https://doi.org/10.48047/AFJBS.6.13.2024.5362-5370

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

EFFECT OF MORINGA LEAF EXTRACT AND FLOUR ON REDUCING BLOOD SUGAR LEVELS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS AT POASIA COMMUNITY HEALTH CENTRE, KENDARI CITY.

Fadhilah Az-zahra Hasan[1], Wahiduddin[1] , Ridwan[1] , Masni[1] , Nurhaedar Jafar[2]

[1]Department of Epidemiology, Faculty of Public Health, Hasanuddin University - Indonesia

[2]Department of Health Environment, Faculty of Public Health, Hasanuddin University - Indonesia

[3]Department of Nutritionist, Faculty of Public Health, Hasanuddin University – Indonesia

Volume 6, Issue 13, August 2024
Received: 15 jun 2024
Accepted: 25 July 2024

Published: 15 August 2024

doi:10.48047/AFJBS.6.13.2024.5362-5370

ABSTRACT

Objective: The study aims to determine the effect of moringa leaf extract and flour on reducing blood sugar levels in patients with type 2 diabetes mellitus in the working area of the Poasia Health Centre, Kendari City.
Methods: The type of research used in this study is analytical research with *Quasi Experiment* with the design of *the non randomised control group pretest posttest design*.
Results: There was a difference in the difference in blood sugar levels between the moringa extract group, moringa flour and the control group with a p value (0.000). Post hoc analysis showed the most significant decrease in blood sugar levels was the moringa extract group.
Conclusion: Moringa extract has the most significant reduction in blood sugar levels in patients with type 2 diabetes mellitus.
Keywords: Type 2 Diabetes Mellitus, Moringa Extract, Moringa Flour, Blood Sugar Levels

INTRODUCTION

Non-communicable diseases are one of the biggest health challenges today and have become a global concern in both developing and developed countries, one of which is diabetes mellitus. One of the goals of the *SDGs* is to ensure universal quality health coverage, including prevention and treatment of communicable and non-communicable diseases. Diabetes prevalence is an important indicator for non-communicable diseases. This goal includes prevention, diagnosis, treatment, disease control, and reduction of disease risk factors. (1).

Data from the *International Diabetes Federation* (IDF) estimates that the prevalence of diabetes in people aged 20-79 years in 2019 reached 9.3% (463 million people) and increased in 2021 to 10.5% (536.6 million people), and is predicted to continue to increase to 12.2% (783.2 million) in 2045. IDF also projects the number of people with diabetes in the population aged 20-79 years in several countries in the world that have identified the countries with the highest number of sufferers, namely China,

India, Pakistan and the United States in the top 4 with 140.87 million sufferers, 74.19 million, 32.96 million and 32.22 million and Indonesia ranks fifth with 19.47 million cases with a prevalence of 10.6%. (2). It is predicted that the prevalence in Indonesia will continue to increase to 11.3% by 2030 and 11.7% by 2045 *and the* disease is one of the causes of death in Indonesia. (4).

Type-2 diabetes mellitus (T2DM) is a long-standing or chronic disease characterised by high or above normal blood sugar (glucose) levels due to insulin resistance or glucose build-up in the blood. Most cases of diabetes mellitus, about 85% - 95% of the total population affected by the disease, occur in type 2 diabetes mellitus. (3).

Data from the Kendari City Health Office shows that the prevalence of diabetes mellitus cases in 2018 was 0.8% and increased to 1.6% in 2022. Puskesmas Poasia is the health centre with the most cases of diabetes mellitus in Kendari City. Data from the Kendari City Health Office Poasia Puskesmas in 2021 found an *Incident Rate of* 105 per 100,000 population, an increase of 127 per 100,000 population in 2022.

People with diabetes mellitus require treatment throughout their lives to reduce symptoms, prevent disease progression and prevent complications from developing. (5). The rapidly increasing incidence of type 2 diabetes highlights the need for effective therapy. Diabetes management involves pharmacological (drugs and insulin) and non-pharmacological (diet and exercise) approaches, as well as alternative therapies using medicinal plants to lower blood sugar levels. (6).

The Moringa plant (Moringa oleifera), known as the "miracle tree", has amazing health benefits, including lowering blood sugar levels. (7). In addition to its medicinal properties, Moringa also contains proteins, vitamins, minerals, and has antifungal, antiviral, antidepressant, and anti-inflammatory properties that are important for human health. (8)(9).

Various processed products made from moringa leaves have been developed to improve nutritional quality and food durability. (10). Technological developments have led to the processing of moringa in capsule form for easy consumption. Differences in moringa processing, both traditional and modern, will result in different effects on the composition and interaction of these capsules in the body (11). (11).

