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The effect of *Moringa oleifera* on blood pressure and high-density lipoprotein in hypertension patients with hypercholesterolemia

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Abstract
This study aims to determine the effect of an extract of Moringa oleifera on systolic blood pressure, diastolic blood pressure and HDL. Hypertension is a condition when blood pressure has an increase which gives continued symptoms in a target organ in the body. Hypertension left untreated will lead to complications and health problems. Prevention by providing the extract of *Moringa oleifera* can reduce systolic blood pressure, diastolic blood pressure and increase HDL. This study uses an experimental method with a pre-posttest control group design. The population is hypertensive patients with hypercholesterolemia who participated in the prolanist program at Health Center. Sample technique uses probability sampling. The sample consisted of 32 respondents, and each group included 16 respondents. Each group was given intervention for 13 days. Systolic blood pressure, diastolic blood pressure was measured on the 5th day, 10th day and 14th day and HDL measurements were carried out on the 14th day. On the 14th day, the intervention group systolic blood pressure showed 133.75 mmHg, diastolic blood pressure 83.25 mmHg, 56.69 mg / dL HDL, whereas the control group of systolic blood pressure showed 148.31 mmHg, diastolic blood pressure 89.19, HDL 49.44 mg / dL, so can be concluded that extract *of Moringa o*leifera can reduce systolic blood pressure, diastolic blood pressure, LDL, triglycerides and increase HDL.

Keywords: systolic blood pressure, diastolic blood pressure, HDL, Moringa leaf extract, hypertension

1. Introduction
Hypertension is a condition in which blood pressure has an increase which continues to cause an organ in the body. This can cause more severe damage, such as stroke (occurs in the brain and causes high death), coronary heart disease (damage to the heart blood vessels), and left ventricular hypertrophy (occurs in the heart muscle). Hypertension can also cause kidney failure, other vessel diseases and other diseases [1]. Generally, hypertension occurs in people over 40 years of age. This disease usually shows no real symptoms, and in the early stages, it has not caused a severe disorder of the health of the sufferer [2].

Hypertension develops from the interaction between genetic factors and complex environmental factors, although more than 90% of cases do not have a clear etiology. Many studies have identified the main factors contributing to hypertension, including Increased sympathetic nervous system activity, increased long-term sodium intake, inadequate daily diet of potassium and calcium, changes in renin secretion associated with increased renin-angiotensin system activity (RAS), increased angiotensin I converting enzyme (ACE) activity which results in excessive production of angiotensin II (Ang II) and activated Kallikrein-Kinin (KKS) system, endothelial dysfunction and reduced vasodilator including decreased availability of naturally occurring nitric oxide (NO) body, abnormal vascular resistance caused by vascular inflammation, increases vascular growth factors and changes cellular ion channels [3].

Moringa leaves (Moringa oleifera) are known to have a high chemical content of potassium, flavonoids, and vitamin C. Moringa leaves (Moringa oleifera) are also diuretic because of their high water content which helps lower blood pressure. Potassium affects both skeletal and heart muscle activity. For example, changes in concentration change myocardial irritability and rhythm. Whereas Vitamin C and flavonoids found in Moringa leaves play a role in fat metabolism by increasing the rate of cholesterol excretion which is discharged in the form of bile acids, increasing HDL levels, and decreasing the reabsorption of bile acids and their conversion to cholesterol [4].

The study showed that the effect of *Moringa oleifera* water extract on LDL and HDL levels in the serum of white rats (*Rattus norvegicus*) given atherogenic diet and extracts of 150, 300 and 600 mg/kg for 8 weeks showed results, that the water extract *Moringa oleifera* at a dose of 300 mg/kg body weight and 600 mg/kg body weight can reduce LDL levels and can increase HDL levels in white mouse serum. A dose of 300 mg/kg body weight is the minimum dose that can give an effect on decreasing LDL levels and increasing HDL levels [5].

Another study was conducted to examine the ethanol extract of Moringa oleifera in white rats Sprague-Dawley strains which were divided into 3 groups dosing 84.330 mg / 200 g WB, dose 168.9 mg / 200 g WB and dose 337.9 mg / 200 g WB, showed that the ethanol extract of Moringa leaves which has a useful antihypertensive effect was a dose of 337.9 mg / 200 g WB [6]. Research has been conducted on humans using Moringa goes with a treatment of 0.3 gr/kg WB and 0.7 g / kg body weight for 14 days has not shown significant results in decreasing blood pressure and cholesterol [7].

