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Effectiveness of Moringa Extract Squeeze Pudding on Weight Gain and Nutritional Status of Children Under Five in the Working Area of Paccerakkang Public Health Center, Makassar City

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ABSTRACT

This was an experimental study conducted in two phases: a descriptive quantitative organoleptic test to assess product acceptability, followed by an analytical cross-sectional study to evaluate the effectiveness of Moringa Squeeze Pudding in improving body weight and nutritional status . **Results:** The intervention of Moringa Squeeze Pudding over 7 days showed a positive impact on toddlers' body weight and nutritional status. The average body weight increased from 9.88 kg to 10.21 kg post-intervention ($p = 0.0001$; $p < 0.05$). The average weight-for-height Z-score improved from -2.09 SD (undernourished) to -1.44 SD (normal nutrition status) with a statistically significant difference ($p = 0.003$; $p < 0.05$).**Conclusion:** Moringa Squeeze Pudding intervention is effective in increasing toddlers' body weight and improving their nutritional status. This product may serve as a locally based supplementary feeding alternative (PMT) and contribute to promotive and preventive efforts in addressing child malnutrition, particularly within community health center service areas

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Key Message

- Nutritional intervention using Moringa Squeeze Pudding effectively improves toddlers' weight and nutritional status.
- Moringa-based pudding represents an innovative food solution as an alternative nutritional intervention to address childhood undernutrition.

INTRODUCTION

The most prevalent nutritional problem among toddlers in Indonesia is poor nutritional status, commonly referred to as undernutrition. Nutritional assessment for toddlers in Indonesia is generally categorized based on weight-for-age and classified as underweight or severely underweight. Malnutrition refers to deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients (1). Several contributing factors to undernutrition in toddlers include economic conditions, education level, environmental factors, diarrhea, maternal knowledge, parenting practices, children's dietary patterns, and insufficient energy and protein intake (2; 3). Nutritional status classified as moderate and severe acute malnutrition (MAM and SAM) is based on weight-for-length/height indicators as outlined in WHO guidelines (4).

In 2018, the prevalence of undernourished children aged 0–59 months in Indonesia was 13.80%, while in South Sulawesi, it exceeded the national average at 18.40% (5). According to the 2023 Indonesian Health Survey, the prevalence

of very low weight-for-age among children aged 0–59 months was 3.9%, and low weight-for-age was 16.1%. For weight-for-length/height, the prevalence of severe malnutrition was 1.7% and moderate malnutrition was 7.4% (6).

Adequate nutritional intake is essential for the growth and development of toddlers (7). Supplementary feeding (PMT) is a nutritional intervention using fortified foods with specific formulations containing added vitamins and minerals, targeting toddlers with nutritional recovery needs (8). From the age of 6 months, complementary feeding (MP-ASI) is required to fulfill energy, protein, and other nutritional demands that cannot be met by breast milk alone (9).

The potential of moringa as a food fortifier should be explored further to determine the appropriate formulations with optimal nutritional value (10). Nutritious supplementary food for children can be easily obtained from local sources, making locally-based foods more accessible and affordable. One such food source is the moringa leaf (*Moringa oleifera*) (11).

Moringa leaves have a significantly higher protein content than eggs and milk. They also possess potential anti-inflammatory, antioxidant, thiamine-rich, tissue-protective, anti-ulcer, and anti-hypersensitivity (12). According to the 2017 Indonesian Food Composition Table, boiled moringa leaves per 100 grams contain 61 kcal energy, 6.1 g protein, 0.9 g fat, 10 g carbohydrates, 0.9 g fiber, 255 mg calcium, 2.1 mg iron, 181.2 mg potassium, 3.972 mg beta-carotene, 6.071 mg carotene, 0.10 mg Vitamin B1 (thiamine), 0.10 mg Vitamin B2 (riboflavin), and 13 mg Vitamin C (13). One example of a moringa-based food product is moringa leaf pudding. Regular consumption of this product has been shown to help increase body weight in undernourished toddlers (14). Supplementary feeding with moringa pudding in five preschool children resulted in an average weight gain of 1.8 kg within 7 days (11). Moringa leaf pudding also significantly influences children's nutritional status by increasing their appetite (15).

There are several reasons why toddlers may not finish the provided supplementary food (PMT), such as unpleasant taste, unappealing aroma, excessive sweetness, forgetfulness on the part of the caregiver, or the child's refusal to consume it (6). Prior to the intervention, a palatability assessment was conducted among toddlers to ensure the product aligned with their preferences. According to nutritional surveillance data from the Paccerakkang Health Center, there were four children classified as severely malnourished and 32 as moderately malnourished. The Bougenville RW.V Posyandu in Berua Subdistrict recorded the highest number of undernourished children, totaling 9 cases. In response to this situation, the present study was conducted to evaluate the effectiveness of moringa squeeze pudding in increasing body weight and improving the nutritional status of toddlers within the service area of the Paccerakkang Health Center, Makassar City.

