

EFFECTS OF CONSUMING BISCUITS MADE FROM *MORINGA OLEIFERA* LEAF ON BODY WEIGHT AND HEIGHT OF CHILDREN UNDER FIVE IN BANGKALAN, MADURA ISLAND

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ABSTRACT

One of the efforts to maintain children's nutritional status is to prevent weight faltering, which was formerly known as failure to thrive. Unresolved weight faltering will cause several problems, such as growth failure, stunting, decreased IQ, morbidity, and mortality in children. Stunting is one of the big problems that occur in Indonesia. One of the continuous strategies to prevent weight faltering is through food supplementation, such as consuming moringa leaf which is high in protein in the form of biscuits. This study aims to determine the effects of consuming biscuits made from *Moringa oleifera* leaf on children's growth in Bangkalan, Indonesia. This study used experimental research method for two months. The sample was drawn using consecutive sampling technique. The subjects in this study were 31 children under five whose weight and height were not according to age. Before moringa biscuits were distributed, children's body weight and height were measured. The nutritional status was evaluated every month for two months. The parameters measured were weight gain and height increase. The results were analyzed using univariate and multivariate tests on SPSS. After giving moringa oleifera biscuits for two months at the Village Health Post (Pos Kesehatan Desa/Poskesdes) of Bangkalan, children's body weight increased by 0.35 kg per month and their height increased by 0.65 cm per month. The distribution of biscuits can be continued to preventing stunting.

Keywords: *Moringa oleifera* leaf, nutrition, weight, height, toddler, stunting

INTRODUCTION

Monitoring children's growth and development requires great attention. It is very important because it will have an impact on the children's physical and mental health in the future. One of the conditions to watch out for is inadequate growth, or often known as weight faltering. Another term for weight faltering is growth faltering or failure to grow. Growth faltering is also known as growth disturbance or shock (Black, Tilton, Bento, Cureton, & Feigelman, 2016). Weight faltering is a condition where the direction of the growth line is less than expected due to stagnant weight or low weight gain of children based on age. Many studies have found that children with weight faltering are lighter and significantly shorter than their peers (Alpine et al., 2019). If growth faltering is not prevented or treated, it can develop to growth failure, stunting, decreased IQ, stunted motor

and cognitive development, and increased child morbidity and mortality (Onyango et al., 2015).

Weight faltering due to malnutrition is one of the significant causes of stunting. Stunting is caused by several factors. The direct cause of stunting is a lack of food intake. In the intake factor, a history of consumption of energy, fat, protein, and iron is associated with of stunting (Azmy & Mundiastuti, 2018). Other factors that cause stunting are indirect causes, such as economic level, inadequate parenting, household food insecurity, and inadequate health services (Kemenkes, 2018). The average prevalence of stunting in children under five in Indonesia between 2005 and 2017 was 36.4% (Kemenkes, 2018). Based on the data from the Nutritional Status Monitoring (*Pemantauan Status Gizi/PSG*) for the last three years, stunting has the highest prevalence compared to other nutritional problems

such as undernutrition, thinness, and obesity. The prevalence of short children under five increased from 27.5% in 2016 to 29.6% in 2017 (Kemenkes, 2018). In 2021, Bangkalan Regency had the highest prevalence of stunting cases in East Java by 38.9%, which was still above the prevalence of East Java. Furthermore, Arosbaya Subdistrict is one of the areas that contributes to the high number of stunting cases in Bangkalan Regency.

One of the strategies to prevent stunting is to increase children's nutritional intake. Energy, protein, fat and iron have important roles in preventing stunting. These nutrients can be obtained from parts of local plants that are easily found, including moringa (*Moringa oleifera*) leaves. Moringa is a plant that has many benefits and nutritious. All parts of the moringa tree can be eaten, including the leaves. In 100 g of fresh moringa leaves, there is 6.7 g of protein and 0.7 g of iron. Moringa leaves can be dried for year-round storage and have a high content of complete protein (30 g/100 g dried leaves), iron (97.9 mcg/g dried leaves), vitamin A precursor (17.6-39.6 mg/100 g dried leaves), calcium, and many other necessary components (Olson et al., 2016).

