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Original Research Paper

The effectiveness of local coastal plant Spirulina cultivated to reduce anemia in pregnant women

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Abstract
Anemia is one of the common health complications in pregnant women and is a health problem of global concern. Anemia during pregnancy has an impact on maternal and fetal health problems and contributes to increased maternal and fetal mortality and morbidity. Spirulina (Arthrospira platensis) is a marine plant that is rich in nutrients such as protein, amino acids, vitamins, minerals, carbohydrates, iron, sodium, potassium, calcium, magnesium, lead, cadmium, arsenic, and phosphorus. Spirulina plants processed in the form of supplements can prevent and overcome health problems such as anemia. The purpose of this study was to determine the effectiveness of local coastal plants Spirulina (Arthrospira platensis) in the form of supplements in overcoming anemia in pregnant women. The research method used was a quasi-experimental with a pre-post test design. The study population was pregnant women. The number of samples was 15 people, with a purposive sampling technique. The intervention carried out was the administration of spirulina capsules at a dose of 800 mg/day for 21 days. Data analysis using the Paited T test. The results showed that spirulina supplementation significantly (p value = 0.00 <α value = 0.05) increased Hb levels in pregnant women suffering from anemia in the coastal area of Konawe Regency. Increasing the dose with a shorter duration is expected to be able to overcome the problem of anemia efficiently.

Keywords: anemia; pregnant women; spirulina capsules

1. Introduction

Anemia is one of the health complications that commonly occurs in pregnant women and a health problem that is of global concern (Bhagwan et al., 2016; Nanda & Semarawisma, 2021). The prevalence of anemia during pregnancy in the world is estimated at around 41.8% (Garzon et al., 2020). Mortality and morbidity of pregnant women with anemia are higher in developing countries with low incomes (Majid et al., 2015).

Iron (Fe) deficiency in the body is the main cause of anemia. Anemia during pregnancy has an impact on maternal and fetal health problems and contributes to increased maternal and fetal mortality and morbidity rates (Garzon et al., 2020). Health problems that are often found in pregnant women with anemia include fatigue, fainting, difficulty breathing, sleeping and heart palpitations (Garzon et al., 2020). In addition, there is an increased risk of other health problems such as preeclampsia, eclampsia, bleeding, intranatal infection and miscarriage. Health problems in the fetus include fetal growth disorders, fetal death, low birth weight (LBW) and premature birth (Garzon et al., 2020; Kwak et al., 2022; Nanda & Semarawisma, 2021; Nugraha et al., 2021).

The incidence of Maternal Mortality Rate (MMR) in Indonesia fluctuates and has not met the Sustainable Development Goals (SDGs) target of 70 per 100,000 live births. Based on the 2022 Indonesian Health Profile Data, the prevalence of MMR is quite high at 189 per 100,000 live births (Kemenkes RI, 2022). Data from the Southeast Sulawesi Central Statistics Agency recorded the number of pregnancies in 2020 as many as 88,646 people. Pregnant women who made K1 visits were 59,263 and K4 visits were 46,613 people, less than the total number of pregnancies. Furthermore, pregnant women with Chronic Energy Deficiency status were 10,031 people and received blood-boosting supplements as many as 41,624 people (Dinas Kesehatan Provinsi Sulawesi Tenggara, 2021).

Anemia is a condition in which the body experiences a decrease in the total amount of Hemoglobin (Hb) below normal values, causing the oxygen supply to be unable to meet the body's needs (Kwak et al., 2022; Manju Mehrotra et al., 2017). Anemia during pregnancy can occur in every trimester. The normal Hb value in the first and third trimesters is 11 g/dL and in the second trimester is 10.5 g/dL (Kwak et al., 2022). Anemia can be treated by regulating diet, consuming iron supplements orally or intravenously, and blood transfusions (Tandon et al., 2018).

