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Moringa Leaf and Red Dragon Fruit Peel (*K Na*) Gummy Candy Increases Hemoglobin in Anemic Teenage Girls

Ni Gusti Kompiang Sriasih*, Ni Nyoman Suindri and Made Widhi Gunapria Darmapatni

Midwifery Departement, Politeknik Kesehatan Kemenkes Denpasar, Bali, Indonesia.
*Corresponding Author E-mail: sriasihkespro1@gmail.com

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Adolescent anemia is a significant public health issue, particularly in developing countries, with serious health and economic implications for young girls. It affects their well-being and can lead to complications during pregnancy and impacts infant health. One approach to combat anemia is the creation of a Gummy Candy formulated from moringa leaves and red dragon fruit skin. This study aimed to assess its effect on hemoglobin levels in female adolescents with anemia. In a quasi-experimental design, 30 participants in the treatment group consumed the Gummy Candy daily for 21 days, while a control group received a version without moringa or dragon fruit skin. Before treatment, hemoglobin levels in the treatment group were 10.84 ± 0.74, increasing to 11.59 ± 0.68 post-treatment, reflecting a change of 0.75 g/dL. In the control group, levels rose slightly from 10.75 ± 0.80 to 10.79 ± 0.82, indicating a change of 0.33 g/dL. Statistical analysis revealed significant differences between the post-treatment hemoglobin levels of the two groups ($p < 0.05$). The results suggest that the Gummy Candy may effectively increase hemoglobin levels in female adolescents suffering from anemia, highlighting the need for further studies on a larger scale.

Keywords: Adolescent girls; Anemia; Childbearing; Gummy Candy

Anemia is a significant global public health issue, particularly prevalent in developing nations. Among adolescent girls, anemia contributes to chronic health conditions, profoundly affecting their well-being, economic stability, and social welfare.[1] Globally, approximately 30% of the population, or 2.20 billion people, are affected by anemia, with the majority residing in tropical regions. In Indonesia, the World Health Organization (WHO) reported that 28.28% of women of reproductive age were anemic in 2016. Adolescent girls face a tenfold higher risk of anemia compared to their male counterparts due to monthly menstruation, which increases their need for iron replenishment.[2]

The results of the 2013 Riskesdas found that 37.1% of adolescent girls experienced anemia, increasing to 48.9% in the 2018 Riskesdas; the highest proportion of anemia occurred in the 15–24-year age group. Based on the results of a study in Denpasar City, Bali, it was found that 45.9% of adolescent girls experienced anemia, of which 50% were caused by insufficient iron intake, even though the coverage of iron supplementation tablets for adolescent girls in Bali Province reached 92.61%.[3]

Anemia arises from numerous and intricate causes, with iron deficiency being identified as the primary and most frequent contributor, particularly among women of childbearing or productive age. Iron deficiency anemia results from insufficient iron intake, impaired iron absorption, heightened iron requirements, and iron loss. This deficiency leads to a decline in ferritin levels, followed by reduced transferrin saturation or increased protoporphyrin levels. If left unaddressed, this progression ultimately results in iron deficiency anemia.[4]

Anemia can lead to numerous negative consequences for adolescent girls. The effects of anemia in adolescent girls and women of childbearing age often extend into pregnancy and childbirth, increasing the risk of complications such as impaired fetal growth, premature birth, low birth weight, developmental delays, stunting, neurocognitive disorders, and bleeding before or during delivery, all of which can endanger both the mother and the baby. Infants born with insufficient iron reserves are likely to experience anemia during infancy and early childhood, further raising the risk of neonatal and infant morbidity and mortality.[5] Research has also established a link between anemia during pregnancy and the length of newborns. Pregnant women with anemia are 5.95 times more likely to have babies with a birth length of less than 48 cm. Additionally, studies have shown a significant correlation between anemia in pregnant women and the occurrence of stunting in toddlers.[4,6,7]

