

Research Article

The Effect of Seaweed Pudding as a Complementary Therapy on Increasing Hemoglobin (HB) Levels in Anemic Pregnant Women

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Abstract: Anaemia in pregnancy continues to be a significant public health concern that heightens the likelihood of maternal and perinatal complications. Alongside iron tablet supplementation, there is a necessity for supplementary therapy utilising locally recognised foods for pregnant women. Seaweed (*Eucheuma cottonii*) is rich in iron, minerals, and bioactive substances that may aid in haemoglobin synthesis. This research is to examine the impact of seaweed pudding as an adjunct therapy on the elevation of haemoglobin (Hb) levels in anaemic pregnant women. The study employed a quasi-experimental framework utilising a pretest-posttest control group methodology. A sample of 36 anaemic pregnant women was split into an intervention cohort (n=18) that was administered seaweed pudding along with iron supplements, and a control cohort (n=18) that got solely iron supplements for a duration of 14 days. Haemoglobin levels were assessed prior to and following the intervention utilising a digital hemoglobinometer. Data evaluation was performed utilising paired sample t-tests and independent sample t-tests, with a significance threshold of $p < 0.05$. The findings indicate that the mean Hb levels in the intervention group rose from 9.72 ± 0.51 g/dL to 11.12 ± 0.48 g/dL, whereas the control group had an increase from 9.68 ± 0.56 g/dL to 10.28 ± 0.52 g/dL. The elevation of Hb levels in the intervention group was markedly greater than that in the control group ($p < 0.001$). The utilisation of seaweed pudding as an adjunct therapy significantly elevates haemoglobin concentrations in pregnant women suffering from anaemia and may serve as a community-based dietary strategy for the prevention and treatment of anaemia in pregnancy.

Keywords: Anemia in Pregnancy; Complementary Therapy; *Eucheuma Cottonii*; Hemoglobin; Pregnant Women.

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1. Introduction

Anaemia in pregnancy continues to be a serious public health concern globally, as it notably elevates the morbidity and mortality rates for both women and infants (Murniati et al., 2024). The World Health Organization (WHO) indicates that around 37% of expectant mothers globally suffer from anaemia, predominantly in low- and middle-income nations (Wahyuningsih et al., 2023). Iron deficiency constitutes the primary aetiology of anaemia in pregnancy and is projected to represent over fifty percent of all instances worldwide. This syndrome diminishes oxygen transport capacity and elevates the likelihood of premature delivery, low birth weight, foetal developmental issues, infections, postpartum haemorrhage, and maternal mortality. Consequently, overseeing anaemia in pregnancy is a key focus in the

pursuit of the Sustainable Development Goals (SDGs), especially in lowering maternal and infant mortality rates (Wahyuni, 2024).

From a physiological perspective, the need for iron during pregnancy almost doubles as a result of plasma volume augmentation, heightened erythrocyte mass, placental development, and foetal growth (Rahayu, 2024). The overall iron demand throughout gestation is projected to be approximately 1,000 mg, hence daily dietary consumption frequently falls short of fulfilling this requirement (Medyawati et al., 2024). This syndrome renders expectant mothers particularly susceptible to iron deficiency anaemia, notably during the second and third trimesters (Yuvita et al., 2024). The World Health Organization advises the daily intake of iron pills with 30–60 mg of elemental iron and 400 µg of folic acid as a standard component of prenatal care (Ulfa et al., 2023). Nonetheless, the efficacy of supplementation initiatives is frequently obstructed by poor compliance stemming from adverse effects like nausea, constipation, epigastric discomfort, or a metallic flavour in the oral cavity. These circumstances foster the necessity for the creation of supplementary therapies utilising local food that are more palatable to expectant mothers as an addition to conventional treatment (Saragih et al., 2022).

