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Moringa Leaf Nanoparticles as an Alternatives to Improve Hemoglobin and Hematocrit Levels in Stunting Toddlers

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Abstract

Background: Stunting is a condition of short toddlers is a discrepancy between height for age which is measured based on the z-score <-2 SD. The highest prevalence of stunting in Central Java was in Magelang Districts by 37.6%. Aims: The objective of this study is to prove that consuming Moringa Oleifera leaf nanoparticles influences the increase in hemoglobin and hematocrit levels in stunting toddlers. Method: This is a quasy experimental study with pretest and posttest with control group design. The number of samples were 40 stunting toddlers who measured based on the z score <-2 SD. Those were divided into treatment groups (Moringa Oleifera leaf nanoparticles dose of 65 mg/day and supplementary feeding) and control groups (supplementary feeding) each group consisted from 20 toddlers. Interventions were given for 21 days. Examination of hemoglobin and hematocrit levels using the Hematology Analyzer method. Results: The hemoglobin level increased significantly from 11,365 g/dL to 12,610 g/dL with a value of p=0.001 in the intervention group. Moreover, hemoglobin level in the control group a slightly increased from 11.455 g/dL to 11.610 g/dL with a value of p=0.648. Hematocrit levels increased significantly (p=0.001) from 35.810% to 43.575% in the intervention group. Hematocrit level also improved slightly in the control group from 31.330% to 31.690%. However, it was not significantly with p=0.455. Conclusion: It is Proved that Moringa Oleifera leaf nanoparticles improves hemoglobin and hematocrit levels in stunting toddlers. The increase hemoglobin and hematocrit levels are greater in the intervention group rather than the control group.

Keyword: Moringa Oleifera leaf nanoparticle, hemoglobin levels, hematocrit levels, stunting

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Introduction

Stunting is a condition of short toddlers (under 5 years old) is a mismatch between TB / U or PB / U as measured by the z-score <-2 SD median standard of child growth according to the World Health Organization (WHO) with a maximum limit of stunting in children of 20%.(Pusat Data dan Informasi Kemenkes RI, 2016) In Indonesia the under-five mortality rate in 2017 was 32/1000 live births.(Kementerian Kesehatan RI, 2018a) Deaths under-five that are as much as 50% are caused by malnutrition problems.(Lima, 2011) The highest prevalence of stunting in Central Java was in Magelang District by 37.6% .(Kementerian Kesehatan Republik Indonesia, 2017)

In toddlers who experience malnutrition one of them due to iron deficiency which is characterized by growth disorders. Then malnutrition is also associated with various pathophysiological changes in the body including the hematological system. As Arun's study said, 95% of malnourished children suffer from anemia with low levels of hemoglobin, hematocrit and erythrocyte numbers but high leukocyte counts.(Arya et al., 2017)

One effort that has been made in dealing with the incidence of stunting is the provision of supplementary feeding. (Kementerian Kesehatan RI, 2018b) The prevalence of toddlers aged 6-59 months who get a PMT in 2018 is 41%.(Waroh, 2019) In Annisa's research explained that as many as 68.5% of parents did not adhere to the supplementary feeding program so that as many as 74.1% of children under five do not experience changes in nutritional status. Some respondents are not compliant in consuming additional food given because toddlers do not like the menu.(Adelasanti, 2018)

Medicinal plants that have been used to improve the health status of malnourished toddlers are moringa leaves which can be eaten as vegetables. Nutrients in it are easily absorbed by the body and do not cause allergies. The main advantage of using Moringa leaves is that local resources are easily available with little or no cost.(Srikanth et al., 2014)(Doria, 2017)

Around the world are producing various products containing Moringa leaves in the form of tablets, capsules, powder or tea.10 Moringa leaves processed in powder form have been widely studied, in recent years the development of nanotechnology products continues to increase. Nanoparticle technology is able to optimize the performance of the content contained in Moringa leaves, especially mineral content.(Syahrial et al., 2019)

The purpose of this study is to prove the administration of Moringa leaf nanoparticles affect the increase in hemoglobin levels and hematocrit levels in stunting toddlers.

