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Effect of Intervention of Soy Milk Fortified with Moringa Leaf Powder on Improving Nutritional Status

Pengaruh Intervensi Susu Kedelai yang Difortifikasi Bubuk Daun Kelor terhadap Peningkatan Status Gizi Balita

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ABSTRACT

Background: Wasting and stunting status in children impacts growth and development. One of these efforts is providing supplementary food and local food-based recovery with regional specialties. The local plants can be fortified with food additives.
Objective: To determine the effectiveness of fortification of Moringa leaf powder in soy milk to improve the nutritional status of children under five.
Methods: The research design used a quasi-experimental design with a pre-test and post-test control design group approach. This study used total sampling with 15 children under five in the intervention and control groups. The intervention provided was education with toddler nutrition booklets and the provision of 100 CCs of soy milk that had been fortified with 0.32 mg. It was given for two consecutive months with a frequency of three to four times weekly. The control group was given education and nutrition booklets for toddlers.
Results: The results of this study showed that there was a significant difference between the mean difference in body weight (BB) in the intervention group and the control group (p-value: 0.001 CI: -0.911-(-0.245)). However, the difference in mean height (TB) in the intervention group and the control group showed no significant difference (p-value; 0.157; CI 2.244 – 0.38)). There was a significant increase in nutritional status in the intervention group (p-value: 0,009 CI: (-1.159 – (-0.174) Conclusion: Fortification of Moringa powder in soy milk can increase the weight of toddlers with poor nutritional status.

INTRODUCTION

Most infant deaths in tropical and sub-tropical regions are caused by malnutrition[1]. Poor nutritional status in children significantly impacts growth and development, not only physical but also mental development and cognitive abilities. Continuing these impacts can lead to lower work productivity in the future[2]. Indonesian Basic Health Research (Riskesdas) 2013 presented National data on the Prevalence of Malnourished and Malnourished Toddlers at 19.6%. There was an increase of 18.4% when compared to the results of the 2007 Riskesdas, or equivalent to 4,646,933 children under five in Indonesia still experiencing malnutrition and poor nutritional status[3].

The government has made various strategic efforts, both the Ministry of Health of the Republic of Indonesia and the Regional Health Office. The tactical approach was taken to anticipate an increase in the incidence of wasting in children and to review various studies and policies related to stunting and wasting in infants and toddlers. One of the programs to suppress and prevent the increase in infant and toddler malnutrition is the government providing additional food (PMT) for recovery. PMT recovery is recommended by using a typical menu and introducing local food according to the conditions of the local community[4]. PMT in infants and toddlers can be nutrient-dense foods, drinks, and healthy foods[5].

Srikanth V et al. (2014) reported that the moringa plant *(Moringa oleifera)* had been shown to improve the nutritional status of children with poor nutritional status[1]. *Moringa oleifera* is the monogeneric family's most widely cultivated pan-tropical species native to the sub-Himalayan. *Moringa oleifera* is benzolive, drumstick tree, kelor, marango, mlonge, mulangay, nébéday, saijhan, and sajna. Since 150 BC, Moringa leaves have been used in the diet of queens and kings to maintain mental and skin health[1,6]. Soybean (Glycine max) is a legume species native to East Asia and has been used in children's diets for more than 2,000 years in the East. Soy protein formulas have been available for nearly a century. Today, increasing cow's milk allergies and preferences for vegetarian diets drive consumers towards alternatives to cow's milk[7]. The

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prevalence of cow's milk protein allergy ranges from 2% to 3%. Signs and symptoms are often seen in children, such as disturbances in the digestive tract, respiratory tract, and skin, to anaphylactic reactions. Some studies have proven that giving soy milk to term babies can significantly increase body weight and length on a regular chart. In addition, protein levels and bone mineralization in clinical trials are expected in infants who consume soy milk[8]. Therefore, providing additional food in soy milk fortified with Moringa leaf powder can be carried out further research to determine its effectiveness in improving toddler nutrition, as well as an effort to introduce soy milk fortified with Moringa leaf powder as PMT recovery.