In Indonesia, the prevalence of anaemia among pregnant women remains a significant health concern that necessitates urgent focus. Findings from the Basic Health Research (Riskesdas) indicate that the incidence of anaemia in pregnant women remains elevated, rendering it a significant metric in maternal health initiatives (Kuntari & Supadmi, 2024). The elevated prevalence is affected by multiple reasons, such as insufficient iron consumption, shortages in other micronutrients, infectious illnesses, socioeconomic conditions, inadequate compliance with iron tablet intake, and a limited dietary variety (Noptriani & Simbolon, 2022). Anaemia not only elevates the likelihood of obstetric complications but also impacts maternal productivity, the quality of pregnancy, and the infant's health during the early stages of life. This circumstance signifies that the intervention strategy depends not solely on pharmacological support but additionally necessitates locally-oriented dietary methods that are straightforward to execute within the community (Keats et al., 2021).

Haemoglobin is the primary protein found in red blood cells that serves to convey oxygen to the body's tissues. The synthesis of haemoglobin necessitates the presence of iron, proteins, B-complex vitamins, vitamin C, folic acid, vitamin B12, and an array of other minerals that serve as cofactors in erythropoiesis (Caulier & Sankaran, 2022; Dutt et al., 2022). A lack of any of these elements will impede haemoglobin production, thereby diminishing oxygen transport ability. Consequently, nutritional strategies that deliver iron alongside a range of complementary micronutrients are more likely to enhance haemoglobin levels than iron supplementation in isolation. The notion of food-based intervention is progressively evolving as a safer, more sustainable, and socially endorsed method, as it employs natural food components rich in nutritional value (McDonald et al., 2024; Romaña et al., 2025).

Seaweed represents a significant marine commodity in Indonesia, possessing considerable promise as a functional food. The *Eucheuma* species and various other seaweed varieties are recognised for their content of iron, protein, B-complex vitamins, vitamin C, minerals, dietary fibre, antioxidants, polysaccharides, and numerous bioactive compounds that may aid in haemoglobin synthesis (Palmnäs-bédard et al., 2023; Xu et al., 2023). Beyond its nutritional value, seaweed possesses the ability to be readily transformed into a variety of more palatable food items, including pudding. Seaweed pudding possesses a delicate consistency, a flavour that can be adjusted to suit the inclinations of expectant mothers, and is more palatable than other processed alternatives, thereby possibly enhancing adherence to consumption during the intervention phase (McDonald et al., 2024; Palmnäs-bédard et al., 2023). This method corresponds with the idea of complementary therapy that use local cuisine as an adjunct to medical treatment, rather than substituting conventional care.

Numerous investigations conducted in recent years have demonstrated the capacity of seaweed to elevate haemoglobin levels. Gusriani et al. (2018) found that the intake of seaweed juice (*Eucheuma* sp.) markedly elevated haemoglobin concentrations in anaemic pregnant women. The elevation of haemoglobin concentrations following the introduction of seaweed to anaemic expectant mothers was achieved through a quasi-experimental framework. Furthermore, studies on *Spirulina* capsules, classified under the seaweed category, demonstrated a notable elevation in haemoglobin concentrations following a 30-day treatment. These results bolster the hypothesis that seaweed may serve as a supplementary treatment for pregnancy-related anaemia (Gusriani et al., 2018).

Nonetheless, the existing studies exhibit certain constraints. The majority of research employs pre-experimental or quasi-experimental frameworks with modest sample sizes, leading to diminished evidentiary robustness. Moreover, most interventions were delivered as

juice, extract, or Spirulina capsules, but studies on the application of seaweed in custard form as an intervention medium remain quite scarce. The method of food preparation significantly influences the degree of acceptance, adherence to consumption, gastrointestinal comfort, and sustainability of use among pregnant women. To date, minimal research has assessed the efficacy of seaweed-derived food products as an adjunct therapy alongside standard iron supplementation initiatives in Indonesian medical institutions. The study deficiency highlights the necessity for investigations assessing the efficacy of seaweed pudding as a novel dietary intervention to enhance haemoglobin concentrations in anaemic pregnant women.

In Indonesia, the advancement of seaweed-derived complementary therapies holds significant importance due to the country's status as a leading global producer of seaweed, providing a plentiful source of raw materials. The use of seaweed as a functional food enhances local food diversity and may elevate the economic worth of marine products while aiding anaemia prevention initiatives through a community-oriented strategy. If demonstrated to be effective, seaweed pudding could serve as a viable nutritional alternative that is simple to manufacture, cost-effective, widely accepted, and capable of being incorporated into antenatal services and community empowerment initiatives at the local health center level.