Methods

This research is a quasy experimental with pretest and posttest with control group design. This research was conducted at the Publich Health Center of Grabag I and Grabag II, Magelang District, Central Java for 21 days from February to March 2020.

*The sa*mple in this study were 40 stunting toddlers measured based on the z score <-2 SD divided into treatment groups and the control group consisted of 20 toddlers each. In the treatment group Moringa leaf nanoparticles were given daily at a dose of 65 mg/day and supplementary feeding while the control group were only given supplementary feeding for 21 days which was assisted by an enumerator.

Before and after the intervention, hemoglobin and hematocrit levels were examined using the Hematology Analizer method.

This research has obtained ethical clearance eligibility from Dr. Moewardi Number 1.483/ XII/ HREC/ 2019. Prior to the implementation of this researchers, it had obtained approval letter from national and political unity of Magelang District Health Office and the heads of the Publich Health Center of Grabag I and Grabag II.

Result and Discussion

Table 1. Frequency distribution of toddler characteristics based on iron and vitamin C intake

Variable	Group		*P value*
	Treatment	Control	
Iron intake			
Enough	8 (40%)	5 (25%)	0,250*
Less	12 (60%)	15 (75%)	
Vitamin C intake			
Enough	0	2 (10%)	0,244*
Less	20 (100%)	18 (90%)	

** Chi-square Test*

Based on table 1, iron intake per day in stunting toddlers in the treatment group was found as much as 40% had sufficient iron intake while toddlers who had less iron intake were 60%. In the control group of toddlers with enough iron intake as much as 10% while toddlers with less iron intake as much as 90%. Based on homogeneity test there is no difference between iron intake in the treatment group and the control group p = 0,250 or p =>

0.05 meaning homogeneous. Recommendations for iron adequacy for children aged 12-36 months is 8 grams/day and age 37-60 months is 9 grams/day.(Bloch et al., 2013) Iron is a micro nutrient that is important for the body. Iron is needed in the process of hemopobesis, namely the formation of hemoglobin molecules. Lack of iron intake in childhood can cause stunted growth which if it lasts for a long time can lead to stunting.(Sundari & Nuryanto, 2016) This study is in line with research that has been done in Indonesia which says that in stunting infants who have adequate iron intake as much as 1 toddlers and inadequate iron intake as many as 40 toddlers(Losong & Adriani, 2017; Roziko, 2016)

Vitamin C intake per day in stunting toddlers in the treatment group was not obtained by toddlers with adequate vitamin C intake while toddlers who had less vitamin C intake as much as 100%. In the control group of toddlers with enough vitamin C intake as much as 10% while toddlers with less vitamin C intake as much as 90%. Based on the homogeneity test there was no difference between the intake of vitamin C in the treatment group and the control group p = 0.244 meaning equivalent or homogeneous. Suggested nutritional adequacy levels of vitamin C for children aged 12-36 months is 40 grams/day and ages 37-60 months which is 45 grams/day.(Bloch et al., 2013) Consumption of vitamin C contained in fruit has an important role in the process of absorbing iron by increasing four times the absorption of nonheme iron.(Mahameru Pradanti et al., 2015) In the process of absorption of iron in the body the nutrient in the form of vitamin C is able to increase the absorption of food through the stages of formation of the ferroaskorbate complex. Iron absorption will increase by about 20% -25% due to a combination of iron salt with 200 mg of ascorbic acid.(Adriani, 2016) In this study it was found that intake of vitamin C in the treatment and control groups had not yet reached the requirement. In line with previous studies which showed that the average intake of vitamin C in stunting toddlers was 15.96 mg, as much as 10% with adequate vitamin C intake and as many as 90% had less vitamin C intake.(Roziko, 2016) Other studies also showed that the intake of vitamin C from 60 stunting toddlers were 39.9% with good vitamin C intake and 60.1% with less vitamin C intake.(Hendrayati dan Ramlan Asbar, 2018)