The negative impact of anemia on adolescent girls, based on the life cycle, where adolescent girls are prospective mothers, so that conditions during adolescence will affect the pregnancy and childbirth process, and affect the baby they are carrying.[8] Considering the long-term consequences of anemia, it is important to prevent and treat anemia in adolescent girls so that iron needs are met. Various efforts have been made to prevent anemia in adolescent girls, namely providing modules to improve positive behavior in adolescent girls in overcoming anemia, providing education on preventing anemia through *feed groups* , and currently a Health Center program is providing supplementation of blood-boosting tablets containing 60 mg of elemental iron and 400 ìg of folic acid.[9] All of these anemia prevention efforts have not been able to show effective results, the evidence is that anemia in adolescent girls is still quite high. Many teenage girls do not want to take iron supplements because they taste bad and smell fishy.[10] Based on the 2019 Bali Province Health Research and Development Agency Report, the main reason teenage girls aged 10-19 years do not take iron supplements is because of the bad taste and smell, as well as the side effects.[11]

Efforts to increase iron intake can also be done by consuming other food sources. One innovation that can be done to provide a substitute product for iron supplementation tablets in an effort to overcome anemia in adolescent girls is to create a gummy candy formula based on fruit and vegetables, namely a mixture of moringa leaves (*Moringa oliefera*) and red dragon fruit skin (*Hylocereus polyrhizus*) which is called *KNa* gummy candy.

Several studies have found that moringa leaf extract can be used as an alternative in overcoming anemia.[12,13] Likewise, research on dragon fruit found effective results in overcoming anemia[14], but no research has been found that combines moringa with red dragon fruit skin. So far, what is widely used is dragon fruit flesh. In general, this study aims to find the effect of *KNa* (Moringa Leaves and Red Dragon Fruit Skin) gummy candy on hemoglobin levels of female adolescents with anemia.

MATERIALS AND METHODS

Preparation of *KNa* gummy candy

Preparation of moringa leaf simplicia and red dragon fruit skin, taken from Bona Village, Blahbatuh District, Gianyar Regency, Bali. Moringa leaves and red dragon fruit skin are obtained through a sorting process, simplicia, making moringa leaf extract and red dragon fruit skin is carried out at the Agricultural Laboratory (Food Science and Technology) Warmadewa University Denpasar. The manufacture of Gummy Candy *KNa* (Moringa Leaves and Red Dragon Fruit Skin) at the Nutrition Department Laboratory, Denpasar Health Polytechnic, in collaboration with the Nutrition of Politeknik Kesehatan Kemenkes Denpasar.

Based on the results of physical, phytochemical, antioxidant, toxicity and

organoleptic tests, the formula used in this study contained 50 ml of red dragon fruit skin extract, 100 ml of moringa leaf extract, 20% glucose syrup. heated at a temperature of 80 ^{0} - 90 ^{0} C, added sucrose (80% concentration), gelatin (20% concentration) while stirring until the solid material dissolved at least 65% ± 15 minutes, the fire was turned off, poured into molds and cooled at room temperature for 1 hour, stored at a temperature of 5 ^{0}C for 24 hours, then to neutralize the temperature left at room temperature for 1 hour, then *the gummy candy* was removed from the mold. Phytochemical tests contain alkaloids and phenols, IC_{50} 510 µg / mL, Fe 53.6 mg / kg, and Vitamin C 180 mg / g, practically non-toxic.

Study population is all female adolescents in the Working Area of Blahbatuh I Health Center, Gianyar, Bali; inclusion criteria: female adolescents aged 15-19 years, menstruating, domiciled in the Working Area of UPTD Blahbatuh I Health Center, Gianyar, never/currently suffering from symptoms of chronic diseases that result in anemia, cooperative and willing to be respondents. Exclusion criteria; subjects are not willing to continue the treatment given. The sample size in the treatment group was 30 people and the control group was 30 people. The treatment group was given *KNa* gummy candy every day one tablet for 21 days, the control group was given gummy candy that did not contain moringa or dragon fruit skin for 21 days, then a posttest was conducted. In this design, hemoglobin measurements were carried out before and after the experiment in the treatment group and in the control group. Aside from avoiding additional iron supplements, the subjects received no special dietary restrictions and continued their usual eating habits.

The data were statistically tested with the Wilcoxon Test (inter-group data) and Mann-Whitney (inter-group data) in SPSS statistics. Statistical test results are significant if $p < 0.05$.

