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Effect of a Standardized Mung Bean (*Vigna radiata*)–Guava (*Psidium guajava* L.) Juice Intervention on Hemoglobin Concentration in Patients Undergoing Chemotherapy: A Controlled Quasi-Experimental Study

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ABSTRACT: Background: Chemotherapy-induced bone marrow suppression is a major contributor to anemia among patients receiving cytotoxic treatment and may adversely affect fatigue, treatment tolerance, and health-related quality of life. Mung bean (*Vigna radiata*) provides dietary iron, folate, and protein, whereas guava (*Psidium guajava* L.) is a rich source of vitamin C, which facilitates the absorption of non-heme iron. Although previous research has suggested that a combined mung bean–guava juice preparation may increase hemoglobin (Hb) concentration, the available evidence has largely been derived from uncontrolled pre–post studies, limiting causal interpretation. Evidence from controlled studies remains limited.

Objective: To evaluate the association between a standardized mung bean–guava juice intervention and changes in Hb concentration among patients undergoing chemotherapy in West Aceh District, Indonesia, using a concurrent control group.

Methods: A quantitative, controlled quasi-experimental study with a pretest–posttest control-group design was conducted among 60 patients undergoing chemotherapy. Participants were recruited using purposive sampling and allocated through a predetermined non-randomized procedure to an intervention group ($n = 30$) or control group ($n = 30$). The intervention group received a standardized mung bean–guava juice preparation at a 1:1 ratio, administered orally once daily for seven consecutive days following chemotherapy. The control group received routine chemotherapy and standard supportive care without the juice intervention. Hb concentration was assessed at baseline before chemotherapy and again after the seven-day observation period. Within-group changes were assessed using paired-samples t -tests, while between-group differences in Hb change (ΔHb) were evaluated using an independent-samples t -test. Categorical Hb status was compared using the chi-square test or Fisher's exact test, as appropriate. Statistical significance was defined as $p < 0.05$.

Results: In the intervention group, mean Hb concentration increased from 10.74 ± 1.89 g/dL at baseline to 12.47 ± 1.69 g/dL at posttest, corresponding to a mean increase of 1.73 g/dL (paired t -test, $t = 6.77$, $p < 0.001$). In the control group, mean Hb increased from 11.16 ± 1.78 g/dL to 11.93 ± 1.82 g/dL, corresponding to a mean increase of 0.77 g/dL ($t = 3.02$, $p = 0.005$). The between-group difference in ΔHb was 0.96 g/dL in favor of the intervention group and was statistically significant (independent-samples t -test, $t = 2.66$, $p = 0.010$; 95% CI, 0.24–1.68 g/dL). The proportion of participants achieving adequate Hb status increased from 23.3% to 73.3% in the intervention group and from

33.3% to 50.0% in the control group; however, the posttest between-group difference was not statistically significant ($p = 0.111$; Fisher's exact test, $p = 0.110$).

Conclusion: Seven days of standardized mung bean–guava juice supplementation was associated with a significantly greater increase in Hb concentration than standard supportive care alone among patients undergoing chemotherapy. The findings provide controlled preliminary evidence supporting the potential role of this accessible, culturally familiar nutritional intervention as an adjunct to chemotherapy supportive care.

1. INTRODUCTION

Cancer remains a major global public health challenge and is among the leading causes of morbidity and mortality worldwide. The global burden of cancer continues to increase as a consequence of population growth, ageing, demographic transitions, and the persistence of modifiable and non-modifiable risk factors[1,2]. According to the latest global estimates reported by the World Health Organization (WHO) through the International Agency for Research on Cancer (IARC) on World Cancer Day 2024, approximately 20 million new cancer cases and 9.7 million cancer-related deaths occurred worldwide, based on data from 185 countries. Lung, breast, colorectal, prostate, and stomach cancers accounted for the largest proportions of newly diagnosed cases, representing 12.4%, 11.6%, 9.6%, 7.3%, and 4.9%, respectively [3,4]. Beyond its direct effects on survival, cancer imposes a substantial burden on patients through treatment-related complications, functional impairment, nutritional disturbances, and deterioration in health-related quality of life. Consequently, improving supportive care alongside definitive cancer treatment has become an increasingly important component of comprehensive cancer management. Indonesia is also experiencing a substantial and increasing cancer burden[5,6]. Data from the national Basic Health Research (Riset Kesehatan Dasar; Riskesdas) indicated that the prevalence of cancer or tumors increased from 1.4 per 1,000 population in 2013 to 1.79 per 1,000 population in 2018[7,8]. This increasing burden presents important challenges for healthcare systems, particularly in relation to the long-term management of patients undergoing multimodal cancer treatment. At the provincial level, cancer also represents an important health concern in Aceh. According to data from the Aceh Health Office, 1,318 cancer cases were recorded in 2022, with breast cancer accounting for the largest proportion (1,117 cases), followed by cervical cancer (186 cases) and retinoblastoma (15 cases)[5,9,10]. These findings emphasize the need not only to strengthen cancer prevention and treatment but also to address treatment-related complications that may adversely affect patients' clinical outcomes and quality of life[11–13].