Table 2. Analysis of differences in mean hemoglobin levels before and after the intervention in the treatment and control groups

Variable	Group		*P value*
	Treatment (Mean±SD)	Control (Mean±SD)	
Hemoglobin level (g/dL)			
Before intervention	11,365±1,027	11,455±1,008	0,781**
After intervention	12,610±1,403	11,610±1,020	0,014**
Difference	1,245±1,329	0,155±1,496	0,020**
P value	0,001*	0,648*	

**Paired t test, **Independen t test, SD: Standard Deviation*

Table 2 shows that in the treatment group before the intervention the mean hemoglobin level was 11,365 ± 1,027 and after the intervention it was 12,610 ± 1,403 (p = 0.001) meaning that there was a significant increase in the hemoglobin level after the intervention. In the control group the mean hemoglobin levels before the intervention were 11.455 ± 1.008 and after the intervention 11.610 ± 1.020 (p = 0.648) meaning that there were no significant differences in the mean hemoglobin levels after the intervention. The test results used the Independent T Test before the intervention (p = 0.781) which means there was no difference in the mean hemoglobin levels before the intervention between the treatment group and the control group. The mean hemoglobin level after the intervention in the treatment group and the control group (p = 0.014) meant that there were significant differences in the mean hemoglobin level after the intervention between the two groups. Difference in hemoglobin levels in the two groups (p = 0.020), which means that there were significant differences in the difference in hemoglobin levels between the treatment and control groups.

Hemoglobin is a blood component that has a function as a means of transporting oxygen (O2) containing iron in red blood cells and carbon dioxide (CO2).(Guyton A.C and John E. Hall, 2011) In hemoglobin consists of two thirds of iron.15 Iron is a micromineral that plays an important role in the human body because it has a vital function, namely the formation of red blood cells.(Hamzah & Yusuf, 2019) Iron deficiency has been linked to poor cognitive performance in children and will occur in the

long term due to iron deficiency.(Adedapo et al., 2009)

Iron deficiency anemia occurs when the balance of iron intake, iron stores and loss of iron in the body is not enough to fully support the production of erythrocytes. Iron deficiency is the main cause of anemia, the prevalence of anemia in infants reaching 47.4% is included in the high category in developing countries. Toddlers are an age group prone to experiencing iron deficiency. That is because the need for iron in infants increases during growth, low bioavailability and food intake and due to infections and parasites.(Ikatan Dokter Anak Indonesia, 2011)

Anemia in children is a major health problem in communities throughout the world. This is related to serious consequences such as growth disturbance, impaired motor and cognitive development and can increase morbidity and mortality.(Ayoya et al., 2013) WHO estimates that around 800 million people in the world have anemia and around 273.2 million are children aged 5 years. The most common cause of anemia found in infants is due to iron deficiency, apart from iron deficiency anemia is also caused by lack of micronutrient intake such as vitamin C, which is known that vitamin C as an enhancer to prevent the occurrence of iron deposition in the intestine.(Herawati et al., 2018) Factors that are cause anemia, especially in infants, which is due to low intake of protein and zinc.(G. Barragan-Ibanesz, 2016)

The component that plays a role in the formation of hemoglobin is iron. In the moringa leaf nanoparticles (Moringa Oleifera) contain iron as much as 32.375 mg / 100gr and vitamin C 56.549 ppm. Vitamin C in Moringa leaves affects the release and absorption of iron from transferrin to body tissues. In the process of absorption of iron, vitamin C has the function of helping reduce iron into fermentation in the small intestine so that it is easy to absorb. Nonheme iron absorption can increase 4-fold if in the presence of vitamin C.(Osman et al., 2012) The size of Moringa Oleifera Moringa leaf nanoparticles in this study was 614.4 nm. Nanoparticle technology is able to optimize the performance of the content in the leaves of Moringa (Moringa Oleifera) especially the mineral content, so that the mineral content can be absorbed easily by the body compared to minerals without going through the nanoparticle technology process.(Syahrial et al., 2019)