This study was approved by the ethical committee Politeknik Kesehatan Denpasar, Bali-Indonesia, with ethical clearance reference number: 070/1529/IP/DPM PTSP/2024 and research permit Number: 070/1529/IP/DPM PTSP/2024 from the Investment and One-Stop Integrated Service Office of the Gianyar Regency Government, Bali. Participants gave consent using an approved consent form. Then, patients were informed about the study's details, including the general overview, purpose, risks, and benefits. Confidentiality was maintained throughout the study, which was conducted following the Declaration of Helsinki.

RESULTS

The characteristics of the majority of research subjects shown in table 1 in both groups were those with high school education; in the treatment group, the majority were 16-17 years old, while in the control group, the majority were 17 years old.

Table 2 presents the mean hemoglobin (Hb) levels and their 95% confidence intervals (CIs) at baseline and post-intervention for both the intervention and control groups. In the intervention group, the Hb concentration increased from 10.84 ± 0.74 (95% CI: 10.57–11.11) at baseline to 11.59 ± 0.68 (95% CI: 11.35–11.83) after treatment, yielding a mean change of 0.75 g/dL (95% CI: 0.60–0.90). By contrast, the control group rose from 10.75 ± 0.80 (95% CI: 10.46–11.04) to 10.79 ± 0.82 (95% CI: 10.49–11.08), with a mean change of 0.33 g/dL (95% CI: 0.19–0.47). The net difference in the Hb increase between groups was 0.42 g/dL (95% CI: 0.24–0.60). These findings suggest that the gummy candy containing Moringa

Table 1. Baseline Characteristics

Characteristics	Intervention (n = 30)	Control (n = 30)
Age (Mean ± SD)	15.77 ± 1.78	15.83 ± 2.00
Age Range (years)	12–18	12–18
Education		
Primary School	4 (13.3%)	3 (10.0%)
Junior High School	9 (30.0%)	11 (36.7%)
Senior High School	17 (56.7%)	16 (53.3%)

leaves and red dragon fruit peel is associated with a statistically significant yet modest improvement in hemoglobin levels, compared to the placebo.

Table 3 shows the effect of changes in hemoglobin levels before and after in the treatment group, namely all female adolescents who were given *KēNa* gummy candy treatment experienced an increase in Hb levels with a significance value of 0.000 or $p < 0.05$, meaning that there was an effect of giving *KNa* gummy candy on increasing Hb levels of female adolescents. In the control group, there was an increase in Hb in 25 adolescents and the remaining 5 people, a significance value of 0.415, meaning that there was no effect of giving placebo gummy candy on Hemoglobin levels.

Table 4 shows analysis of differences in Hemoglobin levels before and after in the intervention and control groups using the *Mann Whitney* test. Before the intervention *Mean Ranks* 31.22 in the treatment group, 29.78 in the control group, with a significance value of 0.75 means there is no significant difference in hemoglobin levels before treatment in the treatment and control groups. After treatment *Mean Ranks* 38.99 in the treatment group, 22.02 in the control group, with a significance value of 0.00 means there is a significant difference in hemoglobin levels after treatment in the treatment and control groups.

DISCUSSION

Subject Characteristics In this study, the treatment group consisted of adolescents aged 14 to 18 years, mostly high school educated, who had anemia. WHO data on the prevalence of anemia worldwide shows that 1.62 billion people are

Table 2. Average Hb Levels Before and After in the Intervention Group and Control Group (g/dL)

Group	Hb at Baseline (Mean ± SD)	Hb Post-Intervention (Mean ± SD)	Mean Change	Difference of Mean Change
Intervention (n = 30)	10.84 ± 0.74 (10.57–11.11)	11.59 ± 0.68 (11.35–11.83)	0.75 (0.60–0.90)	
Control (n = 30)	10.75 ± 0.80 (10.46–11.04)	10.79 ± 0.82 (10.49–11.08)	0.33 (0.19–0.47)	
Difference	–	–	–	0.42 (0.24–0.60)

Table 3. Effect of Hemoglobin Before and After in Treatment and Control Groups

Hemoglobin Level	Treatment f	Treatment %	*p*	Control f	Control %	*p*
Decrease	0	0	0.000	0	0	0.415
Increase	30	100		25	83.33	
Settling	0	0		5	16.67	

Description: *Wilcoxon test*

Table 4. Differences in Hemoglobin Levels Before and After in the Intervention and Control Groups