METHODS

Research Design

This research was conducted using a quasi-experimental design with a pre and post-test approach with a control group design. The intervention group was given education with a toddler nutrition booklet, three pieces of biscuits (90kcal), and 100 CC of fortified soy milk with 0.32 mg. The control group was given nutrition education for toddlers and three pieces of biscuits (90kcal) through toddler class. Officers gave soy milk fortified with Moringa leaf powder to toddlers three times a week to reduce children's boredom risk. This study was carried out for the next two months. The evaluation was done by examining body weight and height after 24 days of giving moringa soy milk to see the development of nutritional status. In addition, daily menu filling was carried out a week before and during the intervention as a control.

Sample Size

The sample was determined from a population of under-five children with malnutrition through a total sampling technique and met the inclusion criteria set by the researchers. The inclusion criteria in this study were toddlers aged 1-3 years whose parents are permanent residents in Kedungwuni I District, Pekalongan Regency, Indonesia. While the exclusion criteria are as follows: 1) toddlers with congenital disabilities and chronic pain, 2) toddlers whose parents are not willing to be respondents, 3) toddlers who are allergic or do not want to drink soy milk (including dropping out), 4) toddlers who are disobedient in consuming soy milk (not followed up).

Determining the sample size was calculated using Stata 12 software through the mean approach. The power used was 80%, and the degree of significance (α) was 0.05. The mean and SD used in calculating the sample size refer to Zongo (2013)[9]. The calculation results obtained a sample size of 20 for each group. Researchers added 10% of each group's sample size to anticipate lost respondents to follow-up. The sample size was 23 toddlers for each intervention and control group. Of the sample size, five were excluded due to disabilities and co-morbidity, eight respondents were not followed up, and three were unwilling to become respondents, so the sample size was 15 toddlers for each group.

Research Instruments

Several research instruments used specific objectives and functions, including 1) a general questionnaire to obtain general information on the subject, including personal identity, educational background of the subject's parents, and income of their parents. The general questionnaire was filled out at the beginning of the study; 2) Checklist for nutritional status and medical history, containing checklist entries for weight, height, results of nutritional status calculations (filled in by the researcher), and history of illness suffered at the beginning and end of the study, 3) In this case, the instrument for recording the child's daily menu uses a 1x24-hour food recall for assessment before intervention and a 1x24-hour food record at the time of intervention.

Nutritional Interventions in Research

This study used a fortified formulation of Moringa leaf powder in soy milk whose composition had been tested in previous studies by comparative testing and mineral content testing at the Food Technology Laboratory, Gadjah Mada University, and organoleptic tests on toddlers at Tunas Mulia Kedungwuni PAUD 2 times.

Intervention descriptions are prepared based on the Template for Intervention Description and Replication checklist[10]. The description of the interventions carried out is as follows: 1) This study's intervention was fortifying moringa leaf powder in soy milk; 2) Interventions are given to improve the nutritional status of toddlers faster than just giving additional food with biscuits. Where fortification of Moringa leaf powder included in soy milk is calculated according to the nutritional intake needs of toddlers with details of 45.74 kcal calories of soy milk fortified Moringa leaf powder and 90 kcal 3 pieces of biscuits. Giving the number of interventions is adjusted to the subjects' age, which is divided between 1-3 years, namely 0.32 mg in 100cc of soy milk; 3) Giving at the age of 1-3 years, is given one pack for two months in a row, which is given a week three to four times to reduce the boredom effect of drinking soy milk. The preparation of 1 pack is 100cc of milk; 4) The intervention procedure consists of identifying the nutritional status and nutritional needs of children under five, the middle stage (intervention stage), and the final stage, the evaluation stage (follow-up); 5) The Intervention was carried out by researchers assisted by implementing midwives and health cadres (as enumerators) in giving soy milk to the control and intervention groups; 6) The location in implementing the intervention is a place that supports the client's comfort in interacting with the researcher. Interventions are carried out in each client's home; 7) intervention is given at the age of 1-3 years with an approach to the subject's parents as guardians who agree to the implementation of the intervention. The intervention used a language approach appropriate to the educational status and ethnicity of the research subject's parents, 8) No intervention modifications were made during the study, 9) After the Intervention was carried out, the researcher (and enumerators) followed up at the next meeting and asked for the willingness of

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the subject's parents to remain and obey in participating in the research until the end, 10) Follow-up was carried out after 24 days of giving moringa soy milk to see the development of nutritional status.