In another study also showed an increase in hemoglobin levels by giving Moringa

Oleifera leaf extract at a dose of 1,400 mg/day for 21 days in women with anemia aged 18-49 years with an average value of 10.58 ± 1.36 to 11.37 ± 1.46 an increase but has not reached normal values.(Suzana et al., 2017) Furthermore, in the Nismawardah study (2019) showed that the administration of Moringa leaf nanoparticles with a dose of 28.57 mg / kgBB / day for 21 days in cancer patients who had received chemotherapy showed an increase in hemoglobin levels, hematocrit levels, the number of erythrocytes and leukocytes count after the intervention in this study showed an increase in hemoglobin levels reached normal values.(Nismawardah, 2019).

Table 3. Analysis of differences in mean hematocrit levels before and after the intervention in the treatment and control groups

Variable	Group		*p value*
	Treatment (Mean±SD)	Control (Mean±SD)	
Hematocrit level (%)			
Before intervention	35,810±2,902	31,330±3,772	0,001**
After intervention	43,575±6,154	31,690±3,477	0,001**
Difference	7,765±6,654	0,360±2,109	0,001**
P value	0,001*	0,455*	

**Paired T Test, **Mann Whitney, SD: Standard Deviation*

Table 3 shows that before intervention in the treatment group the mean hematocrit level was 35.810 ± 2.902 and after the intervention it was 43.575 ± 6.154 (p = 0.001) meaning that there was an increase in the hematocrit level after administration of the intervention. In the control group the mean hematocrit levels before intervention were 31.330 ± 3.772 while the mean hematocrit levels after intervention were 31.690 ± 3.477 (p = 0.455) meaning that there were no significant differences in the mean hematocrit levels after the intervention. The test results used Mann Whitney before the intervention in the two groups (p = 0.001) which means there were differences in the mean hematocrit levels before the intervention. Mean hematocrit levels after intervention (p = 0.001) means that there are significant mean differences in hematocrit levels after the intervention between the treatment and control groups. Difference in hematocrit levels in the two groups (p = 0.001), which means that there were significant differences in the mean difference in hematocrit levels between the treatment and control groups.

Hematocrit levels will increase (hemoconcentration) due to an increase in the

number of erythrocytes or because of a decrease in blood plasma volume. Hematocrit levels will decrease (hemodilution) due to a decrease in the number of erythrocytes or due to an increase in blood plasma levels for example in cases of anemia.(Meilanie, 2019)

Hematocrit is the ratio between the volume of red blood cells (erythrocytes) with the total volume of blood. In women the hematocrit range from 35% -47% and men 41% -54%. Deviations from this range can be used to help diagnose certain conditions related to health status such as dehydration and anemia.(Berry et al., 2016) Hematocrit levels are influenced by the formation of red blood cells in which the substance that plays a role is iron.(Almatsier, 2010)

In a related study showed that an increase in hematocrit levels by giving Moringa Oleifer leaf powder at a dose of 0.038g / kg Moringa Oleifera is 41.39 ± 1.59 with a significance level of p = 0.05.(Adegbite et al., 2016) Other studies that are in line with this study are there was a significant difference in hematocrit levels before the intervention namely in the intervention group 31.5667 ± 4.93452 whereas after administration of 250x2 Moringa Oleifera leaf capsules for 14 days in the intervention group 38.3867 ± 1.14759.(Estiyani et al., 2017)

Conclusion

Moringa leaf one of the plants that can be used as an alternative to increase hemoglobin levels and hematocrit levels in stunting toddlers is added by using nanoparticle technology that is able to accelerate the absorption of the mineral content of Moringa leaves in the body.

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