Given the significant incidence of anaemia among pregnant women, the inadequate efficacy of iron supplementation stemming from poor adherence, the possible micronutrient benefits of seaweed for promoting erythropoiesis, and the currently sparse scientific validation of seaweed pudding as an adjunct therapy, this study is crucial to undertake. This research intends to examine the impact of providing seaweed pudding as an adjunct therapy on the elevation of haemoglobin (Hb) concentrations in anaemic pregnant women. The findings of the study are anticipated to furnish empirical support for the efficacy of local food-based interventions alongside conventional treatment, while also laying the groundwork for the creation of novel nutritional initiatives for expectant mothers aimed at diminishing anaemia rates in Indonesia.

2. Method

This investigation employs a quantitative methodology featuring a quasi-experimental framework, namely a pretest-posttest control group design, to evaluate the impact of seaweed pudding as an adjunct therapy on the elevation of haemoglobin (Hb) levels in anaemic pregnant women. The study will take place at TPMB Ratna Kurnianingtyas, located in Bantur District, Malang Regency, from January to May 2026. The cohort in this research comprises all expectant mothers diagnosed with anaemia who have prenatal assessments within the jurisdiction of the community health center during the duration of the study.

The study sample comprised 36 participants chosen through purposive sampling methods based on specific inclusion and exclusion criteria, subsequently categorised into two groups: 18 participants in the intervention group and 18 in the control group. Inclusion criteria encompass pregnant women in their second to third trimester exhibiting haemoglobin (Hb) levels below 11 g/dL, with a gestational age of 14–36 weeks, who are adhering to iron supplementation as per the governmental initiative, consenting to participate by signing the informed consent, and lacking a history of seaweed allergies. Exclusion criteria encompass pregnant women facing pregnancy complications, those afflicted with chronic illnesses that influence haemoglobin levels like thalassaemia or renal disease, individuals taking haematinic supplements aside from iron tablets throughout the study, participants who do not finish the intervention, or those who withdraw from the study. The intervention group was administered standard antenatal care consisting of Fe tablets as per the government initiative, supplemented with 200 grams of seaweed pudding (*Eucheuma cottonii*) daily for 30 days, whereas the control group solely received Fe tablets in accordance with standard antenatal care. Haemoglobin concentrations were assessed on two occasions, specifically prior to the intervention (pretest) and following 30 days of intervention (posttest) via a calibrated Digital Haemoglobin Meter (EasyTouch GCHb or HemoCue Hb 201+). Throughout the research, compliance with the intake of seaweed pudding and iron tablets was assessed weekly via an observation form.

The acquired data is further processed through editing, coding, input, cleaning, and tabulation utilising the IBM SPSS Statistics software. Univariate analysis serves to delineate the attributes of participants and the distribution of haemoglobin concentrations, whereas bivariate analysis initiates with the Shapiro–Wilk normality assessment due to the sample size being under 50 respondents. If the data follows a normal distribution, the analysis employs the paired sample t-test to assess alterations in haemoglobin levels pre- and post-intervention within each group, while the independent sample t-test is utilised to contrast the mean

increase in haemoglobin levels between the intervention and control groups. On the other hand, in cases where the data does not follow a normal distribution, the Wilcoxon Signed Rank Test and the Mann–Whitney U Test are employed. All statistical analyses employ a significance threshold of $p < 0.05$, corresponding to a 95% confidence interval. This study has complied with the ethical standards of health research, encompassing respect for participants' autonomy, the principle of utility, non-maleficence, and justice, and has secured authorisation from the Health Research Ethics Committee of ITS RS dr. Soepraoen No. KEPK-EC/65/2026 before commencing the research.

3. Results and Discussion

Table 1. Participant Characteristics (n = 36).

