

Red spinach-containing snack food improved hemoglobin and hematocrit levels of girl adolescents in Riau Archipelago

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ABSTRAK

Latar Belakang: Anemia banyak terjadi pada remaja yang ditandai dengan turunnya kadar hemoglobin dan hematokrit darah. Bayam merah (*Alternanthera amoena* Voss.) sebagai salah satu pangan tinggi zat besi berpotensi diteliti pengaruhnya dalam mengatasi anemia.

Tujuan: Penelitian ini bertujuan untuk mengevaluasi efek mengonsumsi kudapan yang mengandung bayam merah terhadap kadar hemoglobin dan hematokrit pada remaja putri anemia di SMP Negeri 2 Bintan Timur, Kepulauan Riau.

Metode: Penelitian ini merupakan penelitian kuasi eksperimental dengan pendekatan pretest-posttest dengan kelompok kontrol dengan 36 subjek yang dibagi menjadi dua kelompok. Kelompok perlakuan diberikan kudapan yang mengandung bayam merah, sementara kelompok kontrol menerima kudapan tanpa penambahan bayam merah selama 14 hari. Sampel darah kemudian diambil dan dianalisis kadar hemoglobin dan hematokritnya. Data kemudian dianalisis dengan T-tes dependen.

Hasil: Penelitian ini membuktikan bahwa ada beda kadar hemoglobin dan hematokrit pada kelompok perlakuan antara sebelum dan sesudah intervensi, dengan peningkatan masing-masing $0.4 \pm 0.05\text{g/dL}$ dan $2.1 \pm 0.07\%$. Sementara itu, pada kelompok kontrol tidak ada perbedaan kadar hemoglobin dan hematokrit antara sebelum dan sesudah perlakuan.

Kesimpulan: Kudapan yang mengandung bayam merah memengaruhi kadar hemoglobin dan hematokrit pada remaja putri anemia di Kepulauan Riau. Produk ini dapat dijadikan sebagai alternatif kudapan dalam penanganan anemia.

KATA KUNCI: *alternanthera amoena voss.*; anemia; remaja; zat besi; makanan

ABSTRACT

Backgrounds: Anemia often occurs in adolescents, characterized by a decrease in hemoglobin and blood hematocrit levels. Red spinach (*Alternanthera amoena* Voss.) as a food high in iron has the potential to be studied for its effect in treating anemia.

Objectives: To evaluate the effect of red spinach-containing snack foods on the hemoglobin and hematocrit levels of anemic adolescent girls at SMP Negeri 2 Bintan Timur, Riau Archipelago.

Methods: It was a quasi experimental study with a pretest-posttest control group design with 36 subjects, divided into two groups. The treatment group received red spinach-containing snack foods, while a control group received plain snack foods for 14 days. At the beginning and the end of the study, blood was collected and analyzed for hemoglobin and hematocrit levels. Data were analyzed using a t-test.

Results: The study showed the differences in hemoglobin and hematocrit levels in the treatment group before and after intervention, with an increase of $0.4 \pm 0.05\text{g/dL}$ and $2.1 \pm 0.07\%$, respectively. Meanwhile, the control group showed no differences in hemoglobin and hematocrit levels before and after the intervention.

Conclusions: The red spinach-containing food affected the hemoglobin and hematocrit

levels of anemic adolescent girls in the Riau Archipelago. This product can be used as an alternative food to overcome anemia.

KEYWORDS: *alternanthera amoena* voss.; anemia; adolescent; iron; food

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INTRODUCTION

In 2013, anemia was a significant health problem in Indonesia, with a prevalence rate of 21.7% (1). This means that a substantial portion of the adolescent population in Indonesia was affected by anemia. The prevalence of anemia was notably higher among girls aged 15 to 18 years. This age group was particularly affected by anemia. Anemia's incidence was even more pronounced in the Riau Archipelago, where the prevalence was exceptionally high at 38.1% (2). Inadequate iron intake is identified as a major cause of anemia among adolescents (3). This is often reflected in low levels of blood hemoglobin and hematocrit, which are important indicators of anemia. Untreated or severe anemia may contribute to later life development, particularly physical and academic performance, and decreased immunity (2)(4).

Red spinach (*Alternanthera amoena* Voss) is a famous type of leafy vegetable that is high in iron. It contains a total iron of 7 mg/100 g, higher than green spinach (3.3 mg/100 g) (5). Red spinach also has good nutritional value, like protein, fat, carbohydrates, fiber, mineral (phosphorus, manganese, calcium), vitamins (A, B, and C), and niacin (6). Carotenoid, flavonoid, and

alkaloid is also good as immunity enhancer (6). The previous study reported that hemoglobin levels increased after the intervention of single red spinach juice in pregnant mothers of trimesters 1 and 2 (7) and its combination with beetroot juice (8). The girl given boiled red spinach also proved to have higher hemoglobin levels (9).