The Yogyakarta Muhammadiyah University research ethics committee, obtained the ethical test, ethical number 076/EP-FKIK-UMY/II/2017. Data analysis was done through univariate analysis with frequency distribution and bi-variate analysis with a paired t-test to see the difference in mean weight and height of the intervention and control groups. The degree of significance used was p-value <0.05 at a 95% confidence level.

RESULTS AND DISCUSSION

The number of toddlers lost to follow-up in each group was 25% of the initial sample size, which was 20 respondents for each group. So at the end of the study, there were only 15 respondents in each group. This condition was a limitation of this study because it uses total sampling. The results of univariate analysis on 30 toddler respondents are presented with a frequency distribution (n) and percentage (%) for categorical variables. Numerical variables with non-normal distribution are presented with median values (minimum-maximum). The results of the analysis are as follows.

Characteristics of Respondents

Table 1 shows that less than half of children under five have incomplete immunization history (36.67%). Research by Chabibah et al. (2021) stated that of children who did not receive complete primary immunization, 5,785 were at risk of stunting. Research conducted in Northwestern Ethiopia showed that children with incomplete immunization were 5.6 times more at risk of experiencing stunting. A study at the Biromaru Health Center stated that children aged 2-5 years with incomplete immunizations have a 7.667 times greater risk of stunting than children with complete immunizations[11,12].

Table 1. Frequency distribution of research respondents' characteristics

Variable	Amount (N=30)	
	n	%
Toddler Age (months)		
12 to 37 months	21.500, (13-37)*	
Gender		
Woman	17	56,7
Man	13	43,3
History of breastfeeding		
Exclusive	15	50
Not Exclusive	15	50
Immunization History		
Complete	19	63,3
Incomplete	11	36,7
Past three months of infection history		
There is	6	20
There are not any	24	80

*) written in decimal units, the mean value is presented (min sd max)

A small number of them had a history of infection in the last three months. The history of infectious diseases studied was diarrhea and upper respiratory infection (ARI) in the last three months. The results of research by Sutriani et al. (2020) stated that there is a relationship between a history of infectious diseases and the incidence of stunting in toddlers[12]. Toddlers who suffer from infections can experience decreased immunity, affecting their appetite and body weight. Another visible impact is losing energy in the toddler's body, making the toddler look weak[13].

The Effect of Nutrition Intervention on Toddler Weight Gain

Bivariable analysis on the under-five weight variable was tested using an independent t-test with a significance degree of 0.05. This test was conducted to determine the difference in weight gain in the group that was given education and soy milk fortified with moringa leaf powder (Intervention) and the group that was only given education (control). The results of the analysis are described in the Table below:

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Table 2. Analysis of differences in toddler weight gain in the intervention group and the control group

Variable	Mean ± SD		p-value	Δ average	Δ CI 95%
	Control	Intervention			
Weight	0.111 ± 0.334	0.678 ± 0.522	0.001	-0.578	-0.911 – (-0.255)

Table 2. describes the effectiveness of giving soy milk fortified with Moringa leaf powder on increasing toddler body weight (BB) in the intervention and control groups. Based on the bivariate analysis in Table 2, the independent t-test illustrates the difference in the average toddler weight in the intervention and control groups of 0.58 Kg (p-value; 0.001; CI -0.911-(-0.255). It can be concluded that there is a significant difference between the average weight gain (BB) between the group that was given soy milk fortified with moringa leaf powder and the control group.

The results of the bivariate analysis shows that there was a significant difference between the difference in the mean weight of the intervention group and the control group (p-value; 0.001; CI -0.91-(-0.25). These results are consistent with Zongo's study (2013), which showed a significant difference (p=0.02) between groups of children who were given Moringa leaf powder supplements compared to children who did not get it. Children who received Moringa leaf powder supplements experienced a weight gain of 8.9 ± 4.30 g/kg/day, while children who received not getting moringa leaf powder supplements experienced a weight gain of 5.7 ± 2.72 g/kg/day[14].