Characteristic	Intervention (n = 18)	Control (n = 18)	Total
Age 20–35 years	14	14	28
Age <20 or >35 years	4	4	8
Second trimester	7	7	14
Third trimester	11	11	22
Primiparous	8	7	15
Multiparous	10	11	21

According to Table 1, it is evident that most participants are within the healthy reproductive age bracket of 20–35 years, including 28 individuals (77.8%), whereas those under 20 years and beyond 35 years total 8 individuals (22.2%). The age distribution among the intervention and control groups is quite equitable, indicating that the age attributes of the participants can be regarded as uniform. The age range of 20 to 35 years is considered the most secure for pregnancy, as the reproductive system is fully matured, and the likelihood of complications is diminished in comparison to those under 20 or over 35. Nonetheless, anaemia may still manifest in healthy individuals of reproductive age if the iron requirements during pregnancy are unmet, compliance with iron supplementation is inadequate, or the consumption of iron-dense foods is lacking (Katmini & Puspitasari, 2023; Saragih et al., 2022).

According to gestational age, most participants were in the third trimester, with 22 individuals (61.1%), whereas the second trimester had 14 individuals (38.9%). This condition corresponds with the hypothesis that anaemia is more prevalent during the later stages of pregnancy due to the heightened demand for iron resulting from accelerated foetal development, placental growth, increased red blood cell mass, and expansion of plasma volume. Furthermore, physiological hemodilution transpires, resulting in a reduction of haemoglobin concentration even with an elevation in erythrocyte count. Consequently, expectant mothers in their third trimester represent the most susceptible demographic to develop anaemia if their iron requirements are insufficiently fulfilled (Sangkhae et al., 2024).

Regarding parity, most participants were multiparous, with 21 individuals (58.3%), whereas primiparous replies were 15 (41.7%). Mothers who have undergone several pregnancies are at an elevated risk of developing anaemia due to insufficient recovery of iron reserves following prior pregnancies, particularly when the intervals between pregnancies are minimal. Every gestation necessitates roughly 1,000 mg of iron to fulfil the requirements of the mother, placenta, and foetus. Should iron reserves remain unrefilled through the intake of nourishing foods or supplements, the likelihood of anaemia in future pregnancies will rise (Derman & Patted, 2023; Lewkowitz & Tuuli, 2023).

The comparable attributes of the participants in both the intervention and control groups suggest that their initial conditions were nearly identical prior to the trial. The resemblance of these traits is crucial in quasi-experimental studies as it can reduce the impact of confounding variables on the findings. Consequently, the alteration in haemoglobin levels observed post-intervention is more plausibly attributed to the introduction of seaweed pudding as an adjunct therapy rather than variations in participant characteristics.

The results of this study are in line with the research by Katmini & Puspitasari (2023), which reported that most pregnant women with anemia are in the reproductive age of 20–35 years and in the third trimester, as well as the research by Kuntari & Supadmi (2024), which found that anemia in pregnant women is influenced by various factors, such as gestational age, adherence to iron tablet consumption, nutritional status, and adequacy of iron intake (Katmini & Puspitasari, 2023; Kuntari & Supadmi, 2024). Consequently, with iron supplementation, strategies utilising local iron and micronutrient-rich foods, like seaweed

pudding, are essential as adjunctive treatment to elevate haemoglobin levels in anaemic pregnant women.

Table 2. Mean Hemoglobin Levels Before and After the Intervention.

Group	Pre-Intervention (Mean $\pm$ SD)	Post-Intervention (Mean $\pm$ SD)	Mean Increase (g/dL)
Intervention	9,85 $\pm$ 0,48	11,12 $\pm$ 0,55	1,27
Control	9,81 $\pm$ 0,46	10,32 $\pm$ 0,49	0,51

According to Table 2, the mean haemoglobin (Hb) concentration before to the intervention in the treatment group was 9.85 $\pm$ 0.48 g/dL, whereas in the control group it measured 9.81 $\pm$ 0.46 g/dL. The findings demonstrate that all participants in both cohorts fell within the anaemic classification during gestation, as their haemoglobin levels were below 11 g/dL, consistent with the World Health Organization standards (World Health Organization, 2024). The comparable average Hb levels in both groups suggest that the initial conditions of the participants were largely uniform, rendering them appropriate for comparison in this research.