METHODS

This study is a research Analytical Experiment, namely *Quasi Experiment* with the design of *the non randomised control group pretest posttest design* , to determine the effect of giving extracts and flour of Moringa leaves on lowering blood sugar levels. The intervention group in this study was patients with type 2 DM who were given moringa leaf extract and flour while the control group was patients with type 2 DM who were not given moringa leaf extract and flour and only took antidiabetic drugs.

The population in this study were all PROLANIS participants who suffered from type 2 diabetes mellitus at Poasia Health Centre in 2023-2024 as many as 96 people. The sample of this study is the study population selected to be the subject of research, namely PROLANIS participants who suffer from type 2 DM at Puskesmas Poasia with 18 samples per group each.

This study was analysed using statistical tests with two paired samples, *one*

way Anova and *Pos Hoc* tests using STATA software presented in tabular form.

The ethics of this research were reviewed and accepted in licence number: 03179/UN4.14.1/PT.01.04/2024.

RESULTS

Analysis of the mean change in GDP levels before and after the intervention was conducted to determine the effect of the intervention on the dependent variable and to answer the research question. Data analysis used *paired t test* on normally distributed data and Wilcoxon test on non-normally distributed data. For data analysis in the moringa extract group, the data was not normally distributed.

Table 1. Analysis of Changes in GDP Levels Before and After in the Three Groups

Blood Sugar Levels	Variables	Mean	±SD	P value
Moringa Extract (n=18)	**Pre-Test**	223,22	61,53	0,000
	Post-Test3	151,38	61,40	
Moringa flour (n=18)	**Pre-Test**	222,88	45,99	0,000
	Post-Test3	176,44	50,03	
Control (n=18)	**Pre-Test**	231,55	34,82	0,018
	Post-Test3	212,05	30,41	

In table 1. The results showed that in the moringa extract group, the average blood sugar level before the intervention was 223.22 and after the intervention was 151.38, with a p value of 0.000, which means H0 is rejected, indicating a significant difference between blood sugar levels before and after the intervention. In the moringa flour group, the results showed that the blood sugar level before the intervention was 222.88 and after the intervention was 176.44, with a p value of 0.000, which means H0 is rejected. In the control group, the results showed that the blood sugar level before the intervention was 231.55 and after the intervention was 212.05, with p=0.018.

Table 2. *One Way Anova* Test Results

Group	n	Difference between Pre-Test and Post-Test Score		P Value
		Mean	±SD	
Moringa Extract	18	-71,8	29,16	
Moringa Flour	18	-46,4	31,92	0,000
Control	18	-19,5	31,88	

In table 2. obtained a value of p = 0.000 so it can be concluded that there is a significant difference in the difference in GDP levels between the three groups so that further tests can be used to analyse which intervention has the most effect on reducing GDP levels. The further test used or Pos Hoc used is the Tukey Test because the results of normal data distribution analysis and significant anova results meet the requirements for this test.

Table 3. Post Hoc Test

Group	Std.Error	P value
Moringa Flour vs Moringa Extract	10,33	0,045
Control vs Moringa Extract	10,33	0,000
Control vs Moringa Flour	10,33	0,032

In table 3. The Tukey test output results showed that there was a significant difference between the three groups. The comparison between Moringa flour and Moringa extract showed a statistically significant difference with a p value of 0.045. Meanwhile, the comparison between the control group and Moringa extract showed a highly statistically significant difference with a p value of 0.000. The comparison between the control group and the moringa flour group also showed a statistically significant difference with a p value of 0.032. Of the three groups, it can be concluded that the group using moringa extract showed the most significant difference compared to the control group and moringa flour.

DISCUSSION

Based on table 1. Shows the test results of blood sugar levels in three different groups. The group receiving moringa extract, the group receiving moringa flour, and the control group. Each group consisted of 18 subjects. Measurements were taken before (pre-test) and after (post-test) the intervention. In the moringa extract group, the average pre-test value of blood sugar levels was 223.22 mg/dL with a standard deviation (SD) of 61.53 after the post-test, the average blood sugar level dropped to 151.38 mg/dL with an SD of 61.40 with a P-value of 0.000 which indicates that the decrease in blood sugar levels that occurred was highly statistically significant.

The moringa flour group pre-test average blood sugar level was 222.88 mg/dL with SD 45.99 after the post-test average blood sugar level decreased to 176.44 mg/dL with SD 50.03 with a P value of 0.000, indicating that the decrease in blood sugar levels that occurred was highly statistically significant.

