Modification of Teri Fish Snack Bar with Moringa Leaf Addition to Increase Weight in Malnourished Toddlers

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Abstract: The issue of wasting remains a major concern, with Indonesia being the second-highest country in the world for child wasting, reporting more than 760,000 cases of malnourished children. This figure poses a serious threat to the future of Indonesia's younger generation. The 2022 Indonesian Nutritional Status Survey (SSGI) shows that Sigi Regency ranks first in Central Sulawesi with the highest undernutrition rate (156%). Numerous toddler food products now include moringa leaves, and the government has addressed undernutrition through programs such as the Supplementary Feeding Program. Moringa leaves have been widely used to tackle malnutrition issues, as applied in Sigi Regency, where moringa and anchovy (Teri) are staple foods of the Kaili tribe. Local food modification efforts are among the strategies to enhance nutritional intake. This study aims to evaluate the effectiveness of modifying a snack bar made from anchovy fish and moringa leaves to improve weight in malnourished toddlers. The method used was a quasi-experimental design with 40 undernourished toddlers whose weights were measured before and after consuming the modified snack bar. Results showed a significant improvement in the nutritional status of the toddlers, especially for those previously classified as severely malnourished.

Keywords: Snack bar; Anchovies (Teri); Moringa leaves; nutritional status; Malnutrition

1. Introduction

Nutritional problems in toddlers are a serious challenge in public health, especially in areas with limited access to nutritious food (WHO, 2020). Toddler age is a critical period in development where good eating habits are essential for optimal growth (Frisilia. J, 2020). Malnutrition in toddlers can cause impaired physical and cognitive development, as well as increase the risk of infectious and chronic diseases later in life (Smith, LC, et al, 2003). Data shows that in 2018, almost 3 in 10 children under 5 years of age experienced stunting and 1 in 10 children experienced wasting (Unicef, 2021 and 2023).

Based on the results of the 2021 SSGI, the prevalence of stunting showed a decrease from 27.7% in 2019 to 24.4% (Ministry of Health of the Republic of Indonesia, 2021). However, the prevalence of underweight increased from 16.3 % to 17%. When viewed according to WHO

standards, only Bali Province has a good nutritional status with a stunting prevalence below 20% (10.9%) and wasting below 5% (3%).

Malnutrition cases still have a fairly high prevalence in Central Sulawesi, where according to Presidential Decree 63 of 2020, Sigi Regency is included in the 3T region category (Presidential Decree, 2020) making SIGI Regency support the highest wasting prevalence rate of 15.6%, followed by Toli-Toli Regency (13.5%) and Tojo Una-Una Regency (13.3%) (Ministry of Health of the Republic of Indonesia, 2022). In addition, based on data from the Sigi Regency Health Office in 2022, there are six villages that have been designated as loci for handling nutritional problems in the West Dolo area, namely Kaleke Village, Kalukutinggu Village, Bobo Village, Rarampadende Village, Mantikole Village and Balaroa Pewunu Village.

Although there has been a decrease in the prevalence of stunting in Indonesia, there are still challenges in dealing with cases of malnutrition, especially in areas such as the Kaleke Health Center Area, Dolo Barat District. Data Entry EPPBGM Kaleke Health Center until February 2024 showed 63 cases of malnutrition in toddlers (Afandi, R., et al, 2020). Therefore, continuous efforts are needed to increase toddler weight, especially through the development of healthy and highly nutritious local food products. Preliminary studies that have been conducted show that one source of nutrition that can be utilized is anchovies and moringa leaves (Frisilia. J, 2023). Anchovies contain animal protein that is rich in essential amino acids (Dunggio, 2019), while in Indonesia, moringa plants are easy to find and are believed to have many health benefits (Giri, A, 2021). In fact, WHO calls moringa a "miracle tree", showing how extraordinary the benefits of this plant are (Zongo, U., Zoungrana, SL, Savadogo, A., & Traoré, A. S, 2023). Although the nutritional potential of these two resources is large, their use in food product development is still limited and is limited to being processed into home-cooked food. Therefore, there needs to be a modification of food that is easy to consume and packaged in the form of snack bars (Frisilia. J, 2023) as a nutritious snack for all levels of society, especially for toddlers who need additional nutritional intake .