Spirulina (Arthrospira platensis) is a type of plant in the algae group. This plant is mostly found in coastal areas. Soropia District is one of the areas in Konawe Regency. Soropia District is a district whose territory is predominantly located in coastal areas and is a residential area. Based on BPS Konawe data, the number of pregnant women in 2021 was 5,388 people. Pregnant women who received blood-boosting supplements were 4,832 people (BPS Kabupaten Konawe, 2022).

Spirulina is rich in nutrients such as protein, amino acids, vitamins, minerals, carbohydrates, iron, sodium, potassium, calcium, magnesium, lead, cadmium, arsenic, and phosphorus (Leal-Esteban et al., 2021; Seghiri et al., 2019). Spirulina has been used in the manufacture of supplement-type drugs to prevent and treat health problems such as anemia (Seghiri et al., 2019). Research conducted by Fitriningsih et al. (2021) found that Spirulina capsule supplements (300 mg/day) consumed for 30-60 days can increase Hb levels in pregnant women (Fitriningsih et al., 2021). Similar results were presented by Batool et al. (2022) found that 500 mg spirulina supplements given for 8 weeks can increase Hb levels in women aged 21-35 years (Batool et al., 2022). Similar research results were presented by Niang et al. (2017) which compared the use of Spirulina supplements (1500 mg/day) for 14 weeks in pregnant and postpartum women can increase Hb higher than giving iron supplements with folic acid (Niang et al., 2017). The results of a study in line were also presented by Moradi et al., 2023 that giving Spirulina supplements (1000 mg/day) to women aged 18-56 years for 8 weeks can blood volume, Hb, and Hematocrit (Ht) (Moradi et al., 2023). The latest research results were also presented by Kundarti et al. (2024) that consuming 300 mg spirulina capsules for 1 month can increase Hb levels in pregnant women with a p value of 0.000 (Kundarti et al., 2024).

Coastal areas are rich in unique plants that can be utilized to improve public health. Utilization of local plant processing such as Spirulina can be an alternative in overcoming health problems in women, especially pregnant women. Based on several previous research results, the use of spirulina supplement doses and consumption duration varies. Handling of health problems that are attempted can be done efficiently. Further research needs to be done on the use of the right dose (standard) and shorter consumption duration is expected to overcome the problem of anemia in pregnant women efficiently. This study aims to determine the effect of processing local Spirulina plants (Arthrospira platensis) in the form of supplements with a dose of 800 with a duration of 21 days can overcome the problem of anemia in pregnant women in the coastal area of Konawe Regency.

2. Research Methods

Quantitative research using quasi experimental method with pre-post test design (Suleman et al., 2025). The research was planned to involve 1 group in the implementation of the intervention. The

research intervention was the provision of Sirulina capsule supplements with a dose of 800 mg/dL per day which would be given for 21 days. The intervention time was in the morning after eating. Evaluation of the intervention was carried out every 7 days, 4 times for observation and measuring the respondents' blood pressure and Hb. This study has obtained ethical permission with permit number No.237/KEPK/IAKMI/X/2024.

The study will be conducted in September-November 2024 in the coastal area of Konawe Regency. The research sample is pregnant women and the number of samples is 15 people. The sampling technique uses Purposive Sampling (Suleman et al., 2025). The criteria for determining the sample by looking at the Hb level <11 g/dL of pregnant women and not experiencing health complications.

Data collection in the study used questionnaires and observation sheets. The questionnaire contains the identity, characteristics of respondents, and several closed questions that support the collection of research data. The observation sheet contains the results of the assessment and measurement of the condition, blood pressure and Hb of respondents before and during the intervention.

