

SYSTEMATIC LITERATURE REVIEW: THE EFFECTIVENESS OF RED SPINACH IN INCREASING HEMOGLOBIN LEVELS IN ADOLESCENT GIRLS

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ABSTRACT

Iron-deficiency anemia is a prevalent health concern among adolescent girls and has the potential to impair concentration, reduce productivity, and increase the risk of future pregnancy complications. Red spinach (*Amaranthus tricolor* L.) is a locally available food source rich in iron, vitamin C, and antioxidants, making it a promising dietary intervention for improving hemoglobin levels. This study aims to evaluate the effectiveness of red spinach consumption in increasing hemoglobin levels among adolescent girls through a systematic literature review. The review was conducted following PRISMA guidelines using the Systematic Literature Review approach. Article searches were performed through the Harzing's Publish or Perish application using the Google Scholar database, with the keywords "red spinach" AND "hemoglobin levels" AND "adolescent girls". Inclusion criteria consisted of articles published between 2021 and 2025, studies involving adolescent female participants, interventions using red spinach, publications in Indonesian or English, and full-text availability. Of the 200 articles identified, eight met the eligibility criteria. The findings indicate that all included studies reported an increase in hemoglobin levels after the administration of red spinach in various forms such as extracts, juices, puddings, biscuits, and other processed products within an intervention period of 7 to 14 days. The improvement in hemoglobin levels is associated with the non-heme iron content of red spinach, supported by vitamin C, which enhances iron absorption and erythropoiesis. Therefore, red spinach is proven to be effective and holds considerable potential as a complementary strategy alongside iron supplementation programs.

Keywords: Red spinach; Hemoglobin levels; Adolescent girls; Anemia

ABSTRAK

*Anemia defisiensi besi merupakan salah satu masalah kesehatan yang umum dialami remaja perempuan dan dapat memengaruhi kemampuan konsentrasi, produktivitas, serta meningkatkan risiko komplikasi kehamilan di masa depan. Bayam merah (*Amaranthus tricolor* L.) adalah salah satu bahan pangan lokal yang mengandung zat besi, vitamin C, dan antioksidan, sehingga berpotensi membantu meningkatkan kadar hemoglobin. Studi ini bertujuan menilai efektivitas konsumsi bayam merah dalam meningkatkan kadar hemoglobin pada remaja perempuan melalui tinjauan literatur sistematis. Metode studi menggunakan pendekatan Systematic Literature Review dengan mengikuti pedoman PRISMA. Proses*

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pencarian artikel dilakukan melalui aplikasi Harzing's Publish or Perish dengan database Google Scholar dan menggunakan kata kunci "bayam merah" AND "kadar hemoglobin" AND "remaja perempuan". Kriteria inklusi meliputi artikel terbit tahun 2021-2025, responden remaja perempuan, intervensi berupa bayam merah, artikel berbahasa Indonesia atau Inggris, serta tersedia lengkap dalam bentuk fulltext. Dari 200 artikel yang ditemukan, terdapat 8 artikel yang memenuhi kriteria. Hasil telaah menunjukkan seluruh penelitian melaporkan peningkatan kadar hemoglobin setelah pemberian bayam merah dalam berbagai bentuk olahan seperti ekstrak, jus, puding, biskuit, dan produk pangan lainnya dengan durasi intervensi 7-14 hari. Peningkatan hemoglobin dikaitkan dengan kandungan zat besi non-heme yang dipadukan dengan vitamin C sehingga mempercepat penyerapan dan pembentukan sel darah merah. Dengan demikian, bayam merah terbukti efektif dan berpotensi menjadi pendamping suplementasi tablet tambah darah.