Chemotherapy remains a cornerstone of cancer treatment and is widely used either as a primary therapeutic modality or in combination with surgery, radiotherapy, and hormonal therapy. Although chemotherapy can substantially improve disease control and survival, its cytotoxic effects are not restricted to malignant cells and may also affect rapidly proliferating normal tissues[14,15]. One clinically important consequence is bone marrow suppression, which can impair hematopoiesis and contribute to reductions in circulating blood cells, including erythrocytes and hemoglobin (Hb). Anemia is therefore a common complication among patients receiving chemotherapy and may become more pronounced as treatment progresses[12,13,16]. The WHO Worldwide Prevalence of Anaemia report estimated that approximately 1.62 billion people globally are affected by anemia, while previous evidence has indicated that more than 60% of patients with cancer receiving chemotherapy may develop anemia during treatment.

Chemotherapy-associated anemia is clinically relevant because its consequences extend beyond a reduction in Hb concentration. Reduced oxygen-carrying capacity can contribute to fatigue, weakness, reduced physical functioning, diminished treatment tolerance, and impaired health-related quality of life[17,18]. In patients with cancer, these effects may be particularly consequential because they occur in the context of an already demanding disease trajectory and repeated exposure to cytotoxic treatment[17]. Anemia may also complicate the delivery of cancer therapy and increase the overall burden of supportive care. Therefore, interventions that can safely complement standard medical management and support hematological recovery may have important clinical and nutritional relevance, particularly when they are affordable, culturally acceptable, and feasible to implement in resource-constrained settings.

Nutritional status is an important component of hematopoietic health, particularly because erythropoiesis requires adequate availability of iron and other micronutrients[19,20]. Iron is an essential component of hemoglobin and is therefore fundamental to the production of functional red blood cells. However, the amount of dietary iron consumed does not necessarily correspond

to the amount absorbed and utilized by the body. Iron bioavailability is influenced by its chemical form and by the composition of the meal in which it is consumed. Non-heme iron, which is predominantly derived from plant-based foods, generally has lower bioavailability than heme iron from animal sources[21–23]. Consequently, dietary strategies that combine plant-based sources of iron with nutrients that enhance iron absorption may represent a practical approach to improving iron utilization[23,24].

Mung bean (*Vigna radiata*) is a nutritionally valuable legume that may provide several nutrients relevant to hematopoietic health. It contains protein, folate, thiamine, and a range of essential minerals, including iron, potassium, magnesium, phosphorus, and copper. Mung beans are also widely consumed in Indonesia and can be incorporated into food and beverage preparations using relatively simple processing methods. From a nutritional perspective, their iron content makes mung beans a potentially useful plant-based source of dietary iron. Nevertheless, the utilization of iron from mung beans may be limited by the relatively low bioavailability of non-heme iron. Thus, combining mung beans with an appropriate source of vitamin C may provide a biologically plausible strategy for improving the absorption of plant-derived iron[25–27].

Vitamin C is particularly relevant to this process because it can enhance the absorption of non-heme iron by facilitating the reduction of ferric iron to the more absorbable ferrous form and by promoting the formation of soluble iron complexes in the gastrointestinal tract. Consequently, foods naturally rich in vitamin C may complement iron-containing plant foods when consumed together (8,9). Guava (*Psidium guajava* L.) is a fruit recognized for its high vitamin C content. Reported concentrations vary considerably according to cultivar, maturity, growing conditions, and analytical methods, with values ranging from approximately 11 to 1,160 mg per 100 g of fruit[28–30]. Despite this variability, guava represents a potentially accessible dietary source of vitamin C and may therefore be suitable for combination with mung beans to enhance the bioavailability of non-heme iron. The combination is also nutritionally attractive because it integrates an iron-containing legume with a vitamin C-rich fruit within a single food-based preparation. The potential hematological benefits of combining mung bean and guava have been suggested by previous research. Huda et al. (2016) reported an increase in mean Hb concentration from 8.90 g/dL at pretest to 13.14 g/dL at posttest, corresponding to a mean increase of 4.23 g/dL ($p < 0.05$), following administration of a combined mung bean and guava juice preparation among patients undergoing chemotherapy[31,32]. These findings are potentially important because they suggest that a food-based intervention combining an iron-containing plant source with a vitamin C-rich fruit may contribute to improvements in Hb levels among patients exposed to chemotherapy. Furthermore, such an intervention could potentially be advantageous in settings where access to expensive nutritional supplements or intensive supportive therapies is limited.