This indicates that a higher dose is needed to reduce blood

Pressure and cholesterol. Based on the calculation of conversion from animals to humans the right treatment to lower blood pressure and cholesterol is 0.30 grams/kg. Referring to the research, so that in this study the dose used is equal to 0.30 gram/kg. With the hope that this dose can reduce blood pressure, and increase HDL in hypertensive patients with hypercholesterolemia, a study was conducted to determine the effect of leaf extract of *Moringa oleifera*) on blood pressure, HDL in hypertensive patients with cholesterol.

2. Methods

The design used in this study was an experimental design using a pre-posttest control group design. This design is used to determine the effect of giving *Moringa oleifera* leaf extract to systolic blood pressure and diastolic blood pressure while HDL was measured posttest in hypertensive patients with hypercholesterolemia. Extract of *Moringa oleifera* was given to the intervention group while the control group was given captopril and simvastatin. In each group both the intervention group and the control group, systolic blood pressure measurements, diastolic blood pressure with frequency 3 times, namely day 5, day 10 and day 14 and measurements of HDL were carried out on day 14.

The population in this study were hypertensive patients with hypercholesterolemia who participated in the prolanis program as many as 52 people in Woha Health Center, Bima Regency, and Indonesia. The sample of this study was 32 respondents, divided into 16 respondents in the intervention group and 16 in the control group. The sampling technique used is by probability sampling. Probability sampling technique used is stratified random sampling, by dividing into 2 groups in each group as many as 16 people, namely, "group I" respondents who have age ≤ 60 years, blood pressure 140-159 mmHg and cholesterol levels 200-239 g / dL, while "group II" respondents who have age ≥ 60 years, blood pressure 160-179 mmHg and cholesterol level ≥ 240 g / dL.

3. Result and Discussions

Analysis of differences in mean HDL showed significant differences in HDL values between the intervention group and the control group with the results of the HDL statistical test in the intervention group with mean values = 56.60 mg / dL, and the control group mean value = 49.44 mg / dL (t = 2.344 p = 0.001).

Tables 1: Systolic blood pressure, diastolic, HDL after intervention

Variable		Group	
		Intervention	Control
		Mean±SD	Mean±SD
SBP	Pre	163.75±8.544	162.50±10.961
	5th day	151.25±15.234	160.88±10.301
	10th day	142.06±15.088	153.31±9.728
	14th day	133.75±11.579	148.31±8.332
DBP	Pre	98.94±5.916	97.62±6.702
	5th day	91.50±6.088	96.50±7.033
	10th day	85.31±4.159	91.25±5.066
	14th day	83.25±3.474	89.19±4.736
HDL		56.69±8.592	49.44±8.899

The table above shows that the decrease in systolic blood pressure in the intervention group and the control group. The results of a reduction in diastolic blood pressure began to be active on the 10th day where the intervention group experienced an average diastolic blood pressure decrease of 85.31 mmHg, and the control group experienced a significant reduction in diastolic blood pressure with an average value of 89.19 mmHg.

This study is in line with previous research, which states that giving 200 mg/day aloe vera juice can reduce LDL cholesterol levels by 20.36% and increase HDL cholesterol by 18.87% after being offered for 14 days. Giving Aloe Vera juice 200 mg/day was able to reduce LDL in the control group with a mean value of 140.35 mg / dL and the control group 160.90 mg / dL. While HDL cholesterol levels in the intervention group with a mean value of 53.35 mg / dL and the control group 45.66 mg/dl [8].

The addition of simvastatin 1 x 20 mg plus 3x500 mg Moringa leaf extract for 13 days in the active intervention group increased HDL levels compared to the control group which only received simvastatin 1 x 20 mg. After 13 days of intervention showed that there was a significant difference between the two groups after HDL measured on day 14 showed that the intervention group was more effective in reducing n HDL increase with p = <0.05.

Simvastatin is a cholesterol-lowering drug from statins that plays a role in synthesizing body cholesterol [9]. The mechanism of action of simvastatin in reducing blood cholesterol levels is 2 types, namely by inhibiting HMG-CoA reductase and decreasing LDL receptors. Simvastatin by inhibiting HMG-CoA reductase will convert acetyl-CoA to mevalonic acid. 80 Mevalonic acid is a cholesterol precursor. Precursors are compounds that can undergo changes to produce new compounds and require the presence of other regeneration in certain reaction conditions [10]. The mechanism of action of simvastatin by decreasing LDL receptors begins with the elimination of intracellular cholesterol which causes cells to increase the number of specific cell surface LDL receptors that can bind and internalize the circulating LDL. Because of reduced cholesterol synthesis and an increase in LDL catabolism, it causes a decrease in plasma cholesterol.