Kata Kunci: Bayam merah; Kadar hemoglobin; Remaja Perempuan; Anemia

INTRODUCTION

Iron-deficiency anemia remains one of the major health problems affecting adolescent girls, particularly in developing (Rahman & Fajar, 2024). Adolescence is a transitional phase marked by rapid physical growth and development, which consequently increases nutritional requirements (Syarifaini et al., 2024). One essential nutrient during this period is iron, as it plays a key role in hemoglobin (Hb) synthesis responsible for transporting oxygen throughout body tissues. Iron deficiency leads to anemia, a nutritional problem frequently reported among adolescents, especially females (Arifin et al., 2024).

According to the WHO Global Anaemia Estimates 2025, 30.7% of women aged 15-49 years were affected by anemia in 2023. The prevalence was even higher among pregnant women, reaching 35.5% in the same age group. Meanwhile, anemia in non-pregnant women reached 30.5% in 2023 (WHO, 2025). Based on the 2018 Indonesian Basic Health Research (Riskesdas), the prevalence of anemia among Indonesian adolescents was 32%, indicating that approximately 3-4 out of 10 adolescents are affected (Alfiah & Dainy, 2023). This condition is caused by various factors such as menstrual blood loss, inadequate dietary iron intake, and poor nutritional habits. The impact of anemia in adolescents extends beyond reduced concentration and weakened immunity; it may impair growth, lower productivity, and potentially increase the risk of complications during future pregnancies (Amalia et al., 2024).

The government has implemented iron-folic acid supplementation (IFS) programs to prevent anemia. However, the outcomes remain suboptimal due to low adherence and side effects experienced by adolescents (Silitonga et al., 2024). Therefore, alternative non-pharmacological interventions that are better accepted by adolescents are needed, one of which is the consumption of natural food sources rich in iron such as red spinach (*Amaranthus tricolor* L.)

Red spinach is a readily accessible vegetable containing iron, vitamin C, and various phytonutrients that support red blood cell formation. Numerous studies have evaluated the

effect of red spinach consumption on improving hemoglobin levels in adolescent girls; however, the findings remain inconsistent (Purba et al., 2021). Variations in food processing methods, dosage, intervention duration, and study design contribute to the lack of a definitive conclusion regarding its effectiveness as a nutritional intervention for increasing hemoglobin levels.

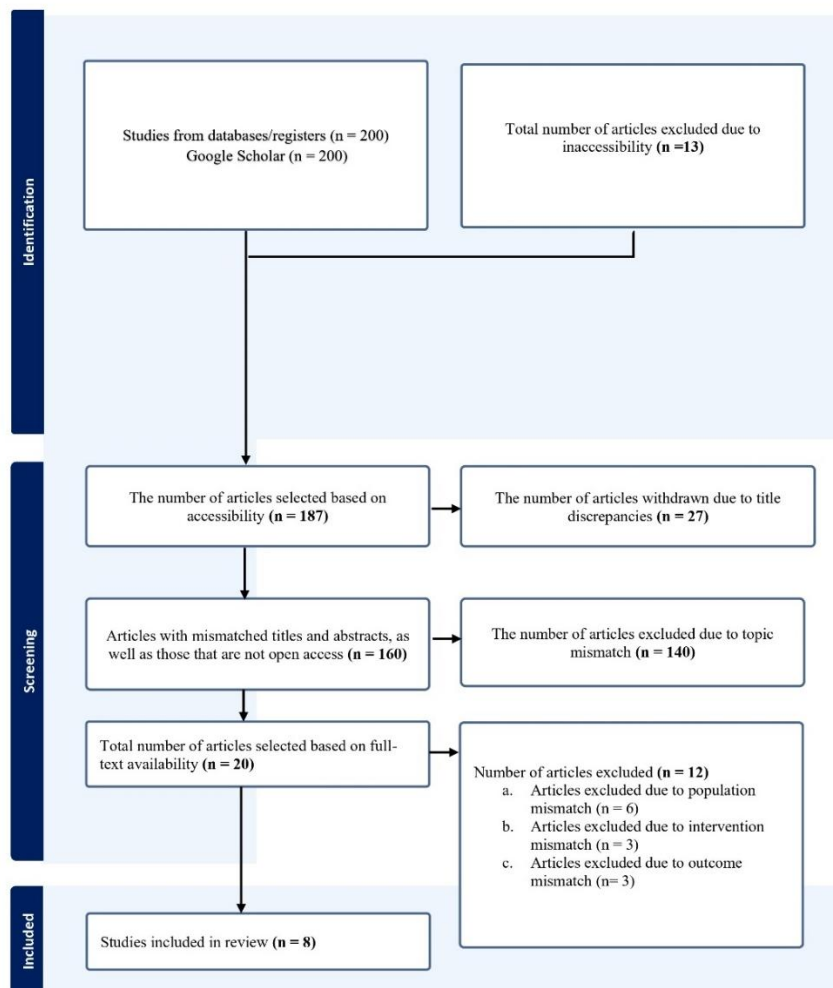
These variations indicate a knowledge gap that requires systematic examination to summarize and assess the quality of existing evidence. Therefore, this study was conducted as a systematic literature review aimed at identifying and synthesizing research findings on the effectiveness of red spinach in increasing hemoglobin levels among adolescent girls. The results are expected to provide a stronger scientific foundation for developing local food-based interventions in anemia prevention programs for adolescents.