However, the existing evidence should be interpreted cautiously. A substantial increase in Hb following a nutritional intervention cannot necessarily be attributed solely to the intervention unless changes are assessed against an appropriate concurrent control group and potential confounding factors are adequately considered. In patients undergoing chemotherapy, Hb levels may be influenced by multiple factors, including cancer type and stage, chemotherapy regimen, treatment cycle, baseline nutritional status, inflammation, bleeding, renal function, concomitant medications, and other supportive treatments[33–35]. Without an appropriate comparison group, it is difficult to distinguish the effect of a dietary intervention from natural variation in Hb levels or changes associated with ongoing cancer treatment. Therefore, controlled evaluation is necessary to establish whether the observed improvement is reproducible and attributable to the intervention. In addition, previous evidence on mung bean–guava juice remains limited in terms of standardized intervention protocols and study settings. Differences in ingredient proportions, preparation methods, intervention duration, frequency of administration, and patient characteristics may affect the reproducibility and interpretation of findings. Evidence generated in one healthcare setting may also not be directly generalizable to other populations, particularly those receiving chemotherapy in regional or non-tertiary healthcare facilities[35–37]. This is particularly relevant in Indonesia, where healthcare access, dietary practices, nutritional patterns, and availability of supportive cancer services may differ substantially between urban tertiary-care centers and district-level healthcare settings.

Accordingly, there remains a need for controlled studies investigating practical, food-based adjunctive interventions that can be implemented alongside standard chemotherapy without replacing established medical treatment. A standardized mung bean–guava juice preparation represents a potentially feasible intervention because both ingredients are commonly available, relatively inexpensive, and culturally familiar in Indonesia. More importantly, the combination has a plausible nutritional rationale: mung bean provides dietary iron and other nutrients involved in hematopoiesis, whereas guava provides vitamin C that may enhance

the absorption and utilization of non-heme iron. Nevertheless, the clinical effectiveness of this combination among patients undergoing chemotherapy requires evaluation using an appropriate comparative design. The present study was therefore designed to address this evidence gap by evaluating the effect of a standardized mixed mung bean and guava juice intervention on Hb levels among cancer patients undergoing chemotherapy in West Aceh District, Indonesia. Using a controlled quasi-experimental design, this study aimed to determine whether the administration of the intervention was associated with a greater improvement in Hb levels than that observed in the concurrent control group. By investigating a low-cost, food-based intervention within a real-world chemotherapy population and a district-level healthcare context, this study seeks to provide contextually relevant evidence regarding the potential role of dietary strategies as adjunctive supportive care for chemotherapy-associated anemia.

