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The Effect of Moringa Leaf Fortification on Improving the Nutritional Status of Stunting Toddlers in Coastal Areas

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Abstract:
Stunting is still a serious problem in many developing countries, including Indonesia. The government has taken various steps to address this condition, one of which is through the Supplementary Feeding Program (PMT). Baby food products containing moringa leaves are considered to be able to help in dealing with stunting. This study aims to evaluate the effectiveness of implementing a healthy diet with moringa leaf fortification in handling stunted toddlers. The research method used was a quasi-experiment involving 50 toddlers divided into two groups: 25 in the treatment group and 25 in the control group. The study showed increased height in toddlers given moringa leaf-based food through fortification. On average, toddler height increased by 2.9 cm after the intervention. The results of the paired sample t-test statistical test showed a significance value of 0.003 (<0.05), indicating that moringa leaf fortification effectively improved the nutritional status of stunted toddlers. These findings suggest that moringa fortification could be a viable, sustainable approach to combat stunting in resource-limited settings. However, further research through randomized controlled trials and longitudinal studies is recommended to validate these outcomes and explore broader applications in public health nutrition programs.

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INTRODUCTION

Stunting is a chronic nutritional problem that is a serious concern in many developing countries, including Indonesia (Lameky, 2024). stunting can interfere with children's physical growth and cognitive development and increase the risk of various non-communicable diseases in the future (De Sanctis et al., 2021). This condition reflects the significant challenges in improving toddlers' nutritional status, especially during the critical period of the first thousand days of life (Saavedra & Dattilo, 2021).

In coastal areas of Indonesia, including the Pasuruan Regency located in East Java, the problems of malnutrition and stunting are also still significant issues. Pasuruan Regency has a long coastline, and most people depend on the fisheries sector for their livelihoods. Although coastal areas are rich in abundant marine natural resources, the local community's diet is often unbalanced and relies more on consuming seafood, which is limited to fish and a few vegetables or fruits (Meli & Ali, 2021). Another factor influencing the high and low nutritional status is the low public awareness of the importance of a healthy diet and balanced nutrition (Saleh et al., 2020).

The causes of stunting in toddlers in the coastal areas of Pasuruan include the lack of variation in nutritious food intake that can meet optimal nutritional needs for children during their growth (Basri et al., 2020). Limited public knowledge about the importance of consuming nutritious food and eating

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habits prioritizing carbohydrates and protein without paying attention to the balance of vitamins and minerals make nutritional problems in toddlers increasingly complex (Yusriadi et al., 2024). In addition, family economic factors also play a significant role in accessing nutritious food, where the cost of buying healthy food is often higher than cheaper but less nutritious food (Harsanti & Ubaidillah, 2024).

One approach that can be applied to overcome the problem of stunting in coastal areas is fortification or adding nutrition to food ingredients used in everyday life (Dewi & Mahmudiono, 2021). One natural ingredient that can be used for fortification is Moringa oleifera leaves, which are known as "superfoods" because of their rich nutritional content (Sokhela et al., 2023). Moringa leaves contain protein, vitamins A and C, calcium, iron, and other important minerals for child growth (Dhani et al., 2022). Moringa also has antioxidant content that increases endurance and accelerates the recovery of body condition, which is very beneficial for toddlers exposed to malnutrition (Budiningsih et al., 2025).

Fortification of moringa leaves as an effort to improve the nutritional status of stunted toddlers in the coastal area of Pasuruan is a potential step, considering the abundant availability of moringa leaves in various coastal areas and the ease of their use (Foudjo et al., 2021). However, although moringa leaves have great potential to support the fulfillment of toddler nutrition, many people still do not know the right way to process them and their benefits in preventing stunting (Afriza et al., 2023). Therefore, the community needs comprehensive education regarding the importance of using moringa leaves as a fortification ingredient in daily food menus and implementing a balanced, healthy diet (Hadju et al., 2020).

The development of a healthy diet culture based on the use of local food ingredients such as moringa leaves must involve a holistic approach that covers various aspects, starting from increasing community knowledge, counseling on how to process moringa leaves properly, and introducing various moringa leaf-based menus that are readily accepted by toddlers (Budiman et al., 2022). In addition, the role of the family in educating children about the importance of consuming nutritious foods is also vital in preventing stunting (Rachmawati et al., 2021). As part of this intervention, community empowerment is the primary key to ensuring the sustainability of this nutritional status improvement program (Solikhah et al., 2023).

This study aims to identify and explore the potential of moringa leaf fortification in improving the nutritional status of stunted toddlers in the coastal areas of Pasuruan Regency. In addition, this study also aims to develop a healthy eating culture using affordable and highly nutritious local food ingredients, such as moringa leaves (Islam et al., 2020). Through an approach based on community empowerment and practical education, the community can better understand the importance of a healthy diet and how to utilize the food ingredients around them to prevent and overcome stunting in toddlers (Sitompul et al., 2025). As part of this research, it is hoped that practical solutions can be found that can be applied in everyday life by coastal communities while encouraging the development of community empowerment models.