METHODS

This experimental study involved administering moringa-based squeeze pudding to toddlers. A descriptive quantitative organoleptic test assessed product acceptability, while a cross-sectional design evaluated its effectiveness on body weight and nutritional status. Data were analyzed using Paired T-Test and Chi-Square with SPSS version 25, and results were presented in tables and narratives. The study took place in July 2025, with the acceptability test conducted one day before the 7-day intervention at Posyandu Bougenville RW V, Berua Subdistrict, Biringkanaya District, Makassar City.

Procedure

Primary data were obtained through hedonic tests completed by toddlers' mothers, assessing preferences for taste, color, and texture. Anthropometric data included weight and height/length measurements. Effectiveness was evaluated using anthropometric indicators and dietary patterns from SQ-FFQ interviews. Informed consent was obtained before the intervention. Instruments included hedonic and nutritional status questionnaires (adapted from IPB 2015), a length board, GEA Wireless Height Meter HT 271, and a digital scale.

Data Analysis

Responses were scored and analyzed based on the hedonic test to assess product acceptability. Nutritional status was assessed using child anthropometric standards based on Ministry of Health Regulation No. 2 of 2020. Nutritional status was classified as poor if Z-score was between -3 SD to <-2 SD, and normal if within -2 SD to +1 SD. Body weight and nutritional status changes were statistically tested using SPSS version 25 with Paired T-Test and Chi-Square. Results were presented in tables and descriptive analysis.

Ethical Clearance

This study obtained ethical approval from Poltekkes Kemenkes Makassar, granted on June 25, 2025, with approval number 1401/M/KEPK-PTKMS/VI/2025.

RESULTS

General Description of Research Location

Geographically, the Paccerakkang Health Center is located in Biringkanaya District, in the northern part of Makassar City. This primary-level health facility is situated in BTN Mangga Tiga, Jl. Poros Mangga Tiga, Paccerakkang Subdistrict. The health center's working area includes community health services (Posyandu) held over 11 operational days across three subdistricts: Berua, Katimbang, and Paccerakkang.

The geographical boundaries of the Paccerakkang Public Health Center in Makassar City are as follows:

- North: Bordered by Jalan Poros Mangga Tiga
- East: Bordered by Lapangan Mangga Tiga (Mangga Tiga Field)
- South: Bordered by the Paccerakkang Subdistrict Office

- West: Bordered by the Mangga Tiga Permai residential complex

Respondent Characteristics

The characteristics of the nine toddler participants are summarized in Table 1. Most were female (77.8%), and the majority were aged 1–3 years (77.8%). Most parents worked in the private sector (88.9%). In terms of education, the fathers were predominantly senior high school graduates (66.7%), while the largest proportion of mothers were also senior high school graduates (44.5%).

Tabel 1. Distribution of Characteristics of Children Aged 12–60 Months

Charateristic	n	%
Gender		
• Female	7	77,8
• Male	2	22,2
Age Group		
• 1 – 3 years	7	77,8
• 4 – 5 years	2	22,2
Parent's Occupation		
• Civil Servant (PNS)	0	0
• Employee	8	88,9
• Daily Laborer	1	11,1
• Enterpreneur	0	0
Father's Education		
• Elemnetary School (SD)	0	0
• Junior High School (SMP)	1	11,1
• Senior High School (SMA)	6	66,7
• Bachelor's Degree (Sarjana (S1))	2	22,2
Mother's Education		
• Elemnetary School (SD)	2	22,2
• Junior High School (SMP)	0	0
• Senior High School (SMA)	4	44,5
• Bachelor's Degree (Sarjana (S1))	3	33,3
TOTAL	**9**	**100**

These data indicate that the Moringa Squeeze Pudding product was consumed by toddlers from families with diverse parental occupations and educational backgrounds. The toddlers' acceptability of the Moringa Squeeze Pudding is summarized in Table 2, based on hedonic test results for taste, color, and texture. Overall, all respondents gave positive feedback. For taste, 33.3% "liked it very much," 55.6% "liked" it, and 11.1% showed moderate liking due to a dislike of white milk. In terms of texture, 88.9% of children expressed liking it. Regarding color, 22.2% "liked it very much" and 77.8% "liked" it.

Tabel 2. Frequency Distribution of Toddler Acceptability for Moringa Squeeze Pudding

Hedonic Test		n	%
Taste	• Like Very Much	3	33,3
	• Lika	5	55,6
	• Moderately Like	1	11,1
Texture	• Like Very Much	0	0,0
	• Lika	8	88,9
	• Moderately Like	1	11,1
Color	• Like Very Much	2	22,2
	• Lika	7	77,8
	• Moderately Like	0	0

It can therefore be concluded that based on the acceptability test, the Moringa Squeeze Pudding was appealing and well-accepted by toddlers in terms of taste, color, and texture. Changes in Body Weight and Nutritional Status Before and After the Intervention. The results of body weight measurements in children aged 12–60 months are presented in Table 3, showing the changes in body weight before and after the intervention with Moringa Squeeze Pudding.