METHOD

This study employed a systematic literature review method. Articles were identified using the Harzing's Publish or Perish application with the Google Scholar database; all stages of the selection process followed the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) guidelines. The keywords used were "red spinach" AND "hemoglobin levels" AND "adolescent girls."

Inclusion criteria consisted of articles published between 2021-2025, involving adolescent respondents aged 12-18 years, written in Indonesian or English, available in full text, open access, using red spinach as the intervention, and presenting significant intervention outcomes. Exclusion criteria included literature surveys, systematic reviews, irrelevant outcomes, respondents with comorbidities, paid-access articles, and articles without full-text availability.

Article selection followed the PRISMA flowchart. The initial search yielded 200 articles. After screening for accessibility, 187 articles remained. Screening based on titles, abstracts, and open-access status produced 160 articles. From full-text screening, 20 articles were retained. In the final stage, only 8 articles met all predefined eligibility criteria.



Gambar 1. PRISMA Flowchart

Source: Authors

RESULTS AND DISCUSSION

A. RESULTS

No.	The research title and year	The study design and methodology	The population and respondents	The procedures and interventions	Research findings
1.	Miel Lidi Bayam Melrah untuk Meningkatkan Haelmoglobin pada Relmaja pelrempuan (Zulmi elt al., 2022)	Thel reselarch elmployed a quantitativel method using a prel-elxpelrimelntal delsign involving two groups with a preltest posttelst control group approach.	This study was conductel among first-yelar studeInts, of whom 22 welrel idelntified as having anelmia, and selcond yelar studeInts, with 29 casels of anelmia. Thel minimum relquireld samplel	Thel study divideld participants into two groups, consisting of adolescelnt felmalel studeInts at Akbid La Tansa Mashiro who welrel diagnoseld with anelmia. Thel intervelntion group first undelrweInt haelmoglobin asselssmelnt and subselequeIntly	Thel findings indicatel that relspondelnts who consumeld relld-spinach stick noodlel elxpelrienceld a 90.5% increlasel in haelmoglobin lelvels. In contrast, participants who did not relcelivel thel intervelntion,