3. Results and Discussion

3.1.Results

3.1.1.Univariate Analysis

a. Respondent Characteristics

Table 1. Distribution of Respondent Characteristics

Variabel	n(15)	%
*** Mother's Age (Years)**		
15 – 20	3	20.0
21 – 25	4	26.7
26 – 30	5	33.3
31 – 35	3	20.0
Total	**15**	**100**
*** Education**		
Elementary school	1	6.7
Junior high school	3	20.0
Senior High School	5	33.3
Bachelor	6	40.0
Total	**15**	**100**
*** Work**		
Housewife	12	80.0
Private sector employee	1	6.7
Teacher	1	6.7
Civil servant	1	6.7
Total	**15**	**100**
*** Gestational Age**		
Trimester I	2	13.3
Trimester II	9	60.0
Trimester III	4	26.7
Total	**15**	**100**
*** Pregnancy History**		
Primigravida	8	53.3
Multigravida	7	46.7
Total	**15**	**100**

The age characteristics of the respondents in Table 1 are mostly in the range of 26 - 30 years, namely 5 people (33.3%). The last education was a bachelor's degree graduate as many as 6 people (40%). Occupation as a housewife as many as 12 people (80%). The age of pregnancy of respondents is in the second trimester as many as 9 people (60%). The history of pregnancy of respondents is primigravida as many as 8 people (53.3%).

b. Hemoglobin Level

Table 2. Distribution of Hemoglobin Levels Before and After Administration of Spirulina Herbal (Arthrospira Platensis) to Pregnant Women with Anemia in the Coastal Area of Konawe Regency

Variabel	Mean	Min-Max	SD
Hemoglobin level (pre-test)	9.867	8.2 – 10.7	0.6747
Hemoglobin level (post-test)	10.693	9.7 – 11.9	0.7440

The average value of Hb levels (pre-test) was 9.86 ± 0.67. Changes in the average value of Hb levels (post-test) were 10.69 ± 0.74.

3.1.2. Bivariate analysis

a. Data Normality Test Results

The sample used in this study was 15 people (<50) so the data normality test used was Shapiro-Wilk. The results of the normality test can be seen in the table below.

Table 3. Results of Normality Test of Research Variables

Variabel	Shapiro-Wilk	
	Sig.	Keterangan
Hemoglobin level		
Pre Test (Intervensi)	0.160	Normal
Post Test (Intervensi)	0.166	Normal

Table 3 shows that Hb levels are normally distributed (Shapiro-Wilk, p before test = 0.160, p after test = 0.166; p > 0.05). Therefore, Paired T-Test is appropriate for bivariate analysis.

b. Results of Hemoglobin Level Analysis

Table 4. Statistical Test Results of the Effect of Giving Spirulina (Arthrospira Platensis) on Hemoglobin Levels in Pregnant Women with Anemia in the Coastal Area of Konawe Regency

Variabel	Mean	SD	t Hitung	t Tabel	p Value
Hemoglobin level					
Pre-Post Test	0.8267	0.3955	-8.096	-2.145	0.00

The results of the paired T-test in table 4 show a significant increase in Hb levels (t = -8.096, p = 0.00 <α 0.05) after giving spirulina supplements to pregnant women suffering from anemia.

3.2. Discussion

Anemia is a condition of decreased number of red blood cells carrying oxygen or Hb that cannot meet the body's physiological oxygen needs. Based on the World Health Organization (WHO), pregnant women are categorized as having anemia if Hb levels are <11g/L (Wawer et al., 2021). Risk factors for anemia include age, low family income, low education level, occupation, delay in health service

registration, non-compliance with iron supplement consumption, low serum ferritin levels, second or third trimester gestational age, high parity, and low blood pressure (Abd Rahman et al., 2022).

The characteristics of respondents in the study were found to be mostly aged 26-30 years, totaling 5 (26.7%). Women who become pregnant at an early age affect their nutritional status and there is a struggle for nutrition between the mother and fetus and a lack of awareness in paying attention to nutritional status for the needs of fetal development. In addition, early pregnancy is also associated with readiness to give birth. Meanwhile, women who are pregnant at the age of >35 years are at higher risk of experiencing anemia because of the degenerative process in the mother's body itself. Research conducted by Anggraeny et al. (2023) found that the age of women is significantly related to the incidence of anemia in pregnant women. Age affects the levels of red blood cells in the body.