Vitamins and minerals contained in Moringa leaves include vitamin C, vitamin B complex, calcium, potassium, magnesium, selenium, zinc, arginine, and histidine, which play a role in the growth of toddlers[1]. The amino acids contained in Moringa leaf powder can be absorbed up to 60%, meaning that it has nutrients that can be adequately absorbed. Moringa is reported to have high-quality protein that is easily digested. The amino acids' quality influences this in Moringa leaf powder. Moringa is reported to have vitamin C, which can help iron absorption. Vitamin A and other nutritional elements are required for vision function, bone growth, immunity, and maintenance of epithelial tissue.[14] The content of nutrients in Moringa leaf powder is likely to have an essential role in increasing body weight.

Moringa leaf powder fortification can increase the absorption and quality of the protein contained in peanuts and soybeans. Protein Efficiency Ratio (PER), Net Protein Resistance (NPR), and Feed Conversion Efficiency (FCE) in experimental animals that had been given food fortified with Moringa leaf powder experienced an increase. PER indicates the relationship between weight gain and protein intake. NPR relates to changes in body weight, while FCE measures the extent to which food has been eaten and is expressed as body mass produced per kg[15].

Growth and metabolic functions depend on the absorption of micronutrients, nutrients, and vitamins in varying amounts. Moringa is rich in nutrients needed for the survival of life, which is very important in carrying out metabolic functions and growth. Moringa contains protein, vitamins (A, B, C, and E), calcium, iron, zinc, iodine, and selenium minerals. Dried Moringa leaves digested protein, calcium, and iron[15] efficiently. Moringa contains seven times more vitamin C than oranges. The calcium content of Moringa is four times that of milk. Moringa's potassium content is three times that of bananas. The protein content of Moringa is twice that of yogurt. The iron content of Moringa is nine times that of spinach. The content of vitamin A in Moringa is twice that of carrots. The fiber content of Moringa is four times that of wheat[16,17]. The characteristics of Moringa, which are high in nutrients, make Moringa a plant that has the potential to overcome the problem of malnutrition, especially in children.

The Effect of Nutritional Intervention on Increasing the Height of Toddlers

Bivariable analysis on the toddler's height variable was tested using an independent t-test with a significance degree of 0.05. This test was conducted to determine the difference in height increase in the group that was given education and fortification of moringa leaf powder in soy milk (Intervention) and the group that was only given education (control). The results of the analysis are described in Table 3:

Table 3. Analysis of differences in toddler height increase (TB) between the intervention group and the control group

Variable	Mean ± SD		*p-value*	Δ average	Δ CI 95%
	Control	Intervention			
TB Toddler	0.933 ± 0.466	1,866 ± 1,789	0.157	-0.933	-2.234 – 0.378

Table 3 illustrates the effectiveness of giving Moringa leaf powder fortified soy milk on the increase in toddler height (TB) in the group given Moringa leaf powder fortified soy milk compared to the control group. There was a difference in the average height increase in the group given soy milk fortified with moringa leaf powder compared to the control group. The average height increase in the intervention group was 1.866 ± 1.789, higher than the average height increase in the control group (0.933 ± 0.466). Based on the bivariate analysis in Table 3. the independent t-test illustrates the mean difference in TB under five in the

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intervention group of 1,866 cm and the control group of 0,933 cm (p-value; 0,157; CI 2,234 – 0.

This study shows that clinically there was a difference in the average height gain in the intervention group and the control group. The average height increase in the intervention group (1.866 ± 1.789) was higher than the average height increase in the control group (0.933 ± 0.466), although this difference was not statistically significant. It is possible that the duration was too short, so it could not optimally evaluate the effect of fortifying Moringa leaf powder. Similar results were shown in a study of malnourished children aged 6-59 months[14].