			size was 42 participants.	received red-spinach stick noodles, which they were instructed to consume daily along with mineral water for a period of 14 days. In contrast, the control group did not receive the red-spinach noodle intervention, allowing for a clear comparison of outcomes between the two groups.	or who were not given the red-spinach stick noodles, showed no improvement, with only 71.4% exhibiting unchanged hemoglobin levels.
2.	Red Spinach-Containing Snack Food Improved Hemoglobin and Hematocrit Levels of Girl Adolescents in Riau Archipelago (Wilandri et al., 2023)	This study employed a quasi-experimental design using a pretest-posttest approach.	The study included a control group consisting of 36 subjects, who were further allocated into two subgroups: an intervention group and a control group.	The study involved a control group consisting of 36 participants, divided into two subgroups. The treatment group received snack products enriched with red spinach, while the control group was given similar snacks without red spinach for a period of 14 days.	This study demonstrates that the measurable difference in hemoglobin and hematocrit levels within the intervention group before and after the treatment, with increases of 0.4 ± 0.05 g/dL and $2.1 \pm 0.07\%$, respectively. In contrast, no changes in hemoglobin or hematocrit levels were observed in the control group across the same period.
3.	Effectiveness of Puding Bayam Merah (Amaranthus Tricolor L) terhadap Peningkatan Kadar Hemoglobin Remaja perempuan (Siagian & Delsmariyenti, 2023)	This study employed a quantitative approach using a quasi-experimental design, specifically a one-group pretest-posttest model.	The study population consisted of 14 female students at SMP IT Insan Utama. All 14 students met the criteria and were therefore included as the total sample using a saturated sampling technique.	The students were provided with red spinach pudding to evaluate its effectiveness in improving hemoglobin levels.	Based on the findings of the study, the Wilcoxon test yielded a p-value lower than α ($0.001 < 0.05$), indicating that red spinach pudding (<i>Amaranthus tricolor</i> L.) is effective in increasing hemoglobin levels among adolescent girls at SMP IT Insan Utama Pekanbaru in 2022.
4.	Pengaruh Peningkatan Kadar Hemoglobin dengan Pemberian Jus Kurma Bayam Merah pada Remaja perempuan (Masfufah et al., 2023)	The study employed a pre-experimental approach utilizing a one-group pretest-posttest design.	The sampling technique employed was purposive sampling, involving a total of 23 adolescent female participants.	A total of twenty-three adolescent girls participated in the study, with the administration of red-spinach date juice serving as the independent variable and hemoglobin levels	The univariate analysis included distribution, frequency, and percentage assessment, while the bivariate analysis employed a paired sample t-test. The

				as the dependent variable.	results demonstrated that red spinach-date juice had a significant effect on increasing hemoglobin levels among female adolescents at SMA Negeri 5 Palu, as indicated by a p-value of 0.000 (<0.005).
5.	Pengaruh Sayur Bayam Merah terhadap Perubahan Kadar Hemoglobin Remaja perempuan Dengan Anemia di SMP 51 Wilayah Kerja Puskesmas Kabil Kota Batam (Mailis & Husaidah, 2025)	The study employed a quasi-experimental design using a two-group approach.	The study involved 32 adolescent female participants, who were assigned into two groups consisting of 16 individuals in the intervention group and 16 in the control group.	The respondents received the intervention followed by the administration of red spinach combined with iron (Fe) for a period of seven days as a preventive measure against anemia.	The study found differences in the mean hemoglobin levels between the intervention and control groups before and after treatment among adolescent girls at SMP Negeri 51 within the Kabil Community Health Center area in 2024. The administration of red spinach significantly contributed to the increase in hemoglobin levels among the students in this setting.
6.	Pengaruh Miel Bayam Merah terhadap Peningkatan Kadar HB untuk Remaja perempuan (Faridi et al., 2022)	This study employed a quasi-experimental design with a purposive sampling technique for participant selection.	This study was conducted at SMA Pellita Tiga Rawamangun and involved female students aged 15-17 years. A total of 30 participants were included after undergoing an initial screening process.	The sample received the intervention by consuming red-spinach noodles once daily for two weeks, with each portion weighing 56 grams. After the 14-day intervention period, the participants' hemoglobin levels were re-measured to determine any changes, followed by a 24-hour dietary recall to assess their nutrient intake.	The findings of this study indicated that most respondents had low hemoglobin levels prior to the intervention, and a notable increase was observed following the administration of red spinach noodles. There was a statistically significant difference in protein and iron intake among respondents before and after the intervention.
7.	Efektifitas Pembelajaran Puding Bayam Merah terhadap Kadar Hemoglobin pada Remaja perempuan dengan Anemia di Pondok Pesantren Al Baaqiyatussa'diyah	The type of research used in this study was a quasi-experimental design employing a one-group	The population consisted of all female students diagnosed with anemia, selected using a total sampling technique,	The sampling technique employed was total sampling. Data collection comprised two stages: preparation and implementation. The preparation stage	The research findings revealed that the mean hemoglobin level prior to the administration of red spinach pudding was 10.04