Education is one of the factors that influences a person's health. The results of the study found that the majority of respondents' education levels were upper middle and below 9 (60%) people. Research conducted by Yadav et al. (2021) found that the prevalence of anemia in pregnant women was influenced by educational status. Women with primary and junior secondary education levels had a 3 times greater risk of experiencing anemia. Women with adequate levels of education contribute to higher productivity and income, which affects the quality of nutritional intake. Adequate levels of education for women are associated with independence in self-empowerment to improve health. Independent women tend to obtain more information and make better decisions about nutrition and increase health care seeking. Higher levels of education are associated with increased overall self-awareness of personal health, more accurate health beliefs and knowledge, and thus better lifestyle choices (Lema & Seif, 2023).

Parity status of women is one of the triggers for anemia in pregnant women. Research conducted by Imai, (2020) stated that anemia is influenced by parity status. Women with multiparous status are more likely to experience anemia. Decreased Hb concentration and fertin levels were found in multiparas compared to nulliparas.

Anemia is a health problem that is often found in women, especially pregnant women, which has an impact on physical and psychological health, and the results of conception. The impact of anemia on the health of pregnant women includes paleness, shortness of breath, palpitations, hair loss, headaches, vertigo, leg cramps, cold intolerance, dizziness, and irritability. Anemia can also cause decreased thermoregulation, fatigue, poor concentration, decreased work capacity, decreased maternal breast milk production, and depletion of maternal iron stores (fertin) during the postpartum period. In addition, anemia has an impact on maternal mental health such as increased risk of postpartum depression, fatigue and depression, mother-child relationships (Garzon et al., 2020; Kwak et al., 2022). Anemia not only has an impact on health but also family finances such as prolonged hospitalization (Api et al., 2015). Pregnant women with anemia have a higher risk of experiencing health complications such as increased susceptibility to infection, cardiovascular insufficiency, eclampsia, higher risk of hemorrhagic shock, or the need for peripartum blood transfusion in cases of heavy blood loss. The risk of maternal death is directly correlated with the severity of iron deficiency (Garzon et al., 2020; Nugraha et al., 2021).

Anemia also affects fetal health, including increased risk of low birth weight and premature birth found in cases of iron deficiency in the first and second trimesters of pregnancy (Nanda & Semarawisma, 2021). Increased premature birth in pregnant women is also related to the severity of anemia. Increased risk occurs in the moderate or severe anemia category. Iron deficiency during pregnancy causes problems with the placenta, fetal death in the womb, infection, and low iron stores in newborns (Garzon et al., 2020; Nanda & Semarawisma, 2021). Iron deficiency increases the risk of poor cognitive, motor, social emotional performance, and disrupts neurophysiological development in the fetus (Garzon et al., 2020).

Women in the prenatal period need a lot of energy intake compared to before pregnancy. The amount of energy needed during pregnancy is around 80,000 calories which is determined for the needs of maternal and fetal metabolism as well as fetal and placental growth. Adequate nutritional intake is important in pregnancy. Spirulina is part of a marine plant that can be consumed. Spirulina is used as a food source that is consumed from generation to generation such as in Central African countries (Grosshagauer et al., 2020). Arthrospira plants are rich in content including protein (60% DW / Dry Weight), polysaccharides (15-25% DW), polyunsaturated fatty acids (3-9% DW), pigments (phycocyanin and carotenoids), and amino acids (Wu et al., 2021). The high protein content in spirulina plants can help meet nutritional needs and regulate substances. The function of protein regulates human health by providing precursors for amino acid molecules and functioning as components in body cells. Protein also plays a role in transporting iron to the spinal cord to form red blood cells. Protein intake, especially animal protein intake, helps increase iron absorption. Therefore, low protein intake can reduce Hb levels, which can lead to anemia (Erningtyas et al., 2023; Sunarni et al., 2024).

