Purple Sweet Potato Fortified Feeding as an Effective Intervention to Improve Toddler Undernutrition

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ABSTRACT
Malnutrition is a condition in which an individual has nutrient intake below adequate levels, leading to impaired growth and development. Efforts to prevent malnutrition in toddlers can be implemented through supplementary feeding based on local food ingredients, including purple sweet potato. This study aimed to determine the effect of purple sweet potato–based supplementary feeding on the nutritional status of underweight toddlers in the Gunungsitoli City area. A quasi-experimental design with pretest–posttest and a control group was employed. The study population consisted of all malnourished toddlers, and a total sample of 20 children was selected using purposive sampling, comprising 10 in the intervention group and 10 in the control group. Before receiving purple sweet potato–based supplementary feeding, most toddlers in the intervention group were categorized as underweight (70%) and of normal height (70%), whereas in the control group, the majority were underweight (60%) and stunted (50%). After the intervention, most toddlers in the intervention group achieved normal weight (90%) and normal height (70%), with a significance value of 0.002 ($p<0.05$). In contrast, the control group remained predominantly underweight (80%) and stunted (50%), with a significance value of 0.08 ($p>0.05$). These findings indicate that purple sweet potato–based supplementary feeding positively affects the nutritional status of underweight toddlers, as reflected in improvements in both weight and height.
Keywords: purple sweet potato; supplementary feeding; toddler undernutrition status

INTRODUCTION
Health is the primary foundation for all humans to achieve a quality, productive, and happy life. To achieve this, various nutritional intakes are very important, such as carbohydrates, proteins, fats, and vitamins, which are essential for the body [1]. This is because malnutrition is often caused by a lack of energy intake, where the amount of energy consumed is less than the amount of energy expended [2] . This often occurs in children under the age of five.

Nutritional status of underweight toddlers is characterized by a deficiency of protein energy, iron nutrition anemia, disorders due to iodine deficiency, and vitamin A [3]. In addition, a lack of these four nutrients will cause hindered growth and development, decreased immunity, low intelligence levels [4]. Thus, weak physical ability and disorders in physical and mental growth [5]. On the other hand, if this occurs over a long period, it will result in toddlers being too short for their age, known as stunting [6]. Worse, if no immediate action is taken, it can lead to death [7]. Therefore, providing additional food based on tubers is necessary to meet toddlers' nutritional intake [8]. One of these is purple sweet potatoes.

Purple sweet potatoes are a local food source that is rich in carbohydrates, fiber, and vitamins [9]. In addition, purple sweet potatoes contain anthocyanin pigments and have a higher protein content compared to other tubers and plants, such as yellow sweet potatoes [10]. Even tomatoes, beets, and carrots [11]. On the other hand, processing young and practical purple sweet potatoes can be done by boiling, frying, and using them as cake ingredients [12]. As a result, after processing they will have a nutrient composition such as 22% fat, 48% carbohydrates, 10% protein, and 20% water [13]. Therefore, purple sweet potatoes need to be utilized to provide supplementary food to address the nutritional status of undernourished toddlers.

Unfortunately, the potential of purple sweet potatoes, which are rich in nutrients, has not been optimally utilized by the local community as a functional food [14]. This leads to a limited level of knowledge and skills among the community in processing purple sweet potatoes [15]. As a result, the prevalence of malnutrition among children under five in North Sumatra Province has increased by 23.8%. The largest contributors are West Nias Regency with a prevalence of 15.8%, South Nias Regency with 18.9%, North Nias Regency with 15.6%, and Gunungsitoli City with 11.1% [16].

The research conducted by Hapsari [17] on the provision of additional food fitbar bingu (purple sweet potato) on the nutritional status of toddlers in Westing at Sako Health Center showed that there was an effect on the change in toddler weight, namely the average weight of the treatment group increased from 10.18 kg to 11.12 kg, while the average weight of the comparison group increased from 10.51 kg to 10.61 kg. However, research testing the intervention of providing purple sweet potato-based supplementary food on the underweight nutritional status in the Gunungsitoli Health Center area has never been conducted. This is evidenced by the level of knowledge and understanding of the community, who are not yet aware of the types of local food ingredients that can be utilized as supplementary food to improve the nutritional status of toddlers. In addition, so far the community has only waited for the supplementary food provided by the health office during posyandu sessions. Not only that, the tubers that people plant are not consumed but sold, and the money is used to buy rice. Research of this kind needs to be conducted to increase the understanding and knowledge of the community about the benefits of purple sweet potatoes. The results can serve as a basis for the community to provide supplementary food for toddlers so that their nutritional status is met, as well as to increase toddlers' interest in consuming it and provide a solution for nutritional improvement. Therefore, the purpose of this study is to determine the effect of providing supplementary food based on purple sweet potatoes on the nutritional status of underweight toddlers in the Gunungsitoli Health Center area.