The average weight gain after the 7-day intervention was 0.33 kg, with the highest gain at 0.6 kg and one child showing no change. Weight-for-height Z-scores (WHZ) indicated overall improvement, with some children moving from undernourished to normal nutritional status (ranging from -2 SD to +1 SD). However, two children, despite gaining weight, had not yet reached normal status.

Based on the analysis, the respondents' data were normally distributed; therefore, a Paired T-Test was used to assess body weight (BW) before and after the intervention with Moringa Squeeze Pudding (Table 4). Based on the analysis, the data were normally distributed, allowing the use of a Paired T-Test to compare body weight before and after the Moringa Squeeze Pudding intervention. The mean body weight increased from 9.878 kg (SD = 2.192) to 10.211 kg (SD = 2.172). The

test produced a p-value of 0.001, indicating a statistically significant difference in body weight before and after the intervention.

Table 3. Increase in Body Weight and Nutritional Status of Children Aged 1-5 Years

No.	Name	Weight (kg)		Weight Gain (kg)	p-Value/Sig*	Z-Score (BB/TB)		Delta Z-Score	p-Value/Sig*
		Before	After			Before	After		
1.	An. AF	13,0	13,4	0,4		-2,01	-1,69	-0,31	
2.	An. TA	12,6	12,6	0,0	0,001	-2,07	-2,07	0	0,002
3.	An. EA	11	11,4	0,4		-2,10	-1,60	-0,5	
4.	An. AS	10,2	10,8	0,6		-2,02	-1,40	-0,6	
5.	An. SN	7,7	8,1	0,4		-2,75	-2,25	-0,5	
6.	An. AK	7,4	7,8	0,4		-2,01	-1,50	-0,7	
7.	An. NA	7,7	7,8	0,1		-2,25	-2,12	0,13	
8.	An. FS	8,2	8,6	0,4		-2,25	-1,75	-0,5	
9.	An. FR	11,1	11,4	0,3		-2,18	-1,09	-1,09	

*The paired t-test analysis confirmed a statistically significant difference ($p < 0.05$) between the mean body weight before and after the intervention)

Changes in nutritional status based on weight-for-length/height Z-scores (WLZ) are shown in Table 5. The Paired T-Test revealed a significant improvement in Z-scores following the Moringa Squeeze Pudding intervention. The mean Z-score increased from -2.18 SD (SD = 0.237), indicating undernutrition, to -1.72 SD (SD = 0.375) post-intervention. With a p-value of 0.002, the results demonstrate a statistically significant improvement in nutritional status after the intervention.

DISCUSSION

Acceptability of Moringa Squeeze Pudding

The organoleptic test indicated high acceptability among toddlers. The appealing color and easy-to-handle packaging attracted children's interest. The sweet taste with a mild moringa flavor was well tolerated. The soft texture facilitated chewing and swallowing. High compliance was supported by parental involvement and children's enthusiasm during feeding sessions.

Macronutrient Content of Moringa Squeeze Pudding

In this study, a food modification utilizing moringa as a local ingredient was developed into a squeeze pudding. From 200 grams of fresh moringa leaves, 250 cc of moringa extract was obtained. Nutritional analysis showed that each 125-gram serving provided 209.1 kcal, 7.3 g of protein (29% of the daily requirement), 4.6 g of fat (9%), and 29.0 g of carbohydrates (13%), based on a 1,400 kcal/day intake. The pudding was given as supplementary feeding (PMT) to children aged 12–60 months for 7 days. No adverse effects, such as diarrhea, nausea, or vomiting, were observed during the intervention. A separate study, which provided 100 grams of moringa leaf pudding every other day over a 14-day period, also demonstrated improvements in weight gain and nutritional status among toddlers, attributed to its nutritional content of 140.69 kcal of energy, 0.67 grams of protein, 3.58 grams of fat, and 17.64 grams of carbohydrates (16).