In the control group, the average pre-test value of blood sugar levels was 231.55 mg/dL with SD 34.82 after the intervention, the average post-test value of blood sugar levels dropped to 212.05 mg/dL with SD 30.41 with a p value of 0.018, indicating that the decrease in blood sugar levels that occurred was statistically significant.

Based on the results, both moringa extract and moringa flour were effective in reducing blood sugar levels significantly compared to the control group. A greater reduction was seen in the group that received moringa extract compared to the group that received moringa flour, as indicated by a lower blood sugar level in the moringa extract group (151.38 mg/dL) compared to the moringa flour group (176.44 mg/dL).

Moringa oleifera leaves are rich in various nutrients and phytochemicals that have been shown to potentially lower blood sugar levels (12). These leaves are commonly consumed as vegetables and nutritional supplements, making them easily accessible for potential health benefits. Moringa oleifera leaves contain various bioactive compounds such as polyphenols, flavonoids,

and alkaloids, which have shown anti-diabetic properties (13).

Phytochemicals found in Moringa oleifera leaves may help improve insulin sensitivity, reduce insulin resistance, and regulate glucose metabolism, all of which are important factors in managing diabetes and hyperglycaemia. (13).

This study is in line with the results of research by S Yasaroh et al that the administration of moringa leaf extract at a dose of 200 mg/kg body weight is effective in reducing blood glucose levels significantly in diabetic rats. On days 14 and 21 post-treatment, the control group showed significant differences compared to the groups that received different doses of extracts. (14).

Moringa leaf extract consists of tannins, saponins, steroids, terpenoids, flavonoids, alkaloids, glucosinolates, proteins, as well as vitamins A, E, and C, amino acids, and polyphenols. (15). As stated by Bhattacharya, et al. the antidiabetic properties of flavonoids, phenols, and glucosides derive from their capacity to inhibit the formation of glycation end products induced by monosaccharides, thereby reducing protein glycation. Functioning as antioxidants, flavonoids fortify pancreatic β-cells against excessive ROS, consequently leading to a decrease in blood glucose levels (16).

The results of this study are also in line with the results of a study by Abdul Munim, et al that the administration of moringa leaf flour given for 25 days at a dose of 2x1 1000 (mg / day) with the results of GDP measurements in the intervention group before and after treatment showed a p value of 0.000, with a difference value of -20.2, it is said that there is a significant difference between fasting blood glucose before treatment and after treatment in the intervention group. (17).

Gopalakrishnan, et al explained that flavonoids, functioning as antioxidants, serve as scavengers of mitochondria-derived ROS, thereby protecting β-pancreatic cells. Based on their antioxidant attributes, flavonoids reduce ROS, thereby protecting β-pancreatic cells from harm. Carbohydrates undergo hydrolysis into monosaccharides by *α-glucosidase* in the small intestine before being absorbed. Through the inhibition of *α-glucosidase* enzyme in carbohydrate absorption, flavonoids induce a decrease in blood glucose levels. (18).

The presence of flavonoids in Moringa leaves, mainly in the form of quercetin, facilitates the reduction of blood glucose levels through antioxidant mechanisms. Quercetin not only inhibits glucosidase activity in vitro but also complements insulin function AMP-activated protein kinase (AMPK) activation by quercetin promotes decreased oxidative stress and increased glucose uptake among rats. Consequently, increased AMPK activity enhanced GLUT-4 transcription and translation, culminating in amplified glucose uptake facilitated by insulin and, in turn, decreased blood glucose levels in the organism (19).

Based on table 2. The results of the one-way anova test found that the extract group showed a difference in the mean value (mean) of the pre-test and post-test of -71.8 with a standard deviation (SD) of 29.16. The difference in negative values indicates a significant decrease in post-test results compared to pre-test. The Moringa leaf flour group showed a mean difference of -46.4

with a standard deviation of 31.92. Although it also showed a significant decrease, the magnitude of the decrease was smaller than the moringa extract group. The control group showed a mean difference of -19.5 with a standard deviation of 31.88. This decrease was much smaller than the other two treatment groups. The test results obtained a p value of 0.000 which means that there is a difference between the three intervention groups of moringa leaf extract, moringa leaf flour and the control group, so further tests can be used to analyse which intervention has the most effect on changes in GDP levels. The further test used or Pos Hoc used is the Tukey Test.

Based on table 3. Tukey test results, flour vs moringa extract comparison results showed that there was a statistically significant difference between the moringa flour and moringa extract groups with a p value of 0.045. The standard error of 10.33 shows the variation in the difference data between these two groups. The results of the comparison between the control group and moringa extract showed a highly statistically significant difference with a p value of 0.000. This indicates that the moringa extract had a significantly greater effect than the control group. The standard error remained the same at 10.33. The comparison between the control group and moringa flour also showed a statistically significant difference with a p value of 0.032. This indicates that moringa flour also has a significant effect compared to the control group, although not as great as moringa extract.