METHODS
This study was conducted in Gunungsitoli City in 2025. The location was selected based on a preliminary survey indicating that the community had limited awareness of local food ingredients that could be used as supplementary feeding to improve the nutritional status of children under five. The study employed a quasi-experimental design with a pretest–posttest control group. The research design consisted of two groups: an experimental group and a control group. The experimental group received purple sweet potato–based supplementary feeding, whereas the control group did not receive any intervention. The nutritional status of both groups was measured before the intervention and re-measured afterward.

The study population comprised all undernourished toddlers in Gunungsitoli City, totaling 30 children. The sample was selected using a non-probability purposive sampling technique, in which the researchers intentionally chose participants who were considered most relevant to the research objectives. According to Sugiyono [18], simple experimental research involving an experimental and a control group should include a

sample size of 10 to 20 participants. Therefore, this study used a total sample of 20 toddlers, with 10 assigned to the experimental group and 10 to the control group. Participants in both groups were selected based on identical inclusion criteria.

The research variables consisted of the independent variable, namely the provision of purple sweet potato–based supplementary feeding, and the dependent variable, namely the nutritional status of underweight toddlers. The research procedure began after the researchers obtained a research permit and ethical approval. Data collection started with an explanation of the researcher's identity and the distribution of informed consent forms as proof of participant agreement. Subsequently, baseline measurements of weight and height were conducted for both the intervention and control groups.

The supplementary feeding provided to the intervention group consisted of purple sweet potato–based products prepared in the form of balls and pudding, administered for 90 days. The ingredients for the purple sweet potato balls included 1,000 g of purple sweet potato, 60 g of cornstarch, 40 g of granulated sugar, and 500 g of palm sugar. The purple sweet potato pudding was prepared using 250 g of purple sweet potato, 500 ml of coconut milk, 180 g of granulated sugar, one packet of white agar-agar, ¼ teaspoon of salt, and one packet of vanilla. After the 90-day intervention period, weight and height measurements were repeated for both groups.

Data collection consisted of primary and secondary data. Primary data were obtained through direct observation by measuring body weight and height before and after the intervention. Secondary data were obtained from reports issued by the Gunungsitoli City Health Office. Data analysis included univariate and bivariate procedures. Univariate analysis used frequency distributions with percentages or proportions for demographic variables such as weight and height. Bivariate analysis examined the effect of the independent variable on the dependent variable using the paired t-test. A p-value ≤ 0.05 indicated a statistically significant effect.

RESULTS

The results of this study began with measuring the frequency distribution of body weight and height in both the intervention and control groups before the administration of purple sweet potato–based supplementary feeding. The findings showed that in the intervention group, there were 10 toddlers, of whom 7 (70%) were classified as underweight and 3 (30%) had normal weight. In the control group, which also consisted of 10 toddlers, 4 children (40%) were categorized as severely underweight and 6 children (60%) as underweight.

Regarding height, the intervention group consisted of 10 toddlers, with 2 children (20%) classified as very short (severely stunted), 1 child (10%) as short (stunted), and 7 children (70%) as having normal height. In the control group, 3 children (30%) were categorized as very short (severely stunted), 5 children (50%) as short (stunted), and 2 children (20%) as having normal height.

Following the baseline assessment, the intervention was carried out by providing purple sweet potato–based supplementary feeding to the intervention group, while the control group did not receive any supplementary feeding. Table 1 shows that, after receiving the intervention in the form of purple sweet potato–based supplementary feeding, the experimental group consisted of 10 toddlers, of whom 1 child (10%) was classified as underweight and 9 children (90%) had normal weight. In contrast, the control group, which did not receive purple sweet potato–based supplementary feeding, consisted of 10 toddlers, with 2 children (20%) categorized as severely underweight and 8 children (80%) categorized as underweight.

Table 2 presents the significance values obtained from comparing the control and intervention groups after the administration of purple sweet potato–based supplementary feeding. The paired t-test was used for statistical analysis. For body weight in the intervention group, the correlation coefficient between pre- and post-supplementation was 0.21, indicating a weak but positive relationship. The significance value was 0.002 ($p<0.05$), demonstrating that purple sweet potato–based supplementary feeding had a significant effect on increasing the respondents' body weight. Meanwhile, the control group showed a non-significant result with a p-value of 0.08 ($p>0.05$), indicating no effect on weight gain, as this group served solely as a comparison for the intervention group.