Micronutrient Content and Essential Amino Acids of Moringa Leaves

Moringa leaves are rich in essential nutrients and phytochemicals. The vitamin C content in moringa is seven times higher than that of oranges, vitamin A is ten times higher than that of carrots, calcium is seventeen times higher than in milk, potassium is nine times more abundant than in bananas, and its iron content is twenty-five times greater than that of spinach. Moringa leaves are an excellent source of various vitamins, calcium, iron (Fe), β-carotene, and phenolic acids. The protein content of moringa leaves is also considerably higher compared to eggs and milk. In addition to these nutrients, moringa possesses anti-inflammatory, antioxidant, analgesic, tissue-protective, anti-ulcer, and anti-hypersensitivity properties (12). Moringa contains a complete profile of Essential Amino Acids (EAAs), including arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine (17), , which qualifies it as a high-quality protein source(18). The major amino acids found in fresh moringa leaves per 100 grams are leucine (492.2 mg, 18%), arginine (406.6 mg,

14.96%), and valine (374.5 mg, 13.7%) (17). Inadequate intake of EAAs can disrupt metabolic processes and directly impair linear growth in children. Two of the most abundant essential amino acids in moringa—leucine and valine—are classified as Branched-Chain Amino Acids (BCAAs), which are directly utilized in skeletal muscle without hepatic metabolism. These BCAAs play a crucial role in providing immediate energy and facilitating muscle tissue repair (19).

Leucine is an essential amino acid that can directly activate the *mechanistic target of rapamycin complex 1* (mTORC1) signaling pathway in skeletal muscle, thereby stimulating the initiation of translation and protein synthesis. *Mechanistic Target of Rapamycin Complex 1* (mTORC1) s a crucial protein complex in the human body that serves as a central regulator of cell growth and metabolism, particularly in response to nutrients, energy, and growth factors (20). L-arginine is an amino acid involved in various biochemical processes in the human body. During periods of growth—such as in infants, children, or adults under certain physiological conditions—arginine is considered a conditionally essential amino acid that must be obtained from the diet or provided through supplementation. Arginine plays a critical role in the metabolism of M1 and M2 macrophages. Macrophages are highly adaptable immune cells that are essential for maintaining tissue homeostasis by clearing cellular debris, promoting tissue repair, and controlling infections (21). Valine, on the other hand, plays an active role in supporting mitochondrial health and function, particularly in muscle tissue, by stimulating biogenesis, enhancing energy production efficiency, and reducing oxidative stress (22).

Overview of Weight Gain and Nutritional Status Improvement in Children

Among the 9 children aged 12–60 months who received an intervention in the form of moringa squeeze pudding for 7 days, the average weight gain was 0.33 kg. The mean body weight before the intervention was 9.878 ± 2.192 kg, which increased to 10.211 ± 2.172 kg after the intervention. These findings are consistent with a study conducted by Prianti (2024), which reported a weight gain of 0.68 kg in infants receiving complementary feeding enriched with moringa leaf extract. Similarly, research by Safitri et al. (2024) found an average weight gain of 1.8 kg in children after being given moringa leaf pudding as supplementary food. However, one child in the current study did not experience any change in body weight, which was attributed to a history of pulmonary tuberculosis (TB) (11). This aligns with the findings of Hidayati et al. (2024), which also reported that children with recent (within the last 3 months) histories of diseases such as pulmonary TB did not show improvement in nutritional status, remaining in the undernourished category (16).

Several factors contributed to undernutrition among children who received the intervention, including inadequate energy intake, history of illness (e.g., pulmonary TB and recurrent diarrhea), limited dietary diversity, and maternal knowledge. This is reflected in the results of the SQ-FFQ analysis, which showed that children's dietary patterns did not significantly change after the intervention, aside from the addition of the squeeze pudding. The children's typical diet consisted of rice consumed 2–3 times daily, animal and plant-based proteins several times per week, vegetables 1–2 times per week, and fruits 1–2 times per week, depending on availability.

These findings are consistent with research by Sari and Susilowati (2023), which identified key factors contributing to undernutrition in children, including economic conditions, educational level, environmental factors, diarrhea incidence, maternal knowledge, parenting practices, child feeding patterns, and adequacy of energy and protein intake (2). Another study by Hulu et al. (2022) also emphasized that the main determinants of children's nutritional status were a history of prelacteal feeding, low maternal education, frequent infections in young children (23).

Changes in body weight directly affect children's nutritional status. Among the nine participants, the average z-score improved from -2.18 ± 0.237 to -1.72 ± 0.375 after the intervention, reflecting enhanced nutritional status alongside improved dietary patterns. These results are consistent with findings from Meko et al. (2019), who reported that 33 elementary school children in Kupang experienced improved nutritional status after receiving moringa leaf extract pudding, which was associated with an increased appetite (24). Another study also reported significant improvements in both weight and height among toddlers who were given moringa leaf extract, indicating a significant

positive effect on their nutritional status (25).

Thus, the provision of this supplementary feeding (PMT) helps increase energy intake and meal frequency among toddlers, thereby supporting their growth and improving nutritional status. Furthermore, it serves as an educational tool for mothers by introducing them to various forms of nutritious supplementary foods.

CONCLUSION

Moringa Squeeze Pudding effectively improved toddlers' weight and nutrition. For sustainability, parents should be trained to process moringa into child-friendly foods, supported by Puskesmas collaboration to strengthen local nutrition programs.

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