2. MATERIALS AND METHODS

This study employed a quantitative, controlled quasi-experimental design with a pretest–posttest control-group approach to evaluate the effect of a mixed mung bean (*Vigna radiata*) and guava (*Psidium guajava* L.) juice intervention on hemoglobin (Hb) concentration among cancer patients undergoing chemotherapy in West Aceh District, Aceh Province, Indonesia. The study was conducted in collaboration with the West Aceh District Health Office, which facilitated the administrative research process and access to eligible participants. The study population comprised cancer patients who were receiving chemotherapy during the study period. A total of 60 participants were recruited using purposive sampling and assigned to an intervention group ($n = 30$) and a concurrent control group ($n = 30$) using a predetermined non-randomized allocation procedure. Participants were eligible if they had a confirmed diagnosis of cancer, were undergoing chemotherapy, were aged 4–55 years, had a baseline Hb concentration of <10 g/dL, were able to consume oral nutritional preparations, and provided informed consent or, where applicable, consent from a parent or legally authorized representative. Participants who had received a recent blood transfusion, erythropoiesis-stimulating agents, therapeutic iron supplementation, or other interventions specifically intended to increase Hb concentration during the study period were excluded. Participants in the intervention group received a standardized mixed mung bean and guava juice preparation in a 1:1 ratio, administered orally once daily for seven consecutive days following a chemotherapy session, whereas participants in the control group received routine chemotherapy and standard supportive care without the juice intervention. The mung beans were sorted, washed, cooked until softened, and blended with fresh guava to produce a homogeneous juice preparation, which was administered according to the standardized study protocol. Intervention adherence was monitored throughout the seven-day intervention period using a standardized observation form. Hb concentration was measured immediately before chemotherapy at baseline (pretest) and after completion of the seven-day intervention period (posttest) using the same Hb measurement procedure for all participants. Participant demographic and clinical characteristics were collected using a structured questionnaire and standardized observation form, including age, sex, cancer type, chemotherapy status, and other relevant clinical characteristics. Data were analyzed using appropriate descriptive and inferential statistical procedures. Continuous variables were summarized using means and standard deviations, whereas categorical variables were presented as frequencies and percentages. Data normality was assessed using the Shapiro–Wilk test. Within-group changes in Hb concentration between pretest and posttest were evaluated using the paired-samples t -test, while between-group differences in Hb change ($\Delta\text{Hb} = \text{posttest Hb} - \text{pretest Hb}$) were assessed using the independent-samples t -test. Where parametric assumptions were not satisfied, the corresponding non-parametric tests were applied. The magnitude of the intervention effect was evaluated using the between-group mean difference and 95% confidence interval, with an appropriate standardized effect size reported where applicable. Baseline Hb concentration and other clinically relevant baseline characteristics were considered when interpreting between-group differences because of the non-randomized study design. All statistical tests were two-sided, and a p -value <0.05 was considered statistically significant.

RESULTS

3.1 Univariate Analysis of Hemoglobin Concentration

The descriptive analysis was conducted to characterize hemoglobin (Hb) concentrations before and after the intervention in both the intervention and control groups. Table 1 presents the mean, standard deviation (SD), and observed range of Hb concentrations at baseline (pretest) and following the seven-day observation period (posttest). These descriptive statistics provide an overview of the distribution and magnitude of Hb changes within each study group before the between-group inferential analysis.

Table 1. Descriptive analysis of hemoglobin concentration before and after the intervention

Group	Hb measurement	<i>n</i>	Mean $\pm$ SD (g/dL)	Min–Max (g/dL)
Intervention	Pretest	30	10.74 $\pm$ 1.89	8.00–15.00
	Posttest	30	12.47 $\pm$ 1.69	9.80–15.00
Control	Pretest	30	11.16 $\pm$ 1.78	9.00–15.00
	Posttest	30	11.93 $\pm$ 1.82	9.80–14.80

At baseline, the mean Hb concentration was 10.74 $\pm$ 1.89 g/dL in the intervention group and 11.16 $\pm$ 1.78 g/dL in the control group. Thus, the intervention group entered the study with a slightly lower mean Hb concentration than the control group, although the observed baseline distributions overlapped substantially. Following the seven-day intervention period, the mean Hb concentration in the intervention group increased to 12.47 $\pm$ 1.69 g/dL, corresponding to an absolute descriptive increase of 1.73 g/dL from baseline. In the control group, the mean Hb concentration increased from 11.16 $\pm$ 1.78 g/dL at baseline to 11.93 $\pm$ 1.82 g/dL at posttest, representing a descriptive increase of 0.77 g/dL. The magnitude of the observed increase was therefore greater in the intervention group than in the control group, with an approximately 0.96 g/dL larger crude improvement in mean Hb concentration in the intervention group (1.73 vs. 0.77 g/dL). This descriptive difference provides an initial indication of a potentially greater improvement in Hb concentration among participants receiving the mixed mung bean–guava juice intervention. However, whether this between-group difference represents a statistically significant intervention effect requires confirmation through inferential analysis. The variability of Hb concentration also differed modestly between the two assessment points. In the intervention group, the SD decreased from 1.89 g/dL at pretest to 1.69 g/dL at posttest, whereas in the control group it increased slightly from 1.78 to 1.82 g/dL. The reduction in dispersion observed in the intervention group indicates that posttest Hb values were somewhat less heterogeneous than baseline values; however, this descriptive pattern alone does not establish a treatment-related effect or indicate convergence specifically among participants with lower baseline Hb concentrations. The pretest Hb ranges were relatively broad in both groups (8.00–15.00 g/dL in the intervention group and 9.00–15.00 g/dL in the control group), indicating substantial interindividual variation in baseline hematological status among participants undergoing chemotherapy. Such variability may reflect differences in disease characteristics, treatment exposure, nutritional status, or other clinical factors and should therefore be considered when interpreting the subsequent comparative analysis.