Table 1. Distribution of toddlers' body weight after the provision of purple sweet potato–based supplementary feeding

Body weight	Treatment group		Control group	
	Frequency	Percentage	Frequency	Percentage
Severely underweight	0	0	2	20
Underweight	1	10	8	80
Normal	9	90	0	0
Risk of being overweight	0	0	0	0

Table 2. The effect of providing purple sweet potato-based supplemental food on undernutrition status based on body weight

Pre and post body weight	Correlation coefficient	p-value
Treatment group	0.21	0.002
Control group	0.61	0.008

Table 3. Distribution of height after the provision of purple sweet potato–based supplementary feeding

Height	Treatment group		Control group	
	Frequency	Percentage	Frequency	Percentage
Very short	0	0	2	20
Short	1	10	5	50
Normal	7	70	3	30
Tall	2	20	0	0

Table 4. The effect of providing purple sweet potato-based supplemental food on undernutrition status based on height

Pre and post height	Correlation coefficient	p-value
Treatment group	0.57	0.001
Control group	0.83	0.008

Table 3 shows that, in the intervention group (which received purple sweet potato–based supplementary feeding), there were 10 toddlers, with 1 child (10%) classified as short (stunted), 7 children (70%) classified as having normal height, and 2 children (20%) classified as tall. In the control group (which did not receive purple sweet potato–based supplementary feeding), there were also 10 toddlers, with 2 children (20%) categorized as very short (severely stunted), 5 children (50%) categorized as short (stunted), and 3 children (30%) categorized as having normal height.

Table 4 presents the significance values obtained from comparing height measurements between the control and intervention groups after the administration of purple sweet potato–based supplementary feeding. The paired t-test was again used for analysis. For height in the intervention group, the correlation coefficient between pre- and post-supplementation was 0.57, indicating a strong and positive relationship. The significance value was 0.01 ($p<0.05$), meaning that purple sweet potato–based supplementary feeding had a significant effect on increasing

respondents' height. In contrast, the control group showed a non-significant result with a p-value of 0.08 (p>0.05), indicating no effect on height increase, as this group functioned solely as a comparison for the intervention group.

DISCUSSION

Body weight and height are fundamental anthropometric benchmarks commonly used to assess the nutritional status of young children, and providing purple sweet potato–based supplementary food is one of the appropriate steps to address this issue. The following discussion elaborates on the findings of this study.

Body weight and height before supplementary feeding

The results showed that the majority of toddlers in both the intervention and control groups were classified as underweight before receiving purple sweet potato–based supplementary feeding. The researchers assumed that this condition was caused by insufficient daily energy intake, limited food variety, and suboptimal meal frequency. Inadequate calorie or nutrient intake may occur when children are picky eaters, frequently refuse food, or experience digestive problems that hinder optimal nutrient absorption. This is consistent with Duma Jerriyah Harahap [19], who reported that factors influencing weight gain in toddlers include infection history, exclusive breastfeeding, family income, number of family members, maternal nutritional knowledge, eating habits, and parenting patterns.

Meanwhile, although most respondents had normal height, some were categorized as short or very short. Low height before intervention may indicate deficiencies in energy and essential nutrients such as protein, iron, and zinc during previous growth periods. The researchers assumed that short and very short stature were influenced by food intake, health status, genetics, and birth length. This aligns with Anggi Tria Abimayu [20], who stated that stunting is influenced by food intake and infectious diseases. Other indirect factors affecting growth include birth weight, birth length, gender, age, and weight gain status.

Body weight after supplementary feeding

The study found changes in body weight among toddlers in the intervention group after receiving purple sweet potato–based supplementary food for 90 consecutive days at a dose of 1.2 grams/day for ages 12–59 months. Ninety percent of respondents in the intervention group were categorized as having normal body weight, with an average weight gain of 0.72 kg. Bivariate analysis showed a significant value of p = 0.002. These findings are similar to Apriliani [21], who reported increased weight among undernourished toddlers after receiving supplementary food made from purple sweet potatoes. Puspitasari [22] also explained that the utilization of purple sweet potatoes in PMT programs for stunted toddlers resulted in significant improvements in nutritional status, particularly body weight and height.

The improvement in the intervention group can be attributed to the energy-dense nutritional content of purple sweet potatoes and the enhanced nutritional status of previously malnourished toddlers. This is in line with Latifah [23], who explained that purple sweet potato brownies can improve toddlers' nutritional status. In contrast, the control group did not experience significant weight gain because they did not receive additional nutrients and bioactive compounds found in purple sweet potatoes. Sweet potatoes contain complex carbohydrates, dietary fiber, and anthocyanins, which support energy metabolism and digestive function. High fiber content enhances nutrient absorption and satiety, influencing energy balance and body weight [24]. Aisyah [25] also reported a significant effect of purple sweet potato cookies on toddler weight (p-value = 0.000).