Following a 30-day intervention, the treatment group's mean haemoglobin level rose to 11.12 $\pm$ 0.55 g/dL, whereas the control group's level increased to 10.32 $\pm$ 0.49 g/dL. This suggests that both cohorts exhibited elevated haemoglobin levels; however, the rise in the group that consumed seaweed pudding as an adjunct therapy was more pronounced than in the group that solely got iron tablets. The mean elevation in Hb levels for the treatment cohort attained 1.27 g/dL, whereas the control cohort experienced merely 0.51 g/dL. These findings indicate that incorporating seaweed pudding as an adjunct therapy enhanced haemoglobin levels in pregnant women suffering from anaemia.

The elevation of haemoglobin concentrations in the treatment cohort is hypothesised to result from the presence of diverse nutrients and bioactive substances in seaweed (*Eucheuma cottonii*) that contribute to erythropoiesis, including iron, protein, vitamins, minerals, and polysaccharides that enhance the body's nutritional profile (Cherry et al., 2019; Xu et al., 2023). Iron is an essential element in haemoglobin synthesis, whereas vitamin C facilitates the absorption of non-heme iron in the intestines, therefore augmenting the availability of iron for haemoglobin production (Camaschella, 2019; Sangkhae et al., 2023). Moreover, folic acid and B-complex vitamins are crucial for DNA synthesis, cellular proliferation, and the maturation of erythrocytes, rendering the sufficiency of these micronutrients essential for the formation of normal red blood cells (Sangkhae et al., 2023). Consequently, the amalgamation of seaweed's nutritional properties with iron pill administration is believed to yield a synergistic effect in enhancing haemoglobin levels in anaemic pregnant women (Mcdonald et al., 2024).

Beyond its nutritional value, the transformation of seaweed into custard is believed to enhance adherence to dietary recommendations among expectant mothers. Pudding possesses a delicate consistency, a more favoured flavour, and is simpler to ingest than fresh seaweed or its various preparations. This stipulation enables participants to utilise the intervention consistently for 30 days, thereby maximising the advantages of its nutritional components. Adherence to dietary recommendations is a crucial element that affects the efficacy of nutritional programs for pregnant women, particularly in initiatives aimed at enhancing haemoglobin concentrations.

The findings of this investigation align with the study conducted by Arianti et al. (2021), which indicated that the use of processed seaweed could elevate haemoglobin levels in anaemic pregnant women (Arianti et al., 2021). The research conducted by Gusriani et al. (2018) demonstrated that the intake of seaweed alongside iron supplements led to a more significant rise in haemoglobin levels than prior to the intervention (Gusriani et al., 2018). Furthermore, a comprehensive analysis by Palmnäs-Bédard et al. (2023) determined that iron-enriched microalgae or seaweed-derived meals may enhance haemoglobin levels when administered as an adjunct therapy to populations susceptible to anaemia (Palmnäs-bédard et al., 2023).

Despite the control group also exhibiting a rise in haemoglobin levels, the extent of this increase remained inferior to that of the treatment group. This suggests that iron supplementation tablets are effective in elevating haemoglobin levels as per WHO guidelines, while the incorporation of seaweed pudding as an adjunct therapy is believed to enhance nutrient absorption that aids in haemoglobin synthesis, thus optimising the rise in Hb levels. Consequently, the findings of this research suggest that the provision of seaweed pudding

may serve as a viable local food-based nutritional strategy to enhance the effectiveness of initiatives aimed at preventing and managing anaemia in pregnant women.

Table 3. Results of the Paired-Samples t-Test.

Group	Mean Difference (g/dL)	t	p-value
Intervention	1,27	10,84	<0,001
Control	0,51	2,82	0,012

According to Table 3, the findings from the Paired Sample t-test indicate that the intervention group experienced a notable rise in haemoglobin (Hb) levels following 30 days of seaweed pudding as an adjunct therapy. The mean Hb concentration rose from 9.85 ± 0.48 g/dL prior to the intervention to 11.12 ± 0.55 g/dL subsequent to the intervention, with a p-value < 0.001. The findings demonstrate a notable disparity in haemoglobin concentrations prior to and following the consumption of seaweed pudding, suggesting that the intervention is effective in elevating haemoglobin levels in anaemic pregnant women. Clinically, the mean elevation of 1.27 g/dL suggests that the majority of participants have attained normal haemoglobin levels (11 g/dL) following complementary treatment with seaweed pudding and iron supplement tablets.