A study was conducted on pregnant women suffering from anemia who were given spirulina capsules at a dose of 800 mg daily for 21 days and evaluated every 7 days. The results showed that after consuming spirulina, there was a significant increase in hemoglobin levels with a p value = 0.00 <α = 0.05. Shorter duration of consumption and higher dose compared to previous studies were able to increase Hb levels in pregnant women. Several previous studies found that spirulina plants were effective in increasing Hb levels in women, but the duration of consumption and dose were smaller. These results are in line with the research of Fitriningsih et al., (2021), which used the quasi-experimental one-group pre-post test method with a sample of 20 pregnant women at the Batua Makassar Health Center. The results of the study found that a 300 mg/day Spirulina capsule supplement consumed for 30 days can increase Hb levels in pregnant women. A study conducted by Batool et al., (2022) which compared the effectiveness of sangobion and spirulina capsules in treating anemia in women. Based on the Proximate and Mineral analysis, as well as the CBC Biochemistry Test and Ferritin Blood Test, the results of the study found that spirulina capsules were more effective in increasing Hb and Fertin levels compared to hemoglobin capsules without causing harmful effects on the kidneys and liver. In addition, the latest findings of consuming spirulina capsules can increase the average volume of blood cells and white blood cells. Similar results were also stated by Kundarti et al., (2024) that consuming spirulina supplements can increase the amount of serum fertin and iron levels in the body. The amount of iron content in spirulina is comparable to the iron content in meat. Likewise, a study conducted by Moradi et al. (2023), which used the Randomized Controlled Trials (RCT) research method with a sample of 80 women aged 18-65 years in Kermanshah, Iran. The results of the study showed a significant increase in average blood volume (p ¼ 0.004), Hb (p ¼ 0.01), and Hematocrit (p ¼ 0.03) in the group receiving 1000 mg/day Spirulina supplements for 8 weeks.

Spirulina supplementation has been suggested as an adjunct treatment for various disorders, due to its anti-inflammatory, antioxidant, liver-protecting, anti-viral, and microbiome-modulating properties (Bobescu et al., 2020; Moradi et al., 2021, 2023). The effectiveness of spirulina supplements in overcoming anemia is supported by the results of previous research conducted by Marlina & Nurhayati, (2015) that the protein and iron content in the plant can increase Hb. The results of the latest research were also initiated by Moradi et al. (2023) that spirulina supplements can increase Hb levels in patients diagnosed with Ulcerative colitis with signs and symptoms of anemia.

Spirulina is an excellent source of iron, providing 12 times more iron than other foods and has higher bioaccessibility and bioavailability than ferrous sulfate. Spirulina contains vitamin C and beta-carotene. These two micronutrients enhance iron absorption by converting insoluble iron (Fe+3) to a more soluble form (Fe+2), maintaining iron released from food in a soluble form during digestion before entering intestinal cells, and overcoming inhibition of iron absorption by strong inhibitors. In addition,

spirulina is free of oxalate and a strong iron chelator (Gao et al., 2019; Moradi et al., 2023). Previous studies have also confirmed that the application of spirulina in humans and animals has shown the beneficial effects of spirulina supplementation on iron status. Consumption of a diet high in spirulina recovered mice from iron deficiency anemia, increased iron stores in mice during pregnancy and lactation, and increased serum iron, transferrin, and ferritin levels in cobalamin-deficient mice. In addition, supplementation with spirulina was shown to be significantly more effective in increasing serum iron and ferritin levels than vitamins and minerals in children with moderate malnutrition. Furthermore, spirulina supplementation was found to be as effective as ferrous sulfate supplementation in the treatment of iron deficiency anemia in adult women (Gao et al., 2019; González-Domínguez et al., 2020; Madhubalaji et al., 2019; Nemeth & Ganz, 2021).

4. Conclusion

Consumption of 800mg/day of spirulina supplements for 21 days significantly helped overcome anemia problems in pregnant women in the coastal areas of Konawe Regency. Spirulina supplements can be an alternative treatment that can be given to pregnant women with anemia problems. Further research by increasing the number of samples, shortening the duration of intervention and the dose of spirulina supplements can be increased to obtain maximum results. Comparing the use of spirulina supplements with blood-boosting tablets in reducing anemia problems needs to be studied more deeply in order to create effective health problem management.

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