A previous study found the diverse effects of moringa intervention in children between 6 and 24 months of age. Children aged six and older showed the highest prevalence of stunted development in the moringa flour intervention ($p > 0.005$), with a total of 44 children (42.7%). Furthermore, children under one year of age showed the highest prevalence of stunted development with a total of 29 children (30.9%), in the moringa extract intervention ($p > 0.005$) (Basri, Hadju, Zulkifli, Syam, & Indriasari, 2021). In summary, the effects of intervention on stunting in children between 0 and 24 months of age could not be seen. Another previous study has showed that moringa leaf extract can stimulate height growth of up to 0.342 cm with an estimated percentage of 16.2% (Muliawati & Sulistyawati, 2019). Meanwhile, consuming moringa biscuits for 21 days increases children's protein intake. As a result, moringa biscuits can be an alternative for increasing children's nutritional intake (Tarigan, 2020). Moringa leaves have a high content of protein, but taste and smell bad when consumed. The distribution of moringa leaves will not be accepted especially by children. Therefore,

to increase their acceptance, biscuits made from moringa leaf flour were developed by taking into account the nutritional content, especially protein, which can meet children's daily needs. For this reason, this study aims to determine the effects of consuming biscuits made from moringa leaf flour on children under five at the Village Health Post (*Pos Kesehatan Desa/Poskesdes*) of Bangkalan.

METHODS

This study used experimental research method and was conducted for two months at the Community Health Center of Arosbaya, Bangkalan Regency, East Java. This study received ethical approval from the Ethics Commission of the Faculty of Medicine, Universitas Airlangga No. 261/EC/KEPK/KHUA/2022. The sample was drawn using consecutive sampling technique (Safitri, Indri Puji Lestari, 2022). The subjects in this study were 31 children under five consisting of 14 boys and 17 girls. Moringa leaf biscuits were given to children between 1 and 5 years of age whose weight and height were not according to age. Before moringa biscuits were distributed, body weight and height were measured. Subsequently, each child got five packs of biscuits every month. One pack of moringa leaf biscuits consists of eight biscuits with a net weight of 320 grams, and the content of moringa leaf powder is equivalent to 35 grams of protein. The biscuits were distributed at the Poskesdes, whereas the dissemination of nutritional disorders in children and efforts to treat them was carried out by the Arosbaya Community Health Center to the parents of the children. Every day, the children were required to eat at least one biscuit. After a month, the parents and children were gathered back at the Poskesdes to measure the children's weight and height. Subsequently, the moringa biscuits was distributed again for the following month. After two months, the children's weight and height were measured again by the Poskesdes officers.

In this study, commercial moringa biscuits were used. The biscuits had been tested for their nutritional value so that they were safe for consumption. The contents of moringa biscuits per 100 grams are vitamin A (350 mcg), vitamin D (5 mcg), vitamin E (5 mg), vitamin K (5 mcg),

vitamin B1 (0.4 mg), vitamin B2 (0.4 mg), vitamin B3 (5 mg), vitamin B6 (0.36 mg), vitamin B12 (0.6 mcg), folate (60 mcg), calcium (310 mg), iron (6 mg), zinc (3 mg), selenium (13 mcg), iodine (70 mcg), sodium (80 mg), phosphorus (195 mg), moringa flour (0.07 mg), water (3%), protein (11 g), total fat (17 g), linoleic acid (2 g), linolenic acid (0.4 g), trans fat (0 g), cholesterol (1.8 g), total carbohydrate (65 g), dietary fiber (4 g), sugar (19 g), and sodium (80 mg). The total energy per 100 grams is 460 calories, whereas the energy from fat is 150 cal.

The data collection was carried out three times. The evaluation was carried out once a month by measuring the weight, height, and condition of any infection in children after consuming moringa biscuits. Height and weight were measured using a microtome and a digital scale standardized by the Ministry of Health of the Republic of Indonesia. The data on weight and height were analyzed using



Figure 1. Dissemination of the benefits of Moringa biscuits.



Figure 2. Moringa biscuits

univariate and multivariate tests on SPSS and presented in a graphical form.

The dissemination of the benefits of moringa biscuits for children's growth was also conducted to increase the parents' knowledge about child nutrition.

RESULTS

In this study, the subjects were 31 children between 1 and 5 years of age in the Arosbaya Subdistrict, Bangkalan Regency, East Java. Among 31 children, 14 of them were male and 17 of them were female. Therefore, the minimum age was one year and the maximum age was five years, with a median of 3 years. Each child consumed 40 moringa biscuits per month for two months.