With this research, it is hoped that an effective solution can be found to increase the weight of malnourished toddlers, while supporting the use of local food and the local economy in the Kaleke Health Center Area.

2. Materials and Methods
2.1 Types and Design of Research

This study is a Quasi - experimental study with a pre-post design approach. Samples will be selected randomly from the Kaleke Health Center, which is one of the Health Centers that is the locus of stunting in Sigi Regency. This study was conducted on groups of toddlers who experienced malnutrition problems which were divided into two groups, namely:

The intervention group used anchovy snackbar with the addition of moringa leaves and the control group was given PMT from the Government, both groups will be given intervention for two months.

Before the intervention, the weight of both groups will be measured and after 2 months of intervention, it will be measured again.

Then the data obtained was processed using a computer application using a t-test to determine whether or not there was an increase in the nutritional status of malnourished

toddlers before and after being given an intervention of providing anchovy snack bars with the addition of moringa leaf flour.

The dosage for providing snack bars is based on the toddler's PMT needs, namely 10 to 15 percent of the total AKG, where the toddler's AKG needs are 1600 kcal Aditya, et al (2017).

2.2 Population and Sample

1) Population

The population in this study were all toddlers who experienced malnutrition problems in the Kaleke Health Center area. With a population of 63 toddlers with malnutrition

2) Sample

A sample is a portion or representative of the population to be studied. If the research is conducted on a portion of the population, it can be said that the research is a sample research.

3) Sample Size

The sample size is determined using the Slovin formula:

$$n = \frac{N}{1+N\,(e)^2}$$

$$n = \frac{63}{1+63\,(0,1)^2}$$

= 37.9 rounded to 38

in this study, there were 38 toddlers aged 2-5 years with malnutrition problems who were randomly selected in 2024. To overcome respondents who dropped out, a sample of 2% was added. So that the sample size becomes 40 respondents who will be intervened.

4) Sampling Techniques

The sampling technique was carried out by simple random sampling according to each region of the 6 locus villages experiencing nutritional problems in the Kaleke Health Center area. The inclusion criteria in this study were:

Inclusion Criteria: all toddlers aged 2-5 years who experience malnutrition in the Kaleke Health Center area and are willing to be respondents after signing an informed consent. Exclusion criteria are toddlers who are under 2 years old and do not have nutritional problems.

2.3 Time and Location of Research

The time this research was conducted in 2024 in 6 villages with nutritional problems which were the working areas of the Kaleke Health Center, Kec. West Dolo District. Sigi, namely Kaleke, Balaroa Pewunu, Rarampadende, Mantikole, Pesaku, and Kalukutinggu ..

3. Results and Discussion

3.1 Respondent Characteristics

This study involved 40 toddlers who experienced malnutrition problems, with respondent characteristics including age , gender, and area of residence as follows:

Table 1. Distribution of Age, Sex and Area of Residence

Toddler Age	N	%
2 years	14	35.0
3 years	12	40.0
4 years	14	35.0
Amount	**40**	**100.0**
Gender	**N**	**%**
Man	18	45.0
Woman	22	55.0
Amount	**40**	**100.0**
Residential Area	**N**	**%**
Kaleke	5	12.5
My necklace	8	20.0
Balaroa Pewunu	6	15.0
Mantikole	11	27.5
My Message	6	15.0
Rarampadende	4	10.0
Amount	**40**	**100.0**