3.2 Bivariate Analysis of Hemoglobin Change

Bivariate analysis was performed to assess within-group changes in hemoglobin (Hb) concentration from baseline to post-intervention and to compare the magnitude of Hb change between the intervention and control groups. The change in Hb concentration (Δ Hb) was calculated as the posttest Hb concentration minus the pretest Hb concentration. Within-group changes were evaluated using paired *t*-tests, whereas the difference in Δ Hb between groups was assessed using an independent-samples *t*-test.

Table 3. Bivariate analysis of changes in hemoglobin concentration

Group	Mean pretest (g/dL)	Mean posttest (g/dL)	Δ Hb (g/dL)	<i>t</i>	<i>p</i>
Intervention	10.74	12.47	1.73	6.77	<0.001
Control	11.16	11.93	0.77	3.02	0.005
Between-group difference in Δ Hb	—	—	0.96	2.66	0.010 (95% CI 0.24–1.68)

In the intervention group, the mean Hb concentration increased from 10.74 $\pm$ 1.89 g/dL at baseline to 12.47 $\pm$ 1.69 g/dL following the intervention, corresponding to a mean increase of 1.73 g/dL. This within-group increase was statistically significant (*t* = 6.77, *p* < 0.001), indicating a significant improvement in Hb concentration over the observation period. Similarly,

in the control group, the mean Hb concentration increased from 11.16 ± 1.78 g/dL at baseline to 11.93 ± 1.82 g/dL at posttest, corresponding to a mean increase of 0.77 g/dL. This change was also statistically significant ($t = 3.02$, $p = 0.005$), indicating that Hb concentration increased significantly during the study period even in the absence of the intervention. However, the magnitude of the increase in Hb concentration was greater in the intervention group than in the control group. The mean change in Hb was 0.96 g/dL greater among participants who received the mixed mung bean–guava juice intervention. The between-group analysis demonstrated a statistically significant difference in Δ Hb ($t = 2.66$, $p = 0.010$), with an estimated mean difference of 0.96 g/dL (95% CI: 0.24–1.68) in favor of the intervention group. these findings indicate that the mixed mung bean–guava juice intervention was associated with a significantly greater improvement in Hb concentration compared with the control condition over the seven-day observation period. Although both groups demonstrated significant within-group increases in Hb concentration, the greater magnitude of improvement observed in the intervention group suggests a potential beneficial effect of the intervention on Hb status.

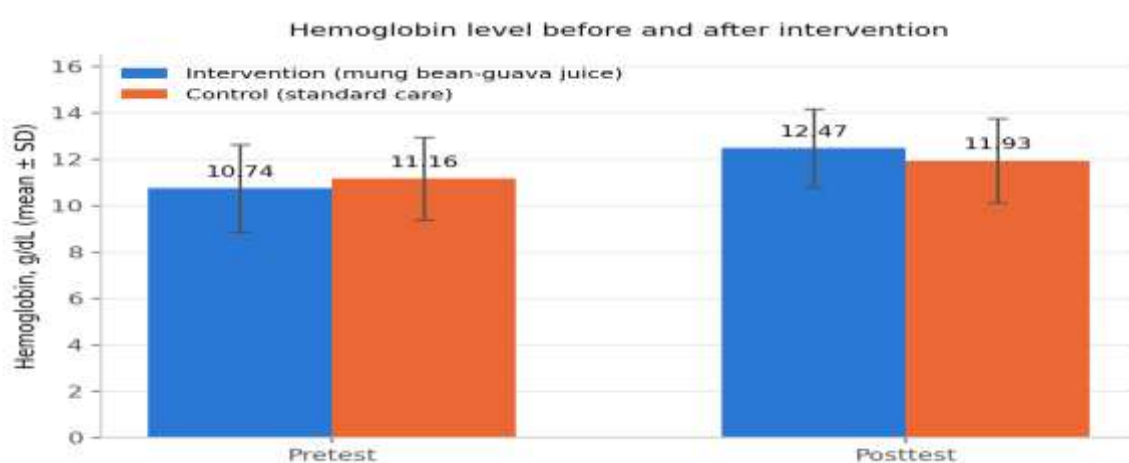
3.3 Hemoglobin Status by Category

Table 4. Proportion of participants with adequate hemoglobin status before and after the intervention

Hemoglobin status	Intervention group, n (%)	Control group, n (%)	<i>p</i> -value (between groups)
Adequate Hb — before intervention	7 (23.3)	10 (33.3)	0.567 ^a
Adequate Hb — after intervention	22 (73.3)	15 (50.0)	0.111 ^a / 0.110 ^b

^a Chi-square test with Yates' continuity correction; ^b Fisher's exact test.