Hemoglobin	Group	N	Mean Ranks	Sig
Before	Treatment	30	31.22	0.750
	Control	30	29.78	
After	Treatment	30	38.99	0.000
	Control	30	22.03	

Description: *Mann Whitney test*

suffering from anemia. This is in accordance with data from the Basic Health Research (Riskesdas, 2013) showing that the prevalence of anemia in Indonesia is 21.7%, with 26.4% for children aged 5–14 years and 18.4% for children aged 15–24 years.[15] *KẽNa* gummy candy made from moringa leaf extract and red dragon fruit skin has good nutritional content to increase hemoglobin concentration, anemia status, and iron content in adolescent girls. Therefore, it is important for adolescent girls to understand better the benefits of consuming moringa leaves and red dragon fruit skin.[16,17] Adolescence is a vulnerable period for nutrition due to rapid physical growth and development. In addition, adolescents need sufficient energy to carry out various physical activities. Poor dietary patterns will result in suboptimal growth and development, as well as greater susceptibility to chronic diseases such as cardiovascular disease, cancer, and osteoporosis in adulthood.[18]

Research in Bangladesh shows that the peak growth of adolescent girls is delayed due to consuming fewer calories than the group of adolescent boys. The level of calorie consumption is also influenced by age. The higher the age group, the lower the calorie consumption.[19] In adolescent girls who suffer from anemia, there is a correlation between body mass index and hemoglobin (Hb) levels. The behavior of consuming certain foods in individuals over 10 years of age is seasonings (77.3%), followed by sweet foods and drinks (53.1%), and fatty foods (40.7%). If rapid growth is not balanced with balanced nutrient consumption, there will be relative deficiencies, especially vitamin deficiencies. This phase of adolescent growth requires great attention from parents and their environment. Deficiencies occur when nutritional needs are not met, one of which is the problem of anemia.[20]

Anemia is characterized by a lower-than-normal count of red blood cells or hemoglobin levels. The standard hemoglobin levels vary between men and women, with anemia typically defined as hemoglobin below 13.5 g/dL for male and below 12.0 g/dL for female. Hemoglobin concentration, measured chemically per 100 milliliters of blood, serves as an indicator of the red blood cells' ability to transport oxygen. The body requires iron (Fe) to function properly, with adolescent girls aged 13-18 needing 15 mg/day and adolescent boys requiring 11 mg/day.[21] Iron is essential for hemoglobin production and plays a critical role in oxygen distribution throughout the bloodstream. Each gram of hemoglobin contains 1.3 ml of oxygen, 97% of which is transported from the lungs, while only 3% is dissolved in plasma. As a result, hemoglobin is the primary carrier of oxygen in the body.[13]

The average score before and after the highest treatment group was after treatment with a mean value of 11.59 and a standard deviation of 0.68, a difference in Hemoglobin of 0.75 grams%. In the control group, the highest mean was after treatment, with a mean value of 10.79 and a standard deviation of 0.82, a difference in Hemoglobin of 0.33 g/dL. The effect of changes in hemoglobin levels before and after in the treatment group was that all female adolescents who were given *KNa* (Moringa Leaves and Red Dragon Fruit Skin) gummy candy experienced an increase in Hb levels with a significance value of 0.000 or $p < 0.05$, meaning that there was an effect of giving *KNa* gummy candy on increasing Hb levels in adolescents. In the control group, there was an increase in Hb in 25 adolescents and the remaining 5 people, a significance value of 0.415, meaning that there was no effect of giving a gummy candy placebo on Hemoglobin levels. This study showed that in the control group, there was no significant difference between before and after the intervention.

Adolescence marks the second most significant phase of growth, characterized by rapid increases in height and weight, shifts in tissue composition, and the development of primary and secondary sexual characteristics, all reflecting underlying biological processes. These biological, psychological, and cognitive changes can significantly influence nutritional health. Over two-thirds of the body's iron is found in hemoglobin; typically, an adult's body contains around 10 mg of iron, while children have 11-12 mg, varying by size and sex. As cells age and break down, iron is released and transported to the bone marrow via plasma transferrin for red blood cell production. Daily iron loss is generally minimal, ranging from 0.5 to 1 mg, but menstruating individuals lose more, approximately 15 to 28 mg per month. Additionally, lifestyle factors such as

growing independence, frequent eating out, body size, stress, and overall lifestyle choices can impact dietary habits, potentially leading to nutritional deficiencies and anemia.[22]

