two groups may have introduced potential bias in this study, which can be addressed in future research. Further research with a larger sample size, longer duration, and additional biomarker measurements is needed to strengthen the evidence of its effectiveness.

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