Statistical analysis (paired t-test) showed a p-value < 0.02, indicating a significant difference between body weight before and after supplementary feeding. Purple sweet potatoes contain approximately 123 kcal of energy, 1.2 g of protein, 28.5 g of carbohydrates, and essential vitamins and minerals per 100 g [26]. Their high anthocyanin content functions as a natural antioxidant that supports metabolism and immunity. The natural sweetness and deep purple color increase acceptability, improving consumption and contributing to weight gain. Purple sweet potatoes also contain approximately 110 µg of vitamin A per 100 g, which supports physical growth, brain development, and immunity. Their antioxidant content protects body cells and improves digestive health, which is crucial for children in growth phases and helps prevent stunting [27].

The results also showed that 10% of respondents in the intervention group remained underweight despite receiving purple sweet potato–based supplementary food. The researchers assumed that this occurred because the respondents were ill for one week, experiencing fever, nausea, and vomiting, which hindered weight gain. Although weight increased from 12 kg to 13 kg by week 4, illness in week 5 reduced progress, resulting in a final weight of 12.7 kg at the end of the 90-day observation. This assumption is supported by Harahap [28], who explained that infection affects weight gain because nutrients are expelled from the body, appetite decreases, and nutritional needs increase. Rahman [29] reinforced this by explaining that toddlers with infection history have a five-times higher risk of poor nutritional status. Rosyana [30] also found a significant influence of home conditions, eating habits, and health status on toddler nutritional status (p < 0.05).

Height after supplementary feeding

The results indicate that providing purple sweet potato–based supplementary food positively impacted height in the intervention group. Before the intervention, 20% of respondents were severely stunted, 10% were stunted, and 70% were normal. After the intervention, the categories changed to 10% stunted, 70% normal, and 20% tall. Bivariate analysis showed a significant effect with a p-value of 0.001 (p < 0.05).

Purple sweet potato products appear to support linear growth due to their energy and macronutrient content. Sutarto et al. [31] emphasized the importance of vitamin A in purple sweet potatoes for growth, development, and immunity. Husnah [32] reported that purple sweet potatoes contain 110 µg of vitamin A per 100 g, supporting physical growth and brain development. They also contain vitamin C, fiber, calcium, and phosphorus, which are essential for child growth and stunting prevention. Apriliani [33] found that local food supplements reduced stunting rates by 15–30%, with purple sweet potatoes contributing significantly to vitamin A and mineral intake. Kusuma [34] highlighted the role of anthocyanins in protecting body cells and improving digestive health, which supports optimal nutrient absorption and prevents stunting.

Purwanti Fadilah [35] reported that supplementary food based on local ingredients for 30 days significantly increased height among children aged 2–5 years. Nutritional adequacy improved in energy, protein, vitamin A, and iron intake. Purple sweet potatoes contributed to daily energy due to their complex carbohydrates and digestible fiber. Adding eggs, milk, or soy flour increased protein content needed for tissue growth. Mayasari Amran [36] found that purple sweet potato puree increased weight and height in preschool children, with significant WHZ improvements (p < 0.05). Height growth is closely related to energy and protein adequacy; children with ≥90% energy adequacy showed better height growth than those below 80%. Micronutrients such as vitamin A and iron also influence height growth, as deficiencies can impair bone growth and reduce energy metabolism, indirectly affecting linear growth [37].

CONCLUSION

This study examined the effect of purple sweet potato–based supplementary feeding on the nutritional status of underweight children. The findings demonstrated that the nutritional status of underweight children experienced significant improvements in both weight and height following the intervention. These results indicate that purple sweet potato–based supplementary feeding is an effective approach for enhancing child growth. Given its accessibility, affordability, and ease of preparation, this intervention has strong potential to be implemented at the household level as a practical strategy to address undernutrition among young children.

Ethical consideration, competing interest and source of funding

-This research was conducted after the researcher obtained an ethical permit letter from the Poltekkes of the Ministry of Health, Medan with No. 01.26.2441/KEPK/POLTEKKES KEMENKES MEDAN 2025 which was declared ethically appropriate according to health standards, namely social values, scientific values, equal distribution of burdens and benefits, risks, inducements/exploitation, confidentiality and privacy, and consent after explanation.
-There is no conflict of interest related to this publication.
-Source of funding is authors.

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