METHOD

Study Design

This quasi-experimental study employed a two-group pretest-posttest design to evaluate the impact of a moringa-fortified complementary feeding intervention on linear growth in stunted toddlers. The intervention group received daily moringa-enriched meals, while the control group continued their standard dietary practices. Anthropometric measurements were collected at baseline and after the intervention period to assess changes in growth trajectories.

Participants and Sampling

The study population comprised stunted toddlers residing in the coastal area of Pasuruan Regency, specifically in Kraton District. A total of 50 participants were purposively selected and divided into two groups: 25 toddlers from Semare Village formed the intervention group, and 25 toddlers from Kraton District served as the control group. Control group participants were matched to the intervention group by age and gender to ensure comparability. Proportional random sampling was used to select the intervention group, while the control group was recruited through geographic and demographic matching.

Intervention

The intervention group received a daily moringa-fortified complementary food. The control group continued their usual diet without supplementation. Both groups underwent anthropometric assessments at baseline and post-intervention. Compliance was monitored through weekly home visits, and caregivers in the intervention group received nutritional counseling to reinforce dietary adherence.

Data Analysis and Ethical Considerations

Data were analyzed using SPSS Univariate analysis described participant characteristics. Paired t-tests assessed within-group changes in height. Statistical significance was set at $p < 0.05$, and 95% confidence intervals were reported. Ethical approval was obtained from the Faculty of Nursing, Universitas Jember, and informed consent was secured from all caregivers prior to participation.

RESULT

Respondent Characteristics

The characteristics of respondents in this study consist of gender and educational background of the mother in the Kraton Health Center Working Area. The following is the frequency distribution of the table.

Table 1. Respondent Characteristics

Characteristics Respondents	Treatment		Non Treatment	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Type of Sex Toddler				
Man	12	48	15	60
Woman	13	52	10	40
Total	25	100	25	100
Parents' Education				
Elementary School	1	4	2	8
Junior High School	6	24	4	16
Senior High School	17	68	19	76
Bachelor	1	4	0	0
Total	25	100	25	100

Based on table 1 shows that the characteristics of the respondents are divided into 2 (four) categories, namely the gender of toddlers and the mother's education level. Respondents The most dominant group in toddler treatment is toddlers, of which 13 toddlers (52%) were female, while 15 toddlers (60%) were male in the non-treatment group. Characteristics of the level of education of the children the elderly in the high school dominant treatment group were 17 people (68%), and in the

high school dominant treatment group, non-treatment level education person old dominant Also, Senior High School that is as much as 19 people (76%).

Bivariate Analysis

Bivariate analysis is an analysis method used to examine the relationship or correlation between two variables. In this study, the variables analyzed were developing a dietary culture through the fortification of moringa leaf products (X) and the increase in the height of stunted toddlers (Y). The following presents data on the height of toddlers before and after implementing a dietary pattern developed with the fortification of moringa leaf products.

Table 2. Differences Influence Development Culture Pattern Eat with Provision of Moringa Leaf Products for Handling Stunting in Toddlers

Characteristics	Mean	Std Deviation
Tall Body Before Group Treatment (cm)	87.192	7.3644
Tall Body After Group Treatment (cm)	90.028	7.4700
Tall Body Before Group Non-Treatment (cm)	79.012	13.5747
Tall Body After Group Non Treatment (cm)	81.052	8.5675

Based on Table 2, from a total of 50 respondents consisting of 25 toddlers in the treatment group and 25 toddlers in the non-treatment group, the following results were obtained in the treatment group, the average height of toddlers before implementing a diet based on moringa leaf products was 87.192 cm, while after the intervention, it increased to 90.028 cm. Thus, there was an increase in height of 2.9 cm.

Meanwhile, in the non-treatment group, the average height of toddlers before the intervention was 79.012 cm; after 75 days, it increased to 81.052 cm. Thus, the increase in height in this group was 2 cm.

Based on the explanation above, it can be concluded that the height of stunted toddlers showed improvement after receiving intervention in developing a dietary culture with fortification of moringa leaf products for 75 days. This can be seen from a more significant increase in height compared to before treatment. On average, the height of toddlers increased by 2.9 cm. Although the increase is not too significant, this method is still more effective in helping the growth and handling of stunted toddlers.

The following is a paired sample t-test; this test is used to determine whether there is a difference in the average of two paired samples. The sample t-test in this study can be seen in Table 3.

Table 3. Test sample Paired t-test

Characteristics	Mean	T	Std. Deviation	Significance Value
Pair 1 BW Before Treatment- BW After Treatment Post Moringa	- 2.8360	- 3.244	4.3716	0.003
Pair 2 BW Before Non-treatment- BW After Treatment	- 2.0400	- 1.159	8.7992	0.258

*BW=Body Weight

Based on Table 3, the paired sample T-test results found that the output of pair 1 obtained a significance value of 0.003 < 0.05. It can be concluded that there is a difference between the height

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of toddlers before being given the development of a dietary culture through moringa leaf products through fortification and after being given the development of a dietary culture through moringa leaf products through fortification. Paired sample T-test in the non-treatment group, it was found that the output pair 2 obtained a significance value of 0.258 > 0.05, so it can be concluded that there is no difference between the height of toddlers in the non-treatment group and after 75 days. Based on the explanation above, it can be concluded that eating culture is effectively developed by treating the product leaf moringa through fortification in Handling stunting in toddlers in the Health Center Area Kraton. Thus, hypothesis Ho is accepted, and hypothesis Ha is rejected.