The proportion of participants classified as having adequate Hb status increased in both study groups following the intervention period. In the intervention group, the proportion increased from 23.3% (7/30) at baseline to 73.3% (22/30) at posttest, representing an absolute increase of 50.0 percentage points. In the control group, the corresponding proportion increased from 33.3% (10/30) to 50.0% (15/30), representing an increase of 16.7 percentage points. At baseline, the between-group difference in the proportion of participants with adequate Hb status was not statistically significant ($p = 0.567$), indicating no statistically significant difference between groups in the distribution of adequate Hb status before the intervention. At posttest, although the proportion of participants with adequate Hb status was higher in the intervention group than in the control group (73.3% vs. 50.0%), the between-group difference did not reach statistical significance (Yates-corrected $\chi^2(1) = 2.54$, $p = 0.111$; Fisher's exact test, $p = 0.110$). The estimated odds ratio of 2.75 indicates that the odds of achieving adequate Hb status at posttest were approximately 2.75 times higher in the intervention group than in the control group. However, given that the between-group comparison was not statistically significant at the conventional $\alpha = 0.05$ threshold, this estimate should be interpreted cautiously as an observed association rather than conclusive evidence of an intervention effect.



Taken together, the descriptive, bivariate, categorical and cross-check analyses point in a consistent direction: the two groups were adequately comparable at baseline. both groups' Hb rose significantly over the study period, but the rise was significantly larger in the intervention group (Δ Hb 1.73 vs 0.77 g/dL; between-group difference 0.96 g/dL, 95% CI [0.24, 1.68], $p = 0.010$,

$d = 0.69$); and the proportion of participants reaching adequate Hb status increased more in the intervention group as well (23.3%→73.3% vs 33.3%→50.0%), consistent in direction with the mean-level finding even though that categorical comparison alone did not reach significance. Together, these results support the conclusion that the mixed mung bean–guava juice intervention was associated with a significantly greater improvement in Hb concentration than standard care alone in this sample of cancer patients undergoing chemotherapy.

DISCUSSION

This controlled quasi-experimental study evaluated whether a standardized mixed mung bean (*Vigna radiata*) and guava (*Psidium guajava* L.) juice administered for seven consecutive days following chemotherapy was associated with a greater improvement in hemoglobin (Hb) concentration than standard supportive care alone among patients undergoing chemotherapy in West Aceh District. The principal finding was that Hb concentration increased significantly in both groups during the observation period, but the magnitude of improvement was significantly greater in the intervention group than in the control group. Mean Hb increased by 1.73 g/dL in the intervention group compared with 0.77 g/dL in the control group, yielding a between-group difference in Δ Hb of 0.96 g/dL (95% CI, 0.24–1.68; $p = 0.010$) in favor of the intervention. Because this estimate was derived from a comparison with a concurrent control group, the findings provide stronger evidence than a single-group pre–post analysis that the observed Hb improvement may be associated with the intervention rather than solely reflecting temporal changes occurring during the chemotherapy cycle. The magnitude of Hb improvement observed in the present study was smaller than that reported by Huda et al. (2016), who reported an increase in mean Hb from 8.90 to 13.14 g/dL (Δ Hb = 4.23 g/dL, $p < 0.05$) following a mung bean–guava juice intervention[33,38]. Several methodological and clinical factors may explain this discrepancy. Most importantly, the earlier study used a single-group pre–post design without a concurrent control group, making it difficult to distinguish the intervention effect from spontaneous or treatment-related changes in Hb. In the present study, Hb also increased significantly in the control group receiving standard supportive care alone (Δ Hb = 0.77 g/dL; $p = 0.005$), demonstrating that part of the observed pre–post improvement may occur independently of the dietary intervention. Accordingly, the control-adjusted difference of 0.96 g/dL provides a more conservative estimate of the intervention-associated effect than the crude within-group increase reported in the earlier study. Differences in baseline Hb concentration, intervention composition and dosage, administration frequency, cancer characteristics, chemotherapy regimens, treatment cycles, and clinical setting may also have contributed to the variation in effect magnitude across studies.