The content of flavonoids and vitamin C contained in Moringa oleifera can inhibit the formation of cholesterol which results in reduced blood serum cholesterol. Flavonoids can lower LDL, HDL and triglyceride levels by inhibiting 3-Hydroxy-3-methyglutary Coenzyme A (HMG-CoA) reductase this decomposition of cholesterol, LDL, triglycerides become slow which results in the formation of cholesterol, LDL and triglycerides decreased [11]. Other studies also say that Flavonoids can increase the activity of Lecithin Cholesterol Acyl Transferase (LCAT). LCAT is an enzyme that can convert free cholesterol to a more hydrophobic cholesterol ester so that cholesterol esters can bind to lipoprotein core particles to form new HDL; this will increase serum HDL leve ls [12].

Other components found in Moringa leaf extract such as vitamin C are known to reduce cholesterol and LDL levels by increasing the activity of 7α-hydroxylation enzymes in the formation of bile acids. Other studies also stated that there was a significant relationship between vitamin C intakes in patients with heart disease in Dr. M. Yunus Bengkulu [13]. Other studies also say that bile acids are formed by cholesterol

with the help of 7α-hydroxylation enzymes, in the presence of vitamin C to increase -hydroxylation enzyme activity which increases the effect on cholesterol excretion in the process bile acid formation which results in decreased blood cholesterol levels.

Table 2: Diastolic blood pressure decrease

Variable	Group	Mean	Different Mean±SE	*p*
Diastolic				
Before	Intervention	98.94	1.312±2.235	0.561
	Control	97.62		
5th day	Intervention	91.50	-5.000±2.326	0.040
	Control	96.50		
10th day	Intervention	85.31	-5.938±1.639	0.001
	Control	91.25		
14th day	Intervention	83.25	-5.938±1.468	0.000
	Control	89.19		

The mean diastolic blood pressure between the intervention group and the control group showed a significant difference between the results of statistical tests p = 0.05. The intervention group showed significant compared to the control group (F = 79.555, p = 0.000). Diastolic blood pressure on the 5th day has a mean 91.50 showed grade 1 category, but on the 10th day, the mean value was 85.31 until the 14th day mean value is 83.25 showed a normal category with a value of p = <0.05. While the 5th day control group has a mean value 97.62 and the 10th day mean value 91.25 showed grade 1 category, but on the 14th day, mean value 89.19 was in the normal category with p = <0.05.

Table 3: The mean systolic blood pressure between the intervention and the control group

Variable	Group	Mean	Different Mean±SE	*p*
Systolic				
Before	Intervention	163.75	1.250± 3.474	0.722
	Control	162.50		
5th day	Intervention	151.25	-9.625± 4.597	0.045
	Control	160.88		
10th day	Intervention	142.06	-11.250 ±4.488	0.018
	Control	153.31		
14th day	Intervention	133.75	-14.562 ±3.566	0.000
	Control	148.31		

The mean systolic blood pressure between the intervention group and the control group showed a significant difference between the results of statistical tests p = 0.05. The intervention group showed significant compared to the control group (F = 75.721, p = 0.000). Systolic blood pressure showed a decrease from 151.25 to 133.75 while the control group showed a decrease from 152.50 to mean value 148.31 in 14th day. This research is in line with the research conducted before, stating that giving a decoction of a divine crown can reduce the blood pressure of hypertensive patients with hypercholesterolemia. The results of the analysis showed that systolic blood pressure with p = 0.026 and diastolic pressure with p = 0.018. In the intervention group, systolic blood pressure means 142.5 and diastolic blood pressure 90.72 while the control group of systolic blood pressure means 160.4 and diastolic blood pressure mean 95.54.86.

The treatment for each group was carried out for 13 days; the intervention group received captopril 2 x 25 mg plus 3x500 mg Moringa leaf extract effective in reducing systolic blood pressure and diastolic blood pressure compared to the control group which only received captopril 2 x 25 mg. Captopril works by suppressing the renin system of angiotensin aldosterone. Renin is an enzyme produced by the kidneys and works in plasma globulins to produce inactive angiotensin I. "Angiotensin Converting Enzyme" (ACE), will convert angiotensin I to angiotensin Il which is active and is an endogenous vasoconstrictor and can stimulate aldosterone synthesis and secretion in the adrenal cortex. Increased aldosterone secretion results in kidney retention of sodium and fluid, and potassium retention. In its work, captopril will inhibit the action of ACE. As a result, the formation of angiotensin II is inhibited, vasodilation occurs, decreased aldosterone secretion so that the kidneys secrete sodium and fluid and secrete potassium [14].

4. Conclusions

The additions of leaf extract of *Moringa oleifera* dose of 0.30 gram/kg BW for 13 days in hypertensive patients with hypercholesterolemia affects improvement: decrease in systolic blood pressure decreased diastolic blood pressure and elevated HDL cholesterol levels. *Moringa oleif*era leaf extract can be an alternative to handling nursing problems in hypertensive patients with hypercholesterolemia.

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