Source: Primary Data, 2024

The results of the study showed that the characteristics of respondents based on the age of toddlers were 2-4 years. This age is a crucial period for the growth and development of children, where inadequate nutritional intake can have a significant impact on the health status and cognitive development of toddlers. This is in line with the results of previous studies that the age period of 2 to 4 years, toddlers are at a very important stage of development, known as the toddlerhood and early childhood phases. In this phase, there is rapid acceleration of physical growth, cognitive development, and motor and social skills. Adequate nutritional intake is an important key in ensuring that this development process takes place optimally (Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, et al, 2008). Nutritional deficiencies in this phase can cause developmental delays, increased risk of infectious diseases, and cognitive deficits that can continue into adulthood (Grantham-McGregor, S., et al. 2007). According to Piaget's development theory, children aged 2 to 7 years are in the preoperational stage (Piaget, J. 1973) , where they begin to use symbols to think and process information. Nutritional deficiencies during this period can impact children's cognitive abilities and thinking skills. In addition, WHO (2020) and UNICEF (2019) also recognize that this age is a critical period for nutritional interventions to support healthy growth and mental development.

The results of this study also show that the majority of toddlers who experience nutritional problems are in the Mantikole Village area, where this village is still classified as an area with less access to resources and an economy that is still in the development stage, in addition, the people of this village generally consume water that comes directly from springs without boiling it first. This is supported by the results of previous research which stated that the area of residence can influence access to resources such as nutritious food, clean water, and health services. In rural or remote areas, limited access to nutritious food and adequate health services are often the main causes of nutritional problems in toddlers (Victora, CG, et al. 2008). According to the theory of social determinants of health, the physical and social environment in which a person lives influences diet, lifestyle , and access to medical care (Rahman, A., & Chowdhury, S. 2007 and FAO, 2014). WHO research states that children living in areas with higher poverty rates are at greater risk of malnutrition than children in wealthier urban areas (Unicef , 2019). This is due to the limited availability of safe and nutritious food, poor sanitation, and low nutritional knowledge in the community.

The research results show that more toddlers who experience malnutrition are female toddlers. This shows that gender can also influence children's nutritional status, although its influence tends to be contextual and related to cultural and socio-economic factors. In some societies, gender preferences in favor of sons may influence food allocation within the household. Girls may be at higher risk of malnutrition because they are often overlooked in food distribution in resource-limited households. On the other hand, in some communities, boys are more vulnerable to malnutrition because they are often more physically active and require more energy intake. This is in accordance with the results of Fledder johann's research (2014) which states that in some communities in South Asia, girls are more vulnerable to malnutrition than boys because of social preferences that prioritize feeding boys. This contributes to high levels of malnutrition in girls in certain areas. This theory is supported by a gender perspective on health which states that social norms that prioritize men in access to food and health care can create inequalities in nutritional status between boys and girls (Günther, I., et al, 2015).

3.2 Toddler Weight

3.2.1 Body Weight Before Intervention

Table 2. Pre Nutritional Status (Based on Z Score)

Pre Nutritional Status (Based on Z Score)	N	%
Not enough	29	72.5
Very less	11	27.5
Amount	**40**	**100.0**

Source: Primary Data, 2024

Table 2 shows that the nutritional status of toddlers based on the BB/A z score before the intervention, the majority of toddlers experienced malnutrition problems with a percentage of 72.5% and very malnutrition as much as 27.5%.

3.2.2 Weight After Intervention

Table 3. Post Nutritional Status (Based on Z Score)

Post Nutritional Status (Based on Z Score)	N	%
Normal Body Weight	8	20.0
Not enough	27	67.5
Very less	5	12.5
Amount	**40**	**100.0**

Source: Primary Data, 2024

Table 3 shows that the nutritional status of toddlers based on the BB/A z score after the intervention, some toddlers experienced an increase in body weight, where toddlers who experienced very poor nutritional problems decreased to 12.5% and as many as 20% of toddlers had a nutritional status with normal body weight.

3.2.3 Nutritional Status of Toddlers Based on Z Score BB/U before and after intervention

Table 4. Average Nutritional Status of Toddlers Based on Z Score (BW/A) before and after the intervention of providing additional food of anchovy bar snacks with the addition of moringa leaves.