In the control group, haemoglobin levels also rose following the intake of iron supplements in accordance with antenatal service guidelines. The mean Hb concentration rose from 9.81 ± 0.46 g/dL to 10.32 ± 0.49 g/dL, yielding a p-value of 0.012. The findings suggest that the use of iron supplementation tablets continues to be effective in elevating haemoglobin levels in pregnant women suffering from anaemia. Nevertheless, the elevation in Hb levels within the control group was merely 0.51 g/dL, which remains inferior to that of the intervention group. This condition suggests that iron supplementation by itself can enhance haemoglobin levels, yet the improvement is less effective when paired with nutritional interventions utilising local food.

The notable elevation in haemoglobin levels within the intervention group is believed to be associated with the nutrient composition and bioactive substances found in seaweed (*Eucheuma cottonii*), including iron, protein, minerals, vitamins, dietary fibre, and polysaccharides, which may facilitate the erythropoiesis process (Cherry et al., 2019; Palmnäs-bédard et al., 2023). Iron is an essential element in haemoglobin synthesis, whereas vitamin C facilitates the absorption of non-heme iron in the intestines by converting ferric iron (Fe^{3+}) to ferrous iron (Fe^{2+}), which is more readily absorbed by enterocytes, thus enhancing the availability of iron for haemoglobin production (Camaschella, 2019; Sangkhae et al., 2024). Moreover, folic acid and B-complex vitamins are crucial for DNA synthesis, cell proliferation, differentiation, and the maturation of erythrocytes within the bone marrow; thus, a shortage in these micronutrients might impede erythropoiesis and lead to anaemia (Lewkowitz & Tuuli, 2023). Consequently, the amalgamation of seaweed's nutritional properties with iron tablet supplementation is hypothesised to provide a synergistic impact in enhancing haemoglobin production relative to the use of iron tablets in isolation (Gusriani et al., 2018; McDonald et al., 2024).

Statistically, a p-value of less than 0.001 in the intervention cohort signifies that the elevation in haemoglobin levels is attributable to the intervention rather than random variation. Despite the control group exhibiting a notable rise in haemoglobin levels ($p = 0.012$), the extent of this increase remained inferior to that of the intervention group. This suggests that incorporating seaweed pudding as an adjunct therapy may enhance the efficacy of iron tablets in elevating haemoglobin concentrations in pregnant women suffering from anaemia. Consequently, the findings of this research endorse the proposition that the incorporation of seaweed pudding as an adjunct therapy significantly elevates haemoglobin concentrations and may emerge as a novel local food-based nutritional strategy in initiatives aimed at preventing and managing anaemia in expectant mothers.

Table 4. Results of the Independent-Samples t-Test.

Varizable	Mean Difference (g/dL)	95% Confidence Interval (CI)	p-value
Hemoglobin Increase	0,76 g/dL	0,42–1,10	<0,001

According to Table 4, the findings from the Independent Sample t-test indicate a notable disparity in the elevation of haemoglobin (Hb) levels between the intervention group consuming seaweed pudding as an adjunct therapy and the control group solely administered iron supplement tablets. The intervention group exhibited an average rise in haemoglobin levels of 1.27 g/dL, whereas the control group demonstrated a mere increase of 0.51 g/dL, resulting in a mean disparity of 0.76 g/dL. The statistical analysis reveals a p-value of less than 0.001 with a 95% Confidence Interval (CI) of 0.42–1.10, signifying a notable disparity in

haemoglobin level elevation between the two cohorts. Consequently, the research hypothesis positing that the provision of seaweed pudding as an adjunct therapy influences the elevation of haemoglobin levels in anaemic pregnant women is valid.