The acceptance of spinach is usually limited due to its taste. Therefore, it needs to be developed a snack food to increase the intake of red spinach-containing food. So far, there has been a modification of red spinach products to become pudding, but it must be combined with orange juice that is high in vitamin C to enhance the absorption of iron in the body. The consumption during seven days could enhance hemoglobin levels to 2.04 ± 0.2 g/dL (10). However, it has not been studied for other modifications without combination with vitamin C. This study aimed to evaluate the effect of red spinach-containing snack foods on the hemoglobin and hematocrit levels of anemic adolescent girls at SMP Negeri 2 Bintan Timur, Riau Archipelago.

MATERIALS AND METHODS

The research was approved by The Institutional Review Board of Alma Ata

University Yogyakarta with the number of KE/AA/VI/10802/EC/2022 on June 9, 2022. This study was quasi experimental with a pretest-posttest control group design. This research was conducted in June 2022 at the junior high school of SMP Negeri 2 Bintan Timur, Riau Archipelago.

The population of this study was 53 anemic adolescent girls aged 12-15 years old at SMP Negeri 2 Bintan. The subjects were screened based on blood evaluation of hemoglobin levels of <12 g/dL and hematocrit levels of <36 (11), and willingness to participate in this study. They were excluded if they were menstruation, received iron supplement tablets, suffered from thalassemia, chronic illness, gastrointestinal disorder, or died during the study.

The sample size was 18 for each of the control and treatment groups. It was calculated by Lemeshow equation for one population (12), considering the mean difference of (X1-X2) 2.04 g/dL and standard deviation (S) of 1.26 from a previous study (13), the power of 90% ($\beta=0,10$), an alpha level of 0.05 (14), and $Z\alpha = 1,96$; $Z\beta = 1,28$. The Lemeshow equation was shown below.

$$n1 = n2 = \frac{2(Z\alpha + Z\beta)^2(S)^2}{(X1 - X2)^2}$$

The treatment group received red spinach-containing snack food in the form of a fried stick, but the control group received a fried stick without red spinach. All of them received 100 g of snack food for 14 days. The estimation of Fe contained in red spinach was 7 mg/100 g (5). Blood was taken twice using Hemoglobin Hematocrit Testing Fora 6 at the

beginning and the end of the study.

Data were analyzed by a dependent T-test analysis to know the differences in hemoglobin and hematocrit levels before and after the intervention.

RESULTS AND DISCUSSION

Characteristics of subjects

In this study, there were 36 anemic adolescent girls who were selected as subjects and divided into two groups, that was a control group and a treatment group. However, there was one subject in the control group who dropped out because she did not attend the invitation several times during the study.

Characteristics of adolescent girls at SMP Negeri 2 Bintan based on age and anemia symptoms can be seen in **Table 1**. Most of the subjects were 13 years old, both in the control (52.9%) and the treatment group (44.4%). As we know that adolescence is more vulnerable to anemia due to the increasing need for nutrients during the growth period, especially iron needs. Moreover, menstruation and parasitic infestation also affected blood loss in young girls (15). The most incidence occurs in young girls who had imbalance consumption of micronutrients, such as iron, folic acid, zinc, vitamins B6, B12, and C (16) and may had low levels of knowledge about the role of iron in the body (17). The previous study proved that girl aged 16-18 years old were sensitive to malnutrition related to iron deficiency anemia (18), but another studies reported that the age between 12-15 years old was the highest prevalence due to the peak requirement at this period (15).

The characteristics of subjects in this study were also observed from the symptoms of anemia. The data were collected from the interview. All subjects (100%) felt sleepy, but only 74.3% of subjects complained of difficulty in concentrating, and 45.7% felt weak, tired, lethargic, tired, and negligent (**Table 1**). It is noted that other studies have also found clinical symptoms of anemia in girl adolescents, such as pale conjunctiva,

angular stomatitis, swollen and bleeding gums, loss of luster, dry brittle hair, dermatitis, dry nails, and dental caries (18). These symptoms are attributed to the lack of iron in the cells, leading to various physiological disruptions, including problems with oxygen binding, nutrition transport and storage, enzymatic reactions, and immunity function (15).

Table 1. Characteristics of adolescent girls at SMP Negeri Bintan Timur Riau Archipelago

Characteristics	Group				Total	
	Control		Treatment		(n)	%
	(n)	%	(n)	%		
Age (years old)						
12	4	23.5	1	5.6	5	14.3
13	9	52.9	8	44.4	17	48.6
14	3	17.6	6	33.3	9	25.7
15	1	5.9	3	16.7	4	11.4
Anemia symptoms						
Often sleepy	17	100	18	100	35	100
Difficult to concentrate	13	76.5	13	72.2	26	74.3
Weak, tired, lethargic, tired, and inattentive	8	47.1	8	44.4	16	45.7

The effect of red spinach-containing snack food on hemoglobin levels of adolescent girls

Table 2 shows the results of a T-test-dependent analysis to know the effect of red spinach-containing snack food on hemoglobin levels of anemic adolescent girls. This study shows that there was a significant difference in hemoglobin levels in the treatment group ($p < 0.05$), but there was not in the control group ($p > 0.05$). Specifically, the average increase of hemoglobin levels after 14 days of consumption of red spinach-containing food was 0.4 ± 0.05 g/dL in anemic adolescent girls.