Teenagers, during growth, often experience nutritional problems that cause physical changes that affect the need and adequacy of nutritional intake. Iron deficiency anemia may not be known and felt by children or parents. Still, the effects of anemia that cause decreased endurance will have the effect of reducing physical abilities, which will ultimately interfere with the growth and development of children. The imbalance between needs and adequacy will cause nutritional problems, namely anemia, which unhealthy eating habits, poor economic conditions, and strict diets can cause.[23]

The results of this study indicate an increase in hemoglobin in adolescent girls who experience anemia when given *KNa* gummy candy contains many macro- and micronutrients and vitamins; this is in accordance with the results of laboratory tests. One tablet contains 180 mg/g of vitamin C, alkaloid and phenol phytochemicals, an IC50 capacity of 510 µg/mL, 0.00536% Fe equivalent to 53.6 mg/kg, and is non-toxic (LD50 reaches more than 5000 mg/Kg).

Lack of iron intake due to insufficient amount of iron consumed, or the influence of its bioavailability, or the influence of the absorption ability of the iron itself. The absorption factor is an important consideration when giving iron supplements. Many micronutrients are used together with iron to increase nutrient absorption, including vitamin C, zinc, vitamin B12, and others. Vitamin C helps accelerate the absorption of iron in the body and plays a role in transporting iron into the bloodstream and mobilizing iron stores, particularly hemosiderin in the spleen.[24] K*Na* gummy candy contains antioxidants. Enzymatic antioxidants such as the SOD enzyme protect the body's cell membranes and prevent inflammation. Although these enzymes are actually present in the body, SOD activity requires iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu) to function. The catalase enzyme also requires iron (Fe), and the glutathione peroxidase enzyme requires selenium (Se). Enzymatic antioxidants prevent the formation of new free radicals.[25] The results of this study are in accordance with other studies, that consuming moringa leaves and dragon fruit skin, which are rich in macro and micronutrients, will increase iron reserves and increase hemoglobin.[24,26]

The selection of Moringa leaves and red dragon fruit peel was based on their complementary nutritional profiles, particularly in terms of iron, vitamin C, and antioxidant content. While additional insights could be gained by examining each ingredient's independent effects, this study focuses on evaluating their synergistic potential when combined. Future research with separate groups for Moringa-only or dragon-fruit-peel-only studies would enable the discernment of the individual contributions of each component. Despite the relatively small sample size, this exploratory design aimed to assess the potential benefits and feasibility of the gummy candy intervention. Baseline characteristics—such as age, weight, height, and dietary habits—were comparable between groups, ensuring balanced cohorts for analysis.

CONCLUSION

In conclusion, our pilot data suggest that a combined Moringa-leaf-and-red-dragon-fruit-peel gummy candy can positively influence hemoglobin levels among anemic adolescents. Nonetheless, interpretations should remain cautious due to the study's small scale and brief duration. Future research should incorporate larger cohorts, longer follow-up, and separate intervention arms to isolate the specific contributions of each active ingredient. Such efforts will help clarify the broader application of this palatable, nutrient-rich supplement within existing anemia prevention programs.

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Conflict of Interest

The author(s) do not have any conflict of interest.

Data Availability Statement

This statement does not apply to this article.

Ethics Statement

This study was approved by the ethical committee Politeknik Kesehatan Denpasar, Bali-Indonesia, with ethical clearance reference number: 070/1529/IP/DPM PTSP/2024 and research permit Number: 070/1529/IP/DPM PTSP/2024 from the Investment and One-Stop Integrated Service Office of the Gianyar Regency Government, Bali

Informed Consent Statement

Consent was obtained from participants using an approved consent form. Patients were informed about the details of the study, including the general overview, purpose, risks, and benefits. Confidentiality was maintained through all stages. This study was conducted following the Declaration of Helsinki.

Author Contributions

Ni Gusti Kompiang Sriasih: Writing, Data collection, Funding Acquisition, Supervision; Ni Nyoman Suindri, Made Widhi Gunapria Darmapatni: Data Collection, Analysis, Writing – Review & Editing.

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