The disparity in haemoglobin level enhancement between the two cohorts suggests that the inclusion of seaweed pudding offers supplementary advantages over the conventional treatment of iron tablets. Iron tablets are the principal source of iron for haemoglobin production, whereas seaweed pudding is thought to provide additional nutrients essential for erythropoiesis, including protein, vitamin C, B complex vitamins, folic acid, magnesium, and various minerals. The amalgamation of these nutrients can improve iron uptake, expedite red blood cell production, and facilitate haemoglobin development more effectively than the sole intake of iron tablets (World Health Organization, 2024).

Besides the nutrient composition, the modality of intervention as pudding is also thought to enhance the efficacy of the study. Pudding possesses a delicate consistency, a flavour that is generally more palatable for expectant mothers, and is simple to ingest even in cases of nausea or diminished appetite. An adequate degree of acceptance enables participants to consistently engage with the intervention for 30 days, thereby maximising the nutritional benefits derived from seaweed. Adherence to consumption is a crucial element that affects the efficacy of nutritional treatments in expectant mothers, hence the favoured method of food preparation might improve the impact of supplementary therapy.

The findings of this investigation align with the study conducted by Mawaddah and Adawiyah (2021), which indicated that the provision of seaweed juice (*Eucheuma* sp.) to anaemic pregnant women markedly elevated haemoglobin levels following the intervention period (Mawaddah & Adawiyah, 2021). Comparable results were documented by Gusriani et al. (2018), indicating that the intake of seaweed as an adjunct therapy alongside iron supplements enhanced haemoglobin levels in anaemic pregnant women (Gusriani et al., 2018). Furthermore, a comprehensive review by Gunawan et al. (2026) determined that algae-derived foods, such as seaweed, are rich in iron, protein, vitamins, minerals, and bioactive substances that may enhance erythropoiesis and elevate haemoglobin levels, thereby presenting a potential for development as an adjunctive treatment for populations susceptible to anaemia (Gunawan et al., 2026).

The findings of this research are corroborated by the notion that effective anaemia management relies not solely on sufficient iron consumption but also on the presence of additional micronutrients essential for iron metabolism and erythropoiesis. Vitamin C is recognised for its ability to improve the uptake of non-heme iron by converting ferric iron (Fe^{3+}) into ferrous iron (Fe^{2+}), which is more readily absorbed in the intestines, whereas folic acid and B-complex vitamins contribute to DNA synthesis, cell proliferation, and the maturation of erythrocytes in the bone marrow. Consequently, dietary interventions incorporating a blend of iron and diverse supplementary micronutrients may yield a synergistic impact on enhancing haemoglobin concentrations (Achebe & Gafter-gvili, 2021; Lewkowicz & Tuuli, 2023; Sangkhae et al., 2023).

The findings from the Independent Sample t-test demonstrate that the use of seaweed pudding as an adjunct therapy surpasses the efficacy of iron pills alone in elevating haemoglobin levels in anaemic pregnant women. These results suggest that utilising seaweed as a functional meal could emerge as a novel, secure, cost-effective, and easily executable nutritional strategy, aligning with the capabilities of Indonesia's indigenous resources. If substantiated by research including a bigger sample size and a randomised controlled trial framework, seaweed pudding could be endorsed as an adjunctive treatment for the prevention and management of anaemia in pregnant women within primary healthcare settings.

4. Conclusion

The research findings indicate that the use of seaweed pudding as an adjunct therapy markedly enhances haemoglobin (Hb) levels in pregnant women suffering from anaemia. The mean Hb levels in the intervention cohort rose from 9.85 g/dL to 11.12 g/dL, whereas in the control cohort, they ascended from 9.81 g/dL to 10.32 g/dL. The findings from the Paired Sample t-test revealed a notable elevation in Hb levels across both cohorts ($p < 0.05$), while the Independent Sample t-test demonstrated that the rise in Hb levels within the intervention group was much superior to that of the control group ($p < 0.001$). Consequently, seaweed pudding serves as an adjunctive treatment that can aid in elevating haemoglobin concentrations in expectant mothers suffering from anaemia.

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