Besides the content of high iron, in red spinach, there were also vitamin C, vitamin A, and antioxidants like anthocyanins and saponins (10,19). The presence of vitamin A and vitamin C increased the absorption of non-heme iron that is usually found in plants (4)(8). Moreover, the antioxidants had a role in maintaining body stability and immunity that overcome iron deficiency anemia(9).

This result was in line with other research that used boiled red spinach for the girl adolescents at SMK Al-Islam Kudus (13) and red spinach juice for pregnant women in the second trimester in Bandar Klippa Village,

Percut Sei Tuan District, Deli Serdang Regency (20). However, the increase in hemoglobin levels was not as high as in other studies that used green spinach and millet (4) (21). This may be influenced by the high oxalate contents in spinach that may inhibit iron absorption(22).

The effect of red spinach-containing snack food on hematocrit levels of adolescent girls

The effect of red spinach-containing snack food on the hematocrit levels of anemic adolescent girls is shown in **Table 3**. This result proved that the consumption of red spinach-containing snack food could

significantly increase the hematocrit levels of anemic adolescent girls ($p < 0.05$), while it could not happen in the control group ($p > 0.05$). The increase in hematocrit levels was closely related to hemoglobin levels, as the formation of both hemoglobin and hematocrit was influenced by the adequate requirement of iron in the body(23). Hemoglobin reflects a protein that is combined with red blood cells, while hematocrit is calculated as the volume ratio between red blood cells and total blood. The other research also used hemoglobin and hematocrit levels to reflect the iron levels in the body during pregnancy and maternal in Japan (24).

Table 2. The effect of red spinach-containing snack food on hemoglobin levels of adolescent girls at SMP Negeri Bintan Timur Riau Archipelago

Group	Treatment type	Normality test	N	Mean (g/dL)	Standard deviation (g/dL)	P value
Control	Before	0.151	17	11.2	0.46	0.668
	After	0.2	17	11.2	0.46	
Treatment	Before	0.481	18	11.2	0.51	0.001
	After	0.575	18	11.6	0.56	

* $p < 0.05$ was significant by paired T-test

Table 3. The effect of red spinach-containing snack food on hematocrit levels of adolescent girls at SMP Negeri Bintan Timur Riau Archipelago

Group	Treatment type	Normality test	N	Mean (g/dL)	Standard deviation (g/dL)	P value
Control	Before	0.297	17	33	1.26	1
	After	0.32	17	33	1.11	
Treatment	Before	0.224	18	33.5	1.38	0.001
	After	0.36	18	35.6	1.45	

* $p < 0.05$ was significant by paired t-test

The effect of red spinach-containing snack food on the anemia prevalence

Based on **Table 4**, the prevalence of anemia in the control group was almost the

same before and after the intervention period ($p > 0.05$), while in the treatment group, there was a decrease in anemia prevalence after treatment. In addition, there were seven

subjects categorized as non-anemic. The intervention of red spinach-containing snack food had an impact on anemia treatment. This study also indicated that the processing of red spinach becoming snack food that involved heating did not increase the bioavailability of iron in the body. This was shown by the increase in hemoglobin levels after 14 days of treatment, which could not be as high as the previous study that used fresh spinach or

juice (8). Theoretically, heating and cooking may have both negative and positive effects.

On one side, it may increase the bioavailability of protein, iron, and also decrease the oxalate or phytate content that inhibits the iron absorption (25) (22) (18), on the other hand, high-temperature processing during cooking may decrease the antioxidant that has a role in body immunity(9).

Table 4. The effect of red spinach -containing snack food on the anemia prevalence at SMP Negeri Bintan Timur Riau Archipelago

Group	Mild anemia n (%)	Moderate anemia n (%)	Not anemia n (%)
Control			
Before treatment	12 (70.58)	5 (29.41)	0
After treatment	13 (76.47)	4 (23.53)	0
Treatment			
Before treatment	12 (66.67)	6 (33.33)	0
After treatment	9 (50)	2 (11.11)	7 (38.89)

CONCLUSION AND RECOMMENDATIONS

Red spinach-containing snack food could increase hemoglobin and hematocrit levels of adolescent girls at SMP Negeri Bintan Timur Riau Archipelago after 14 days of treatment. This snack food can be an alternative snack food to overcome anemia. Further studies may be needed to develop the product and evaluate its organoleptic and nutritional content.

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