Toddler Nutritional Status		N	Mean	t	p value
Toddler Weight	Before	40	95,100	15,456	0,000
	After		11,353		

Source: Primary Data, 2024

T-test analysis in Table 4 analyzed using Paired t-test obtained a significance value of $p = 0.000$ ($p < 0.05$), indicating a significant difference in the average weight of toddlers who experienced malnutrition before and after the intervention. The difference in weight before and after the intervention was due to the toddlers routinely consuming the snackbars given during the intervention, in addition, during the implementation of the intervention within 2 months, it was continuously monitored by researchers so that toddlers did not consume snacks or other snacks other than snackbars and staple foods provided by their mothers.

Intervention by providing snackbars containing anchovies and moringa leaves positively contributed to weight gain in undernourished toddlers. Anchovies are rich in protein and calcium, while moringa leaves are a rich source of nutrients, including vitamins, minerals, and antioxidants, which are important for supporting child

growth. The combination of these two ingredients in the form of snackbars helps meet the nutritional needs of undernourished children and contributes to weight gain.

Providing food rich in nutrients, especially protein and micronutrients, is very important in the recovery of malnourished children (Bilal Sajid Mushtaq.,et.al, 2021) . Protein functions as a building block for the body, repairing tissue, and supporting growth. Moringa leaves, often referred to as "superfoods," contain various nutrients such as vitamins A, C, and E, as well as essential minerals such as iron, which are very effective in treating malnutrition (Frisilia. J, 2023) .

Other studies that support these findings include a study by Glover-Amengor et al (2016) who found that dietary supplementation rich in protein and micronutrients can improve the nutritional status of malnourished children. Another study by Ogbe and Affiku (2012) also showed that consumption of Moringa leaves has a positive impact on weight gain and overall health in malnourished children.

4. Conclusion

This study shows that the provision of intervention in the form of additional snackbar food enriched with anchovies and moringa leaves successfully increased the weight of toddlers who were malnourished. This is proven by the results of the T-test analysis which showed a significant difference between the average weight of toddlers before and after the intervention, with a p-value of 0.000 (p <0.05). The two-month intervention resulted in an increase in the nutritional status of toddlers, especially in children who were previously in the very malnourished category.

Conflict of Interest

All Authors declare no conflict of interest and agree with the content of the manuscript.

References

Afandi, R., Suryati, E., & Wuwungan, F. (2020). Nutritional content of fish *Teri* (*Stolephorus spp.*) fortified with Moringa leaf (*Moringa oleifera* Lamk) extract as a source of iodine. *IOP Conference Series: Earth and Environmental Science*, 466(1), 012025.

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., & Rivera, J. (2008). Maternal and child undernutrition: Global and regional exposures and health consequences. *The Lancet, 371*(9608), 243-260.

Dunggio, N. (2019). Uji organoleptik dan proksimat nugget ikan *teri* (*Stolephorus sp.*) dengan substitusi tepung jagung (*Zea mays L.*) [Skripsi, Universitas Gorontalo]. Repositori Universitas Gorontalo.

Fledderjohann, J., Vellakkal, S., Stuckler, D., Basu, S., & Ebrahim, S. (2014). Missing women, missing food: The gender gap in child malnutrition. *Social Science & Medicine, 116*, 75-85.

Food and Agriculture Organization. (2014). *The state of food insecurity in the world*. Food and Agriculture Organization.

Frisilia, J. (2020). Efficacy of local food-based *Tabaro dange* against weight of gain and levels of hemoglobin (Hb) in white rats (*Rattus norvegicus* strain Wistar). *Indian Journal of Public Health Research & Development*, 11(04), 701-706. https://ijphrd.com/scripts/IJPHRD%20April_2020%20Combined%20File.pdf

Frisilia, J. (2023). Analisis proksimat *Tabaro dange* berbasis pangan lokal sebagai alternatif makanan darurat. *Jurnal Kolaboratif Sains*, 7(1), 603-608. https://doi.org/10.56338/jks.v7i1.4967

Giri, A. (2021). *Moringa oleifera*: A review on nutritive importance and its medicinal application. *Food Science & Nutrition, 9*(1), 17-31.

