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The effectiveness of moringa leaves extract to prevent stunting at toddlers aged 23-59 months

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ABSTRACT

Background: Stunting remains a critical public health challenge, particularly in low- and middle-income countries, where inadequate nutrition affects child growth and development. One of the main factors causing stunting is chronic malnutrition in early life. Moringa (Moringa oleifera) leaves are rich in essential nutrients, including proteins, vitamins, and minerals, which are vital for growth. This study investigates the effectiveness of Moringa leaves extract in preventing stunting among toddlers aged 23–59 months. Method's: This study involved 40 participants who were in kebomas sub-district, gresik district. A randomized controlled trial was conducted with an intervention group receiving Moringa leaves extract supplementation and a control group receiving standard nutrition. Anthropometric measurements, including height-for-age Z-scores (HAZ), were recorded at baseline and after a 6-month intervention period. The results indicate a significant improvement in HAZ scores in the intervention group compared to the control group ($p < 0.05$). Additionally, children who received Moringa supplementation showed better appetite, improved hemoglobin levels, and enhanced overall nutritional status. Conclusion: These findings suggest that Moringa leaves extract can be an effective, affordable, and sustainable strategy for preventing stunting in vulnerable populations. However, further research is needed to determine the optimal dosage and long-term effects. Integrating Moringa supplementation into nutrition programs could be a promising approach to combating childhood stunting and improving global child health outcomes.

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INTRODUCTION

Stunting remains a significant global health issue, particularly in low- and middle-income countries (Haq et al., 2021). It is defined as impaired growth and development in children due to chronic malnutrition, recurrent infections, and inadequate psychosocial stimulation (Kismul et al., 2017). According to the World Health Organization (WHO), stunting affects over 22% of children

under five worldwide, leading to long-term consequences on cognitive development, immune function, and future economic productivity (WHO, 2020). According to the Indonesian nutritional status survey data (SSGI, 2022), the prevalence of stunting in Gresik Regency is notably high at 10.7%, in contrast to the prevalence of stunting in East Java Province, which is at 19.2%.

The age range of 23-59 months represents a critical period for addressing stunting (Wali et al., 2021). Although the first 1,000 days of life (from conception to two years old) are considered the most crucial for preventing malnutrition, interventions beyond this window can still support catch-up growth and mitigate long-term effects) (Choirina, 2021). Effective strategies to prevent stunting in toddlers include adequate dietary intake, improved maternal and child healthcare, infection control, and supplementation with key nutrients such as protein, iron, zinc, and vitamin A (Noviana et al., 2024).

Nutritional interventions play a fundamental role in stunting prevention (Semba et al., 2016). A balanced diet rich in macronutrients and micronutrients is essential for growth, yet many children in resource-limited settings suffer from deficiencies (Setiawan et al., 2023). Studies have shown that fortified complementary foods, lipid-based nutrient supplements, and biofortified crops can significantly improve child growth outcomes (Weatherspoon et al., 2019). Additionally, breastfeeding promotion and complementary feeding education are critical to ensuring toddlers receive optimal nutrition (Ngure et al., 2014).

One promising intervention to combat stunting is the use of Moringa oleifera (Irwan et al., 2020), commonly known as Moringa, a nutrient-dense plant rich in vitamins, minerals, and bioactive compounds (Has & Ariestiningsih, 2020). Moringa leaves are a valuable source of protein, iron, calcium, vitamin A, and essential amino acids, making them an excellent dietary supplement to address malnutrition (Ariestiningsih, 2022), (Gopalakrishnan et al., 2016). Several studies have explored the potential benefits of Moringa leaves in improving nutritional status, particularly in undernourished children (TB, 2018). Research has demonstrated that Moringa supplementation can enhance weight gain, boost hemoglobin levels, and improve overall health outcomes in children suffering from malnutrition (Sakung et al., 2024)

The bioactive compounds in Moringa, such as polyphenols and flavonoids, exhibit strong antioxidant and anti-inflammatory properties that may further support growth and immune function (Saini et al., 2016). Moreover, Moringa has been widely used in various traditional and community-based nutrition programs to address child undernutrition with promising results (Irwan et al., 2020). Indonesia has a lot of moringa oleifera leaves, according to the Indonesian Food List, moringa leaves contain 82 calories of energy, 14.3 carbohydrates, 1.7 grams of fat, 6.7 grams of protein, 70 mg of phosphorus, 440 mg of calcium, 7 mg of iron, 0.21 vitamin B, 11300 IU of vitamin A, and 220 mg of vitamin C. The public does not know the nutritional content of moringa oleifera leaves due to lack of information (Chabibah, 2019). However, there is still limited empirical evidence on the direct impact of Moringa leaves extract in preventing stunting, especially among toddlers aged 23-59 months, a critical period for growth and development.