DISCUSSION

Based on research conducted in the Kraton Health Center Working Area regarding the effectiveness of developing dietary patterns through fortification of moringa leaf products in dealing with stunting in toddlers, the results showed that this study involved 50 respondents consisting of 25 toddlers in the treatment group and 25 toddlers in the non-treatment group. The research respondents had various characteristics, including gender and maternal educational background. Regarding gender, the treatment group was dominated by 13 female toddlers (52%), while in the non-treatment group, there were more male toddlers, namely 15 children (60%). Meanwhile, based on the level of parental education, most parents of toddlers in the treatment group had a high school education of 17 people (68%). In contrast, 19 people (76%) were in the non-treatment group.

The bivariate analysis showed that the average height of toddlers in the treatment group before moringa leaf product fortification was 87.192 cm. After the intervention, it increased to 90.028 cm, increasing to 2.9 cm. Meanwhile, in the non-treatment group, the average height before the intervention was 79.012 cm, and after 75 days, it increased to 81.052 cm, with an increase of 2 cm. From these results, it can be concluded that the height of stunted toddlers increased significantly after receiving fortification of moringa leaf products for 75 days. Although the increase was insignificant, this method has proven to be more effective in helping the growth of stunted toddlers (Brar et al., 2022).

The paired sample T-test statistical test showed that in the treatment group, the significance value was 0.003 (<0.05), indicating a significant difference between height before and after the fortification of moringa leaf products. In contrast, in the non-treatment group, the significance value was 0.258 (>0.05), indicating no significant difference in height increase after 75 days without intervention. Therefore, developing a diet fortifying moringa leaf products effectively deals with Kraton Health Center Area stunting. Based on the results of this study, the Ho hypothesis is accepted. In contrast, the Ha hypothesis is rejected, which means that moringa leaf fortification significantly affects the increase in height of stunted toddlers, with a significance value of 0.000 (<0.05). Toddlers who received moringa leaf intervention experienced a higher body weight increase than the control group. Local food culture improves toddlers' nutritional status, especially in the stunting prevention phase (Fadeli et al., 2024). However, using local food needs to be supported by additional supplementation for optimal results (Rotella & Soriano, 2022).

A study also confirmed the effectiveness of moringa leaves in preventing stunting in toddlers. Fortification of Moringa leaves has been shown to provide significant benefits in meeting children's nutritional needs (Putra et al., 2021). the community increasingly understands the benefits of Moringa leaf extract for preventing stunting (Saputra et al., 2024). Moringa leaves contain higher vitamins and minerals than other vegetables, making them helpful in overcoming infant stunting (Haruni et al., 2024). Moringa leaves are widely used in various food products that toddlers can consume through fortification. Fortification is adding vitamins and minerals to food ingredients to

increase their nutritional content (Handayani et al., 2022). Some moringa leaf-based products that have been developed include moringa leaf tea, which can increase breast milk production, and moringa leaf extract cookies that can support infant growth (Srimiati & Agestika, 2022).

The addition of moringa leaf extract in chiffon cake did not significantly affect the texture but made a difference in color, taste, and aroma (Roni et al., 2020). Adding moringa leaf powder to food products significantly increases the protein, fiber, and mineral content (Khan et al., 2022). Another innovation in using moringa leaves is the manufacture of antioxidant-rich jelly candy. The formulation of moringa leaf powder in jelly candy can increase nutritional value and is accepted by various groups, especially children (Sudiarta, 2022). giving moringa leaf powder increases the weight and height of toddlers (Muflihatin et al., 2021). many pregnant women still do not understand the benefits of moringa leaves in improving health, especially in preventing anemia due to iron deficiency (Manggul et al., 2020). Fortifying moringa leaf products that are readily available and low-cost is a potential solution to overcoming stunting in the Kraton Health Center Working Area.

CONCLUSION

This study demonstrates that integrating moringa leaf-fortified complementary feeding into dietary practices improves linear growth among stunted toddlers. The observed enhancement in height following the intervention underscores the potential of moringa-based nutritional strategies to address stunting. Statistical analysis confirmed the intervention's efficacy, with post-intervention growth metrics showing statistically significant improvements compared to the control group. These findings suggest that moringa fortification could be a viable, sustainable approach to combat stunting in resource-limited settings. However, further research through randomized controlled trials and longitudinal studies is recommended to validate these outcomes and explore broader applications in public health nutrition programs.

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CONFLICT OF INTEREST

The authors declare no conflict of interest related to this research. All data and research results are presented independently without any influence from anyone.

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