	Telmbilahan Kabupaten Indragiri Hilir (Fadhli ELt AL., 2024)	pretelst-posttelst approach.	resulting in a sampel of 37 relspondelnts.	involved completing all corrspondelncel rellateld to obtaining relselarch pelmits, whilel thel implelmeIntation stagel belgan with thel distribution of informeld conseInt forms, followeld by thel collelction of reld blood samplels and thel administration of reld spinach pudding on selparatel days over a conselcutive selveln-day pelriod.	with a standard delviation of 1.014, whelrelas on thel selvelnth day after thel intervelntion, thel melan lelvell increlaseld to 12.09 with a standard delviation of 1.235. The analysis yielldeld a p-value of 0.000 (p < 0.005).
8.	Pelngaruh Pelmbelrian ELkstrak Bayam Melrah telrhadap Pelingkatan Kadar Helmoglobin pada Mahasiswa Jurusan Kelbidanan Univelrsitas Audi Indonelsia (Bangun, 2022)	Thel tytel of relselarch elmployeld was a quasi-elxpelrimelntal study using a prel-telst and post-telst group delsign to deltelrminel thel elffelct of reld spinach exltract administraction on thel increlasel in helmoglobin lelvels among studeInts of thel Midwifely DelpartmeInt at Audi Univelrsity Indonelsia.	The population in this study consisteld of all first-yelar felmalel adolescelnts in thel Diploma III Midwifely Program, totaling 106 individuals relsiding in thel dormitory, from which a sampel of 84 participants was sellecteld.	The studeInts welrel administelreld reld spinach exltract in capsule form to obselvel thel changes in helmoglobin lelvels belforel and after thel intervelntion.	The study findings showeld that thel avelragel helmoglobin lelvell prior to thel administration of reld spinach exltract was 11.955 g/dL (minimum = 8.7 g/dL and maximum = 13.7 g/dL), whilel thel avelragel helmoglobin lelvell after thel administration was 12.404 g/dL (minimum = 8.1 g/dL and maximum = 16.0 g/dL). The diffelrelnce in helmoglobin lelvels belforel and afterl receliving thel reld spinach exltract delmonstateld an increlasel in 58 participants (69.1%). Thesel relsults indicatel that thel administration of reld spinach exltract significantly influelncels thel elnhancelmeInt of helmoglobin lelvels among Midwifely studeInts at Audi Univelrsity Indonelsia.