Figure 1 showed that the average of girls' weight was higher than boys' weight. At the beginning of the study, the average of girls' weight was 14.56 kg. At the same time, the average of boys' weight was 12.16 kg. Both girls and boys gained weight in measurements 1, 2, and 3. In the boy group, the average weight gain was 0.70 kg in the first month. Meanwhile, in the girl group, the average weight gain in the first month was 0.34 kg. In the second month, the average weight gain in the boy group was 0.10 kg, whereas in the girl group was 0.29 kg. Based on the data on weight gain in all samples, the effectiveness of the moringa biscuit intervention on weight gain in the first 30 days was better than in the following 30 days. In the first 30 days, the moringa biscuit intervention resulted in an average weight gain of 0.50 kg. Meanwhile, in the following 30 days, the moringa biscuit intervention resulted in an average weight gain of 0.20 kg.

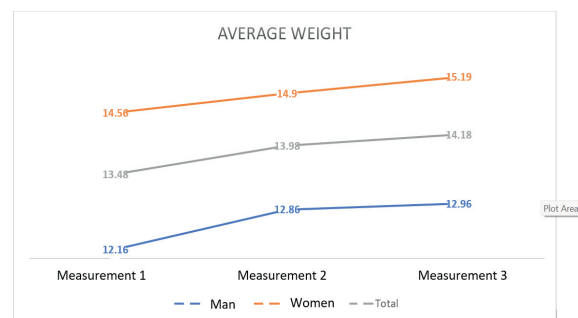


Figure 1. Average weight chart.

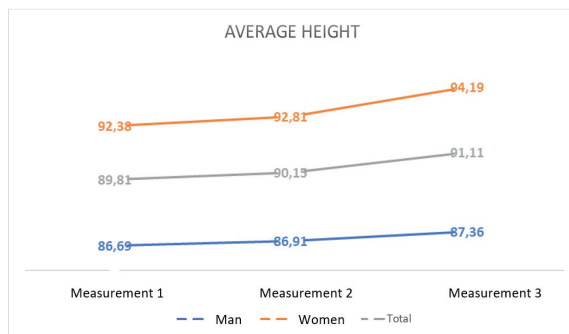


Figure 2. Average height chart.

From Figure 2 above, it can be said that on average, girls were taller than boys. At the beginning of the study, the average of boys' height was 86.69 cm. In comparison, the average of girls' height was 92.38 cm. Both the height of boys and girls increased in measurements 1, 2, and 3. In the boy group, the average increase in height in the second month was 0.22 cm. In the girl group, the average increase in height was 0.43 cm. Meanwhile, in the third month, the average height increase in boys was 0.34 cm. Meanwhile, the average height increase in girls was 1.38 cm. Based on the data on height growth in all samples, consuming moringa leaf biscuits in the second 30-day period was more effective than in the first 30-day period. In the second 30-day period, the average height growth was 0.96 cm, whereas the average height growth in the first 30-day period was 0.34 cm.

We also performed a multivariate analysis to prove the differences between each variable in height, weight, and sex. The multivariate analysis was performed to analyze the factors that played a role in changes in weight and height. The multivariate analysis aims to determine the differences in height and weight simultaneously in each measurement period and whether there was a difference in height and weight simultaneously in the boy and girl groups. Based on the results of multivariate statistical tests, it was found that the F value is 5.026 with a p-value of <0.001. These results indicated a significant difference between the boy and girl groups in each measurement period.

DISCUSSION

This study was conducted to determine the effectiveness of moringa biscuit consumption on children's growth and reduce the number of stunting cases in Indonesia. The results of the data showed that the weight and height of the children who had consumed moringa biscuits for two months increased. This study shows promising results because there are possible solutions to overcome weight and height problems in children under five. The children consumed ten packs of moringa biscuits in two months. One pack of 320 grams contains 35.2 grams of protein, meaning that the children consumed 352 grams of protein and an additional 4500 kcal from moringa biscuits. As a result, their weight and height increased.

A previous study used moringa leaf powder to improve the nutritional status of children between 2 and 5 years of age with malnutrition. This study showed that after the intervention of moringa leaf powder, of the 25 children in each group, the nutritional status of 16 children in the treatment group who consumed Moringa leaf powder and two children in the control group who did not contain Moringa leaf powder nutrition increased (Tandirau et al., 2020).

This is consistent with an earlier study, where one toddler (3.33%) had very poor nutritional status prior to the consumption of moringa leaf powder, seven toddlers (23.33%) were underweight, and 22 toddlers (73.33%) had normal nutritional status. After receiving the treatment, there were no toddlers with extremely low nutritional status, three toddlers with low nutritional status (10%), and 27 toddlers with normal nutritional status (90%) (Rahayu & Nurindahsari, 2018).