During growth, infants and toddlers need calcium intake of up to 650 mg[18]. One of the highest nutrient content in Moringa plants is the mineral calcium, especially in the leaves. The stem contains 30 mg (30%) of calcium, while the leaves contain up to 185 mg (18.5%) per 100 mg[15]. Calcium is an essential mineral in the process of bone formation. In this study, follow-up was carried out only for two months, or it can be said to be short term, so the time is not optimal for observing height as a growth parameter[14].

Effect of Nutritional Intervention on Toddler Nutritional Status

Bivariate analysis with an independent t-test with a significance of p<0.05 and a 95% confidence interval was carried out to test the results of calculating the nutritional status of toddlers based on the Z-score in the intervention and control groups before and after two months of intervention. The reference in determining nutritional status in this study was the Regulation of the Minister of Health concerning Children's Anthropometric Standards number 2 of 2020[19]. The parameters used in determining nutritional status in this study were three parameters, including weight index for age (W/A Z Score), height for age (H/A Z-Score), and weight for height (W/H Z-Score). The results of the analysis are as in Table 4:

Table 4. Analysis of the effect of nutritional interventions on the improvement of toddler nutritional status based on z-score values with BB/A, TB/U, and BB/TB indexes

Index	Mean ± SD		*p-value*	Δ Average	Δ CI 95%
	Control	Intervention			
BB/U Toddler	0.400 ± 0.632	1.000 ± 0.845	0.036	-0.600	(-1.158) – (-0.041)
TB/U Toddler	0.800 ± 0.774	1.200 ± 0.864	0.192	-0.600	(-1.012) – 0.212
BB/TB Toddler	0.800 ± 0.676	1.466 ± 0.639	0.009	-0.666	(-1.159 – (-0.174)

Table 4 presents the effect of the soy milk intervention fortified with Moringa leaf powder on improving nutritional status in the intervention and control groups, based on the Z-score values of the W/A, H/A, and W/H Z-Score indexes. Based on the bivariate analysis in Table 4, the Independent t-test showed that there were significant differences in the nutritional status of children under five in the intervention group and the control group based on the weight/age index (p-value; 0.036; CI (-1.158) - (-0.041)). Table 4 also shows that there were differences in the nutritional status of children under five based on the index of weight for height in the control group and the intervention group (p-value; 0.009; CI: (-1.159 – (-0.174))).

The analysis results show that soy milk fortified with moringa leaf powder can increase body weight and nutritional status based on the calculation of the Z-score based on the weight/age and weight/height indexes. Research conducted by Rahayu, Tri Budi, and Yespy Ana Wahyu Nur Indah Sari (2018) states that giving Moringa leaves can improve the nutritional status of toddlers. The average increase is 0.13[20]. Moringa plants have been widely used to overcome the problem of malnutrition, especially in children and mothers who are still under treatment. This is because Moringa contains many essential amino acids that other plants do not have. Moringa leaves contain more vitamin A than carrots, more iron than spinach, more calcium than milk, more vitamin C than oranges, and richer potassium than bananas. The protein has been shown to rival the protein contained in milk and eggs[21,22]. Moringa leaf powder fortification aims to increase the intake of energy, protein, iron, and zinc in toddlers. The provision of fortification of Moringa leaf powder can be given as processed other food, which is given as a morning and afternoon snack twice daily. This snack is expected to contribute 20% of the daily energy needs of toddlers[23].

Fortification of Moringa leaf powder has been proven to improve the nutritional status of toddlers with malnutrition problems. Zongo (2013), in his research, stated that malnourished toddlers improved their nutritional status following WHO nutritional status assessment standards, namely by assessing weight/age and height/age[14]. At the end of the study, the recovery of nutritional status was faster in the children in the intervention group, namely the porridge diet fortified with moringa leaf powder (z-score -1.00 ± 0.69, compared to the group who only received the porridge diet (z-score -1.00 ± 0.69). scores -1.78 ± 0.87)[14].

CONCLUSIONS

The intervention of soy milk fortified with Moringa leaf powder can significantly improve the nutritional status of toddlers by looking at the weight index for age (W/A Z-Score) and weight for height (W/H Z-Score). The height-for-age index (H/A Z-Score) cannot be proven statistically. It is necessary to conduct similar research with alternatives using moringa flower parts and leaf seeds as fortification materials.

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