Both processed forms of moringa showed significant effects in reducing blood sugar levels, moringa extract was more effective than moringa flour. This may be due to the higher concentration of bioactive compounds or better bioavailability in the extract form. Flavonoid compounds which are bioactive compounds in moringa leaves have shown insulin-resistant antidiabetic activity. Quercetin (about 50% of total flavonoids) and kaempferol, the main bioactive flavonol compounds, have similar chemical structures, so they have similar biological activities and can work synergistically. According to in vitro and in vivo studies, these two compounds can lower blood glucose levels by increasing insulin production, improving its sensitivity, and reducing the activity of the enzyme *amylase glucosidase*. Studies also show that quercetin increases *sodium-glucose cotransporter* 2 (SGLT2) receptors, while kaempferol increases glucose transporter 4 (GLUT4) based on in silico studies. (20).

These results are also supported by phytochemical tests conducted on both products that antioxidant compounds with units of %DH in moringa leaf flour are 97.22 and moringa leaf extract is 96.98. Flavonoid compounds in moringa leaf flour with ppm units of 245 while in moringa leaf extract of 301. Polyphenol compounds in moringa leaf flour amounted to 0.093 while in moringa extract amounted to 0.10.

The results of the study are in line with a study conducted by Sonia Gómez-Martínez, et al, which showed that there were clear differences between groups in changes in fasting blood glucose (FBG) and glycated haemoglobin (HbA1c) levels. During the intervention, the group using MO (Moringa oleifera) had decreased FBG and HbA1c, while the group using PLC (placebo control)

had increased FBG and HbA1c in prediabetic subjects. (21).

Based on the results of research conducted by Setyani, et al, conducted in vitro tests that Moringa oleifera leaf extract can be used as a drug to reduce blood sugar levels. This activity occurs because the methanol extract inhibits amylase enzyme with effectiveness (IC50 8.217 ± 0.792 µg/mL) and hexane extract also inhibits the same enzyme (IC50 9.397 ± 0.298 µg/mL). Although this value was slightly weaker than the positive control drug acarbose (IC50 0.036 ± 0.001 µg/mL), the leaf extract was still effective. In addition, the extract also inhibited glucosidase enzyme (IC50 19.36 ± 2.43 µg/mL) and lipase enzyme from the pancreas (IC50 123.34 ± 3.89 µg/mL), which play a role in diabetes risk. (22).

Based on in vivo tests conducted on diabetic rats and mice, M. oleifera leaf extract significantly increased the ability of pancreatic cells to secrete insulin. This was corroborated by a study that found a dose-dependent increase in insulin sensitivity in diabetic rats. (20).

This study is also in line with a study conducted by Joan R Ilagan, et al found that the combination of Moringa and metformin significantly reduced fasting blood glucose in alloxan-induced diabetic rats. (23). Other studies have also shown that M. oleifera effectively reduces blood glucose levels in human and animal studies, with human trials primarily using the powdered leaf form and animal studies using water or ethanol-based extracts (15). (15).

CONCLUSIONS

There is a difference in blood sugar levels between the moringa extract group, moringa flour group and the control group in patients with type 2 diabetes mellitus in the Poasia Puskesmas working area of Kendari City p (0.000). Based on the post hoc test, the most significant decrease in blood sugar levels was the moringa extract group.

REFERENCES

1. Fadhlurrohman MI, Purnomo EP, Malawani AD. Analysis Of Sustainable Health Development In Indonesia (Sustainable Development Goal's). J Kesehat Lingkung Indones. 2020;19(2):133-43.
2. International Diabetes Federation. IDF Atlas 10th Edition. 2021.
3. Ministry of Health. Indonesia Health Profile 2020. Bali Province Health Profile. Jakarta: Ministry of Health of the Republic of Indonesia; 2020.
4. Amiruddin Ridwan, Nugroho, Purwo Setiyo Tianingrum NA, Sunarti S, Rachman A, Fahrurodzi DS. Predictorrisk of diabetes mellitus in Indonesia, based on national health survey. Malaysian J Med Heal Sci. 2020;16(1):126-30.
5. Mthiyane FT, Dludla P V, Ziqubu K. A Review on the Antidiabetic Properties of Moringa oleifera Extracts: Focusing on Oxidative Stressand In fl ammation as Main Therapeutic Targets. 2022;13(July):1-17.
6. Muna Lubis SA, Aminah TNF, Pangestuty S, Atika R, Sembiring SP, Aidha Z. Factors Associated with the Incidence of Diabetes Mellitus (DM) in Kubah Sentang Village, Pantai Labu District. J Ilm Univ Batanghari Jambi. 2023;23(2):2061.
7. Mthiyane FT, Dludla P V, Ziqubu K, Mthembu SXH, Muvhulawa N, Hlengwa N, et al. A Review on the Antidiabetic Properties of Moringa oleifera Extracts: Focusing on Oxidative Stress and Inflammation as

Main Therapeutic Targets. Front Pharmacol. 2022;13(July):1-17.