One of the things that supported the good results of this study was the nutritional content of the moringa biscuits, namely high protein. In addition to moringa flour, this biscuit contains catfish flour, which contains higher protein (Ananda & Anggraeni, 2021). The biscuits also tasted very good and were easy to digest. Therefore, the children like to eat them. When they were told that these biscuits were made from

plants that were widely available around the house, the subjects were very excited and responded positively.

The results also showed that girls grow faster than boys when they are children under five. This can occur due to the internal factor of sex, which is in accordance with the theory that the average growth rate of girls is higher and heavier than boys under 13 years of age. The growth rate of boys is faster than girls when they are between 12 and 16 years of age (Widanti, 2017). Meanwhile, external factors that affect the growth and development of children are nutrition, stimulation, psychological condition, and socio-economic condition (French, Outhwaite, Langley-Evans, & Pitchford, 2020).

In 100 grams of moringa biscuits, there are useful ingredients that can meet the nutritional needs of children under five, especially those with nutritional disorders. Previous studies found diverse effects of moringa intervention on infants between 6 and 24 months of age. Children under six years of age had the highest frequency of stunted growth in the moringa powder intervention ($p > 0.005$), with a total of 44 children (42.7%). Children under 12 months of age had the highest prevalence of stunted growth in the moringa extract intervention ($p > 0.005$), with a total of 29 children. Additionally, moringa flour intervention in children aged 24 months was associated with the highest prevalence of stunting ($p > 0.05$), with a total of 57 children (48.7%) (Leone et al., 2015; Mahmud et al., 2019).

Another study using the Wilcoxon signed rank test to analyze the data revealed a value of Sig. (two-tailed) of $0.000 < 0.05$, indicating that giving moringa leaves to toddlers had an impact on their nutritional status as measured by their body mass index (BMI) by age. Giving toddlers moringa leaves can increase their BMI. In other words, there was a tendency for an average increase in BMI by 0.13 before and after treatment (Rahayu & Nurindahsari, 2018).

A number of studies pointed to the possibility that supplementation may enhance children's cognitive growth. Using locally available ingredients like moringa leaves to improve the quality of supplemental foods for weaning is one of the steps performed to accelerate the growth

and development of toddlers. According to a study, moringa leaves contain a variety of nutrients crucial for children's growth and development, including calcium, protein, and vitamin A. The concentration of moringa leaf extract is higher than wet moringa leaves (Gopalakrishnan, Doriya, & Kumar, 2016).

Since moringa leaf extract contains a lot of nutrients that toddlers need for growth and development, giving extra moringa leaves will boost their appetite and fulfil their nutrition. According to Joshi's (2010) findings from a different study in Senegal, moringa leaf powder is effective in preventing and controlling malnutrition in young children, pregnant women, and nursing mothers. With a high content of vitamin A, calcium, protein, and zinc, it goes without saying that these activities improve toddlers' weight and height (Joshi & Mehta, 2010).

Moringa oleifera is one of the local foods in Indonesia that has high nutritional contents. Moringa's nutritional supplements can be consumed by pregnant women to help prevent anemia and by children to help prevent stunted growth (Idohou et al., 2011; Iskandar et al., 2015). Given the significant benefits of consuming moringa leaf powder in treating severe acute malnutrition, it should be promoted to improve children's nutritional status and guard against several micronutrient deficiencies, including iron and vitamin A deficiencies (Muffihatin, Vestine, Gandu Eko, & Swari, 2021).

Studies on nutritional supplementation using moringa in toddlers have been carried out, but the results of this intervention are still very mixed. In a 5-year study, various types of nutritional interventions were also carried out and more attention was paid to their effects on the growth and development of children aged 0 to 5 years. However, there were no significant results in reducing stunting in children aged 36 to 42 months (Prado et al., 2019). Therefore, the results of this study can be a solution to the problem of child nutrition. Moringa is highly recommended because the raw materials are widely grown in Indonesia. As a result, it can be used to support the reduction of stunting cases by providing complementary

foods made from moringa raw materials, especially moringa leaf extract.

CONCLUSION

Consuming Moringa leaf biscuits (*Moringa oleifera*) can increase the average height and weight of children under five without causing negative effects and affecting the overall health of children. Moringa leaves are a rich source of protein. Therefore, the results of this study can be a solution to the problem of nutritional intake for children who have a high prevalence of stunted growth and reduce the number of stunting cases in Indonesia.

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