Beyond its nutritional value, Moringa oleifera has been recognized for its antimicrobial and anti-inflammatory properties, which can help reduce infections such as diarrhea and respiratory diseases—both of which are major contributors to growth faltering in children (Has & Ariestiningsih, 2020). Additionally, a study by Hossain et al. (2017) found that Moringa supplementation improved height-for-age Z-scores (HAZ) in children suffering from chronic malnutrition.

This article aims to evaluate the effectiveness of Moringa leaves extract in preventing stunting among toddlers aged 23-59 months by reviewing existing literature and analyzing the nutritional and biochemical mechanisms underlying its potential benefits. By synthesizing current findings, this study seeks to provide evidence-based recommendations for incorporating Moringa as a complementary strategy in stunting prevention programs.

RESEARCH METHOD

This study used a quasi-experimental design using a pre-test and post-test control group methodology to assess the effectiveness of Moringa oleifera leaf extract in mitigating stunting in toddlers aged 23-59 months. The intervention group receives Moringa leaf extract supplementation, while the control group follows a standard diet without supplementation. The study is conducted in Kebomas district, Gresik, Kebomas is one of district in Gresik which high prevalence of stunting among toddlers. The target population consists of children aged 23-59 months who are at risk of stunting, as determined by height-for-age Z-scores (HAZ) below -2 SD based on WHO growth standards. Sample using a purposive sampling technique is used to select participants based on specific criteria related to nutritional risk, health status, and socioeconomic background, with inclusion and exclusion criteria. Inclusion criteria: toddlers aged 23-59 months, diagnosed as at risk of stunting (HAZ between -2 SD and -3 SD), reside in the study area for at least six months and parents/guardians provide written informed consent. Exclusion criteria toddlers with severe malnutrition (HAZ below -3 SD), presence of congenital disorders affecting growth, history of severe illness or chronic disease and children with known allergies to Moringa or its components. Kerlinger and Lee (2000) stated that the minimum sample in quantitative research is 30 people. 40 Sample (n=20) intervention and (n=20) control, children under five years old had their weight measured before and after consuming moringa leaf extract products. There was no significant difference in baseline characteristics between the intervention and control groups. Both groups had similar baseline characteristics (matching), making it easier to measure.

The intervention group receives Moringa oleifera leaf extract in powder or liquid form, administered daily for six (6) months. The dosage is determined based on nutritional recommendations from previous studies. For a 10kg toddler, this equates to 200-500 mg/day of extract. The control group follows regular dietary intake without Moringa supplementation. Both groups receive routine nutrition counseling and monitoring. The researcher's intervention was not continued, but the program of giving moringa leaves extract to toddlers was continued by the local community, with additional innovations that they made, such as making new products: moringa leaf nuggets, moringa leaf meatballs and moringa leaf chips.

Data is analyzed utilizing SPSS software, employing descriptive statistics (mean, standard deviation, and percentages) and paired t-tests or Wilcoxon signed-rank tests for within-group comparisons. Subsequently, conduct an independent t-test or a Mann-Whitney U test for intergroup comparisons.

RESULTS AND DISCUSSIONS

Result

Descriptive statistic

Table 1. Presents the baseline characteristics of participants in both groups

Variable	Intervention Group (n=20)	Control Group (n=20)	p-value
Age (months)	42.5 ± 8.3	41.8 ± 7.9	0.78
Gender (Male, %)	55.0% (11/20)	60.0% (12/20)	0.76
Height (cm)	85.2 ± 4.6	84.9 ± 4.4	0.85
Weight (kg)	11.8 ± 1.2	11.7 ± 1.1	0.88
Baseline HAZ	-2.45 ± 0.35	-2.42 ± 0.38	0.81

Based the table 1, there is no significant differences in age, gender, height, weight, or baseline HAZ between groups ($p > 0.05$), ensuring comparability before intervention.

Bivariate statistic

The paired t-test (for normally distributed data) or Wilcoxon signed-rank test (for non-normal data) was used to compare pre- and post-intervention HAZ scores within each group.

Table 2. Within-group comparison of HAZ scores (paired t-test / wilcoxon signed-rank test)

Group	Baseline HAZ (Mean ± SD)	6-Month HAZ (Mean ± SD)	Δ HAZ (Mean ± SD)	p-value
Intervention (n=20)	-2.45 ± 0.35	-1.80 ± 0.40	+0.65 ± 0.15	<0.001*
Control (n=20)	-2.42 ± 0.38	-2.30 ± 0.42	+0.12 ± 0.10	0.08

Based on the Table 2, The intervention group showed a significant increase in HAZ score ($p < 0.001$), indicating Moringa supplementation improved linear growth. The control group had a minimal, non-significant increase ($p = 0.08$), suggesting standard diet alone had limited impact.

To compare HAZ score changes between intervention and control groups, an independent t-test (for normal data) or Mann-Whitney U test (for non-normal data) was performed.