Tabel 1. Analyzeld Articlel Data

Source: Authors

B. DISCUSSION

This systematic review identified eight studies examining the effectiveness of red spinach in various processed forms including red-spinach noodle sticks, snacks, puddings, juices, vegetable tablets, noodles, and extracts in improving hemoglobin levels among adolescent girls and female students with anemia. Overall, all included studies demonstrated a consistent pattern of findings, namely a measurable increase in hemoglobin concentrations following red-spinach based interventions. For instance, the study by Zulmi et al. (2022) reported an increase of up to 90.5% in hemoglobin levels among participants who consumed red-spinach noodle sticks for 14 days. Similar outcomes were observed in the study by Wilandri et al. (2023), which documented improvements in hemoglobin and hematocrit levels in the group receiving red-spinach-enriched snacks compared to the control group. Additionally, studies by Fadhli et al. (2024) Siagian and Delsmariyenti (2023) demonstrated the efficacy of red-spinach pudding using a one-group pretest-posttest design, both showing significant improvements within a 7-14 day intervention period. Other investigations such as those conducted by Bangun (2022), Faridi et al. (2022), Mailis and Husaidah (2025), and Masfufah et al. (2023) further reinforced these findings, showing that red spinach administered as date red spinach juice, red spinach combined with iron, red-spinach noodles, or red-spinach extract capsules produced meaningful increases in hemoglobin levels among adolescent girls.

The consistency of results across various formulations and populations underscores the potential of red spinach as a viable local dietary intervention to address anemia in adolescents. The mechanism underlying the increase in hemoglobin is presumably linked to the iron, vitamin C, and antioxidant content of red spinach, which together support erythropoiesis and enhance iron absorption. Consequently, these findings carry important implications for healthcare providers, end-users, and policymakers. For healthcare practitioners, red spinach can serve as a complementary approach to iron supplementation, which often faces adherence challenges. For adolescents and their families, palatable preparations such as puddings, juices, noodles, and snacks may improve acceptance and long-term compliance. For policymakers, the evidence supports the integration of plant-based iron sources into local food and nutrition programs, including school health initiatives, community health center programs, and adolescent nutrition interventions.

Nevertheless, several limitations should be noted. At the study level, most research employed quasi-experimental or one-group pretest-posttest designs, as seen in studies by Bangun (2022), Fadhli et al. (2024), Masfufah et al. (2023), dan Siagian and Delsmariyenti (2023). The absence of randomized control groups raises the risk of selection bias and weakens causal inference. Sample sizes were also generally small (approximately 14-37 participants in many studies), which reduces statistical power. Moreover, there was considerable heterogeneity across interventions, including differences in formulation type (pudding, noodles, snacks, juice, vegetable tablets, or extract), dosage, frequency, and duration (7-14 days), making direct comparison or meta-analysis difficult. Several studies measured only hemoglobin levels without evaluating other biomarkers such as ferritin or mean corpuscular volume (MCV), which limits the ability to determine whether the observed increases in hemoglobin reflect long-term improvements in iron stores. Control of confounding factors such as dietary patterns, menstrual status, or concurrent supplement intake was also inadequately reported in most research.

At the relatively low level, additional limitations must be acknowledged. Some relevant local studies may not have been captured due to limited indexing in major databases, leading to a potential publication bias. Furthermore, not all studies reported detailed methods for hemoglobin measurement, complicating the assessment of outcome level risk of bias. The substantial heterogeneity in study design and intervention protocols also precluded the possibility of conducting a robust meta-analysis, resulting in a largely narrative synthesis.

Overall, this review demonstrates that red spinach has strong potential as a local dietary intervention to improve hemoglobin levels among adolescent girls with anemia. Although the available evidence is consistent, methodological limitations across the included studies reduce the overall certainty of the evidence to a moderate level. Therefore, future research should involve rigorously designed randomized controlled trials with larger sample sizes, longer intervention durations, standardized dosages, and more comprehensive iron-status biomarkers. Nevertheless, based on current findings, red spinach remains a safe, accessible, and acceptable complementary strategy for anemia prevention among adolescent girls.

Conclusion

This review concludes that red spinach is effective in increasing hemoglobin levels among adolescent girls, aligning with the study's objective of evaluating local dietary interventions for anemia prevention. All included studies demonstrated improvements in hemoglobin following red spinach consumption across various processed forms. Based on these findings, red spinach can be recommended as a non-pharmacological intervention that is well accepted by adolescents. To strengthen the evidence, future research should employ randomized controlled designs, larger participant samples, longer intervention periods, and more comprehensive iron-status biomarkers.

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