Glover-Amengor, M., Owusu, W., & Laari, P. T. (2016). Effect of dietary intervention on growth, nutritional status, and cognition of malnourished children. *Food and Nutrition Bulletin, 37*(4), 589-599.

Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., & Strupp, B. (2007). Developmental potential in the first 5 years for children in developing countries. *The Lancet, 369*(9555), 60-70.

Günther, I., Harttgen, K., & Klasen, S. (2015). Gender, household behavior, and rural nutrition in developing countries. *World Development, 67*, 1-13.

Kementerian Kesehatan Republik Indonesia. (2021). *Buku saku survey status gizi Indonesia (SSGI) tahun 2021*. Departemen Kesehatan Republik Indonesia.

Kementerian Kesehatan Republik Indonesia. (2022). *Buku saku survey status gizi Indonesia (SSGI) tahun 2022*. Departemen Kesehatan Republik Indonesia. https://repository.badankebijakan.kemkes.go.id/id/eprint/4855/3/Buku%20Saku%20SSGI%202022%20rev%20270123%20OK.pdf

Mushtaq, B. S., Hussain, M. B., Omer, R., Toor, H. A., Waheed, M., Shariati, M. A., ... & Heydari, M. (2021). *Moringa oleifera* in malnutrition: A comprehensive review. *Journal of Current Drug Discovery Technologies, 18*(2), 235-243. https://doi.org/10.2174/1570163816666191105162722

Ogbe, A. O., & Affiku, J. P. (2012). Proximate study, mineral, and anti-nutrient composition of *Moringa oleifera* leaves harvested from Lafia, Nigeria: Potential benefits in poultry nutrition and health. *Journal of Microbiology, Biotechnology, and Food Sciences, 1*(3), 296-308.

Peraturan Presiden (Perpres) Nomor 63 Tahun 2020 tentang penetapan daerah tertinggal tahun 2020-2024. (2020). https://www.kemendesa.go.id/berita/view/detil/3261/ini-daerah-tertinggal

Piaget, J. (1973). *The child's conception of the world*. Rowman & Littlefield Publishers.

Rahman, A., & Chowdhury, S. (2007). Determinants of chronic malnutrition among preschool children in Bangladesh. *Asia-Pacific Journal of Public Health, 19*(3), 232-239.

Smith, L. C., & Haddad, L. (2003). How does growth determine the net effect of economic growth on childhood malnutrition? *Economic Development and Cultural Change, 52*(2), 323-348.

UNICEF Indonesia. (2023). Gizi: Mengatasi beban ganda malnutrisi di Indonesia. UNICEF Indonesia. https://www.unicef.org/indonesia/id/gizi

UNICEF. (2019). *The state of the world's children 2019: Children, food and nutrition*. UNICEF.

UNICEF. (2021). The UNICEF/WHO/WB Joint Child Malnutrition Estimates (JME) group released new data for 2021. World Health Organization. https://www.who.int/news/item/06-

05-2021-the-unicef-who-wb-joint-child-malnutrition-estimates-group-released-new-data-for-2021

Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., & Sachdev, H. S. (2008). Maternal and child undernutrition: Consequences for adult health and human capital. *The Lancet, 371*(9609), 340-357.

World Health Organization. (2020). *Malnutrition: Global targets 2025*. World Health Organization.

World Health Organization. (2020). Nutrition landscape information system (NLiS). World Health Organization. https://apps.who.int/nutrition/landscape/reports.aspx

Zongo, U., Zoungrana, S. L., Savadogo, A., & Traoré, A. S. (2023). Nutritional and clinical rehabilitation of severely malnourished children with Moringa oleifera leaf powder in Ouagadougou (Burkina Faso). *Food and Nutrition Sciences, 4*(9), 991-997. https://doi.org/10.4236/fns.2013.49128