The observed between-group difference is biologically plausible based on the nutritional composition of the intervention. Mung bean provides non-heme iron together with protein, folate, and other micronutrients involved in erythropoiesis [38], whereas guava is a rich source of vitamin C, which can enhance the absorption of non-heme iron by facilitating its reduction to a more absorbable form and maintaining iron in a soluble state [33,39,40]. The combination of these ingredients may therefore enhance dietary iron availability during a period in which chemotherapy-related hematological disturbances may compromise erythropoietic capacity[41,42]. Nevertheless, the present study did not measure serum ferritin, transferrin saturation, or other biochemical indicators of iron status. Consequently, the proposed mechanism remains biologically plausible but cannot be directly established from the present data. An important finding was the significant increase in Hb concentration observed in the control group. This finding emphasizes the importance of including a concurrent comparison group when evaluating nutritional interventions in patients undergoing chemotherapy. Hb concentrations may fluctuate over the course of chemotherapy because of transient treatment-related marrow suppression, subsequent hematological recovery, changes in nutritional intake, management of bleeding or infection, and other components of routine supportive care. Regression toward the mean may also have contributed, particularly because participants entered the study with low Hb concentrations. The present between-group analysis therefore provides a more informative estimate of the intervention-associated change than a simple pre–post comparison within the intervention group alone.

The categorical analysis of Hb status showed a consistent descriptive pattern but did not demonstrate a statistically significant between-group difference at posttest. The proportion of participants achieving adequate Hb status increased from 23.3% to 73.3% in the intervention group, representing a 50.0-percentage-point increase, compared with an increase from 33.3% to 50.0% in the control group, corresponding to a 16.7-percentage-point increase. Although the posttest proportion was higher in the intervention group, the between-group difference was not statistically significant (Yates-corrected $\chi^2(1) = 2.54$, $p = 0.111$; Fisher's exact $p = 0.110$). The estimated odds ratio of 2.75 indicates a higher observed odds of achieving adequate Hb status in the intervention group; however, because the categorical comparison did not reach statistical significance, this estimate should

be interpreted cautiously. The apparent discrepancy between the significant continuous outcome and the non-significant categorical outcome is likely attributable, at least in part, to information loss associated with dichotomizing Hb concentration and the limited sample size. The categorical analysis should therefore be regarded as supportive descriptive evidence rather than independent confirmation of the primary treatment effect. From a clinical and public health perspective, the findings may be relevant to nutritional supportive care in resource-constrained settings. Mung beans and guava are relatively accessible, culturally familiar foods in Indonesia, and their combination does not require specialized equipment or complex preparation. If the observed association is replicated in adequately powered studies, a standardized mung bean–guava juice preparation could potentially serve as a feasible nutritional adjunct to conventional supportive care. Importantly, such an intervention should be positioned as complementary rather than substitutive, and should not replace established clinical management of chemotherapy-associated anemia, including appropriate assessment and treatment of its underlying causes.

The study has several methodological strengths. The use of a concurrent control group allowed the intervention-associated change to be distinguished more effectively from the Hb improvement occurring under standard supportive care alone. The standardized preparation and administration protocol also improved intervention consistency, while the inclusion of patients receiving chemotherapy in a routine district-level healthcare setting enhances the practical relevance of the findings to similar clinical contexts. Several limitations warrant consideration. First, participants were allocated using a non-randomized procedure; therefore, residual confounding and selection bias cannot be excluded despite the absence of a statistically significant baseline difference in categorical Hb status. Unmeasured differences in cancer type, disease stage, chemotherapy regimen and cycle, dietary intake, comorbidities, and other clinical characteristics may have influenced the observed outcome. Second, the sample size of 30 participants per group limits statistical precision and may have reduced the ability to detect differences in the categorical Hb outcome. Third, the intervention and follow-up period were limited to seven days, precluding conclusions regarding the persistence of the observed Hb improvement across subsequent chemotherapy cycles. Fourth, the absence of biochemical measures of iron status and inflammation prevents direct evaluation of the proposed nutritional and physiological mechanisms. Fifth, blinding was not feasible because of the nature of the dietary intervention, potentially introducing performance or reporting bias. Finally, purposive recruitment from a single district may limit the generalizability of the findings to other populations and healthcare settings.