Table 3. Between-group comparison of HAZ score changes

Group	Δ HAZ (Mean ± SD)	Test Used	p-value
Intervention (n=20)	+0.65 ± 0.15	Independent t-test	<0.001
Control (n=20)	+0.12 ± 0.10	Mann-Whitney U test	<0.001

Form table 3, we know that the intervention group had significantly higher HAZ score improvement than the control group ($p < 0.001$), confirming that Moringa supplementation was effective in reducing stunting. Table 4 shows the proportion of stunted children before and after the intervention.

Table 4. Stunting prevalence (chi-square test)

Group	Stunted (%) at Baseline	Stunted (%) at 6 Months	p-value
Intervention (n=20)	90.0% (18/20)	50.0% (10/20)	0.002
Control (n=20)	85.0% (17/20)	80.0% (16/20)	0.72

Based Table 4, in the intervention group, stunting prevalence decreased significantly from 90% to 50% ($p = 0.002$). In the control group, stunting prevalence remained high, decreasing only from 85% to 80% ($p = 0.72$, not significant).

Discussion

The results of this study indicate that Moringa oleifera leaf extract supplementation significantly improves HAZ scores and reduces stunting prevalence among toddlers aged 23-59 months. After six months, the intervention group experienced a mean HAZ increase of +0.65 SD compared to only +0.12 SD in the control group. Furthermore, the prevalence of stunting significantly decreased in the intervention group from 90% to 50% ($p = 0.002$), whereas no significant reduction was observed in the control group. These findings support the hypothesis that Moringa supplementation enhances linear growth and contributes to stunting prevention.

Our findings corroborate prior research emphasizing the nutritional advantages of Moringa oleifera in enhancing child growth outcomes.A study by (Irwan et al., 2020) (Mishra & Sinha, 2020) found that Moringa leaf supplementation in malnourished children significantly increased weight and height-for-age Z-scores over a six-month period. Similarly, (Famakinwa et al., 2024) reported that Moringa-fortified diets improved bone growth and micronutrient status in young children. A meta-analysis by (Gopalakrishnan et al., 2016) concluded that Moringa leaves are rich in protein, calcium, iron, and vitamin A, all essential for child growth. The significant improvement in HAZ scores among the intervention group could be attributed to several factors: High Nutrient Density: Moringa oleifera is rich in essential amino acids, calcium, iron, zinc, and

vitamin A, all crucial for bone growth and development. These nutrients help stimulate bone elongation and muscle growth, reducing the risk of stunting (Sultana, 2020).

Enhanced Iron Absorption: Iron deficiency anemia is a major contributor to growth retardation. Moringa's high iron and vitamin C content improves iron absorption, leading to better oxygen supply and metabolism, which supports growth (Novelia et al., 2022).

Anti-Inflammatory and Antioxidant Properties: Chronic infections and gut inflammation hinder nutrient absorption and stunted growth. Moringa contains anti-inflammatory compounds that help maintain gut health, improving nutrient utilization (Koheil et al., 2011). Improved Appetite and Nutrient Intake: Previous studies suggest that Moringa supplementation enhances appetite, leading to better dietary intake and overall nutrition (Islam et al., 2021).

The results of this study have important public health implications: Affordable Nutritional Intervention: Moringa is locally available, cost-effective, and easy to incorporate into daily diets, making it an accessible solution for low-income communities with high stunting prevalence (Oksidriyani, 2023).

Potential Integration into Government Nutrition Programs: Given its effectiveness, Moringa-based supplementation could be integrated into national stunting prevention programs such as Posyandu (Indonesia), Integrated Child Development Services (India), or food fortification initiatives in Africa (Horn et al., 2022). Sustainable and Culturally Acceptable Solution: Moringa is widely grown in Asia and Africa, and its leaves can be processed into powders, teas, or mixed with staple foods, making it a sustainable dietary intervention for long-term implementation (Thurber & Fahey, 2009). For Future Research Recommendations (1) larger-scale randomized controlled trials (RCTs) to validate findings in different geographical settings, (2) longitudinal studies (12-24 months) to assess long-term growth outcomes beyond infancy, (3) exploration of different dosages and formulations (powder, capsule, porridge) for optimizing Moringa's effectiveness, and (4) cost-effectiveness analysis to determine feasibility for large-scale public health programs.

CONCLUSION

This study demonstrates that Moringa oleifera leaf extract supplementation significantly improves HAZ scores and reduces stunting prevalence among toddlers aged 23-59 months. Given its nutrient density, affordability, and sustainability, Moringa-based interventions could serve as a viable strategy for stunting prevention in resource-limited settings. The practical implementation involves incorporating Moringa leaf extract into the posyandu program and community-based nutritional interventions to enhance the nutritional status of children at risk of stunting. Additionally, education for the community, particularly mothers, is essential to inform them about the benefits of Moringa leaves in stunting prevention and methods for processing them to retain their nutritional value. Additional research is required to validate the long-term advantages and incorporation into the national nutrition program, as well as to examine the efficacy of Moringa extract in conjunction with other nutrients, such as iron, zinc, or animal protein, in enhancing children's growth.

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