8. Doglikuu BID, Abubakari A, Yaseri M, Shakibazadeh E, Djazayery A, Mirzaei K. The potential role of plantains, moringa, plantain-moringa combined diets, and other plant-based dietary patterns in controlling glycaemia among T2DM persons, a hospital based cross sectional survey in Ghana. J Diabetes Metab Disord [Internet]. 2021;20(2):1529-36. Available from: https://doi.org/10.1007/s40200-021-00896-y
9. Kou X, Li B, Olayanju JB, Drake JM, Chen N. Nutraceutical or pharmacological potential of Moringa oleifera Lam. Nutrients. 2018;10(3).
10. Ndukang S, Seran L, Djalo A, Missa H, Baunsele AB. Socialisation and Manufacture of Food Processed Products Made from Moringa Leaves. J Pengabdi Masy Nusant. 2023;3(2):320-9.
11. Angelina C, Swasti YR, Pranata FS. Increasing the Nutritional Value of Food Products by Adding Moringa Leaf Powder (Moringa Oleifera): A Review. J Agrotechnology. 2021;15(1):79.
12. Arora S AS. Nutritional significance and therapeutic potential of Moringa oleifera: The wonder plant. J Food Biochem. 2021;45(10).
13. Watanabe S, Okoshi H, Yamabe S, Shimada M. Moringa oleifera lam. In diabetes mellitus: A systematic review and meta-analysis. Molecules. 2021;26(12):1-18.
14. Yasaroh S, Christijanti W, Lisdiana, Iswari, S R. Effects of Moringa Leaf Extract (Moringa oleifera) on Blood Glucose Levels of Alloxan Induced Diabetes Rats. Pros Semnas Biol 9th Year 2021 FMIPA. 2021;224-9.
15. Owens FS, Dada O, Cyrus JW, Adedoyin OO, Adunlin G. The effects of Moringa oleifera on blood glucose levels: A scoping review of the literature. Complement Ther Med. 2020;50(February).
16. Poojar B, Ommurugan B, Adiga S, Thomas H, Sori RK, Poojar B, et al. Methodology Used in the Study. Asian J Pharm Clin Res. 2017;7(10):1-5.
17. Munim A, Alwi MK, Syam A. Effect of Moringa Leaf Flour (Moringa Oleifera) on Blood Glucose Reduction in Prediabetes Patients in the Samata Health Centre Working Area, Gowa Regency. J Ilm Kesehat Diagnosis. 2019;13(6):605-11.
18. Shi GJ, Li Y, Cao QH, Wu HX, Tang XY, Gao XH, et al. In vitro and in vivo evidence that quercetin protects against diabetes and its complications: A systematic review of the literature. Biomed Pharmacother [Internet]. 2019;109(October 2018):1085–99. Available from: https://doi.org/10.1016/j.biopha.2018.10.130
19. Bule, M., Abdurahman, A., Nikfar, S., Abdollahi, M., & Amini M. Antidiabetic effect of quercetin: A systematic review and meta-analysis of animal studies. Food Chem Toxicol. 2019;
20. Setyani W. Flavonoidsfrom Moringa oleifera leaves revisited: A review article on in vitro, in vivo, and in silico studies of antidiabetic insulin-resistant activity. J Adv Pharm Technol Res. 2023;
21. Sonia G, Ligia ED, Jurado C, Iturmendi N, Nova E. Moringa oleiferaLeaf Supplementation as a Glycemic Control Strategy in Subjects with Prediabetes. Nutrients. 2022;14(1):1-15.
22. Setyani W, Murwanti R. Flavonoids from Moringa oleifera leaves revisited:review article on in vitro, in vivo, and in silico studies of

antidiabetic insulin resistance activity. J Technol Advanced Farm Research. 2023;

23. Ilagan JR, Hurtada WA, Barrion ASA, Estacio MAC, Dizon EI. Glucose lowering effect of horseradish tree (Moringa oleifera Lam. leaf decoction in alloxan-induced diabetic mice. Malays J Nutr. 2016;22(2):267-78.