Future research should employ larger, adequately powered randomized controlled trials involving multiple centers and longer follow-up periods. Studies should incorporate baseline and longitudinal measurements of iron status and inflammatory biomarkers, as well as relevant clinical outcomes such as fatigue, treatment tolerance, transfusion requirements, and health-related quality of life. Adjustment for cancer type, chemotherapy regimen, treatment cycle, dietary intake, and other potential confounders would further strengthen causal inference. Dose optimization and cost-effectiveness analyses would also be valuable for determining the feasibility of integrating this nutritional intervention into routine supportive cancer care. The present findings provide controlled but preliminary evidence that seven days of standardized mung bean–guava juice supplementation, when provided alongside standard supportive care, was associated with a significantly greater improvement in Hb concentration than standard supportive care alone. The magnitude of the between-group difference was 0.96 g/dL (95% CI, 0.24–1.68; $p = 0.010$), while the categorical analysis showed a directionally favorable but statistically non-significant difference in the proportion achieving adequate Hb status. These findings extend previous single-arm evidence (7) by incorporating a concurrent control group and demonstrate the importance of accounting for background hematological recovery during chemotherapy. Nevertheless, given the non-randomized design, short follow-up, modest sample size, and absence of mechanistic biomarkers, the intervention should not yet be considered established therapy for chemotherapy-associated anemia. Confirmation through larger randomized and mechanistically informed studies is warranted before routine clinical implementation can be recommended.

CONCLUSION

This controlled quasi-experimental study demonstrated that a standardized mixed mung bean (*Vigna radiata*) and guava (*Psidium guajava* L.) juice administered for seven consecutive days following chemotherapy was associated with a greater improvement in hemoglobin (Hb) concentration than standard supportive care alone among patients undergoing chemotherapy in West Aceh District. Although both groups exhibited statistically significant within-group increases in Hb during the observation period, the magnitude of improvement was significantly greater in the intervention group, with a mean increase of 1.73 g/dL, compared with 0.77 g/dL in the control group. The resulting between-group difference in Hb change was 0.96 g/dL (95% CI, 0.24–1.68;

$p = 0.010$), favoring the intervention group. The categorical analysis of Hb status showed a similar descriptive pattern. The proportion of participants achieving adequate Hb status increased from 23.3% to 73.3% in the intervention group, corresponding to a 50.0-percentage-point increase, whereas the control group increased from 33.3% to 50.0%, corresponding to a 16.7-percentage-point increase. However, the between-group difference in adequate Hb status at posttest was not statistically significant ($p = 0.111$; Fisher's exact test, $p = 0.110$). The estimated odds ratio of 2.75 suggests a higher likelihood of achieving adequate Hb status in the intervention group, but this estimate should be interpreted cautiously because the categorical comparison did not reach statistical significance. Thus, the categorical findings provide descriptive support for the greater Hb improvement observed in the intervention group but should not be interpreted as independent statistical confirmation of the intervention effect. The observed findings are biologically plausible given the nutritional characteristics of the intervention. Mung beans provide dietary iron and other micronutrients involved in erythropoiesis, whereas guava is a rich source of vitamin C, which may enhance the intestinal absorption of non-heme iron when consumed concomitantly. The combination may therefore provide a nutritional adjunct to standard supportive care in patients experiencing chemotherapy-associated reductions in Hb. Nevertheless, the present findings demonstrate an association between the intervention and improved Hb concentration and do not establish a definitive causal effect. Several methodological considerations should be acknowledged. First, the quasi-experimental design without random allocation limits the ability to exclude residual confounding and selection bias. Second, the intervention was evaluated over a relatively short seven-day period, limiting conclusions regarding the persistence and longer-term clinical relevance of the observed Hb improvement. Third, the study was conducted within a single geographic setting, which may restrict the generalizability of the findings to other populations and healthcare contexts. Finally, the absence of biochemical indicators of iron status, such as serum ferritin, transferrin saturation, or related hematological parameters, precludes a more direct assessment of the mechanisms underlying the observed changes in Hb. The findings suggest that standardized mixed mung bean–guava juice may have potential as a nutritional adjunct to supportive care for improving Hb concentration among patients undergoing chemotherapy. However, the results should be interpreted as preliminary evidence rather than definitive evidence of efficacy. Larger randomized controlled trials involving multiple centers, longer follow-up, adequate control of potential confounding factors, and comprehensive assessment of iron status and other hematological outcomes are warranted to establish the efficacy, safety, durability, and biological mechanisms of this intervention before its routine clinical implementation can be recommended.

DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to applicable ethical and institutional restrictions.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest or competing financial, professional, or personal relationships that could have influenced the conduct, analysis, or reporting of this study.

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AUTHOR CONTRIBUTIONS

Conceptualization: S.G., S., M.H., R.M.Z.; **Methodology:** S.G., S., M.H.; **Investigation:** S.G., S., M.H., R.M.Z.; **Data curation:** S.G., R.M.Z.; **Formal analysis:** S., M.H.; **Writing—original draft:** S.G.; **Writing—review and editing:** S., M.H., R.M.Z.; **Supervision:** S.G., S.; **Project administration:** S.G. All authors contributed to the interpretation of the findings, critically reviewed the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

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