

ORIGINAL ARTICLE

The effect of boiled cosmos caudatus leaves on blood sugar levels in elderly patients with diabetes mellitus

Ellen Pesak¹, Jon Welliam Tangka¹, Samuel Tambuwun¹, Maykel Alfian Kiling¹, Jane Annita Kolompoy¹, Esther Novilian Tamunu¹, Rommy David Watuseke¹, Syamsu Alam², Bongakaraeng Bongakaraeng², Fitrilia Betahai¹

¹Department of Nursing, Politeknik Kesehatan, Kementrian Kesehatan Manado, Manado, North Sulawesi, Indonesia

²Department of Environmental Health, Politeknik Kesehatan, Kementrian Kesehatan Manado, Manado, North Sulawesi, Indonesia

Corresponding Author: Ellen Pesak **Email:** ellenpesak90@gmail.com

Received: 9 December 2024 **Revised:** 4 April 2025 **Accepted:** 12 April 2025 **Available online:** January 2026

DOI: 10.55131/jphd/2026/240109

ABSTRACT

In Indonesia, diabetes mellitus is one of the ten most common diseases among the elderly, with North Sulawesi Province having the highest prevalence. *Cosmos caudatus* leaves contain bioactive components, such as flavonoids and phenolic compounds, which have been shown to be effective in increasing insulin resistance and sensitivity in patients with DM. This study aimed to evaluate the effect of boiled *Cosmos caudatus* leaves on blood sugar levels in elderly patients with diabetes mellitus at the Bahu Health Center in Manado City. This study used a quantitative approach with a quasi-experiment, one-group pre-test post-test design. Ninety elderly respondents with diabetes mellitus at the Bahu Health Center in Manado City were included in this study. Blood sugar levels were measured before and after the intervention with boiled *C. caudatus* leaves. The intervention involved administering boiled water prepared from seven *Cosmos caudatus* leaves twice daily, in the morning and evening, at a dose of 250 ml each time. The findings showed that *Cosmos caudatus* exhibits a range of nutritional and phytochemical properties that support its use as a functional food. Its composition provides benefits for digestive health, energy provision, and antioxidant protection. There was a significant difference in the blood sugar levels of the respondents before and after the intervention. Statistical analysis showed a p-value of < 0.001. Therefore, it can be concluded that this intervention was significant. Boiled leaves of *Cosmos caudatus* have been proven to be effective in lowering blood sugar levels in elderly patients with diabetes mellitus.

Keywords:

diabetes mellitus, elderly, *Cosmos caudatus*, blood sugar levels, herbal therapy

Citation:

Ellen Pesak, Jon Welliam Tangka, Samuel Tambuwun, Maykel Alfian Kiling, Jane Annita Kolompoy, Esther Novilian Tamunu, Rommy David Watuseke, Syamsu Alam, Bongakaraeng Bongakaraeng, Fitrilia Betahai. The effect of boiled cosmos caudatus leaves on blood sugar levels in elderly patients with diabetes mellitus. J Public Hlth Dev. 2026;24(1):119-131(<https://doi.org/10.55131/jphd/2026/240109>)

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder characterized by hyperglycemia and alterations in carbohydrate, protein, and fat metabolism. This condition can lead to severe complications affecting various organs, including the eyes, kidneys, nerves, and cardiovascular system.¹ The prevalence of diabetes is particularly concerning among the elderly population, as aging is associated with increased insulin resistance and decreased pancreatic function, making effective management crucial.² Diabetes will continue to rise globally, particularly in developing countries.³ According to the International Diabetes Federation (IDF) Diabetes Atlas, 425 million individuals worldwide or 8.8% of the adult population aged 20 to 79 years had diabetes in 2017 and 463 million (9.3%) in 2019.⁴

Cosmos caudatus is traditionally used in various cultures for its nutritional and medicinal properties. Preliminary studies suggest that extracts from *Cosmos caudatus* possess bioactive compounds, including flavonoids and phenolic acids, which may contribute to lowering blood glucose levels.⁵ The antioxidant properties of these compounds are believed to enhance insulin sensitivity and reduce oxidative stress, a contributing factor in the pathogenesis of diabetes.⁶ Furthermore, the incorporation of such natural remedies into dietary practices may offer a complementary strategy for managing diabetes, particularly in elderly patients who may prefer holistic approaches to health care.⁷ A previous study also highlighted its antioxidant properties, suggesting that integrating *Cosmos caudatus* into diets could serve as a complementary strategy for diabetes management, aligning with the growing interest in plant-based dietary interventions for chronic diseases.⁸

Lifestyle modifications including dietary changes and physical activity are crucial for effective diabetes management. Regular exercise has been shown to improve insulin sensitivity and lower blood glucose levels.^{9,10} However, elderly patients may face challenges in maintaining an active lifestyle owing to physical limitations. Therefore, integrating gentle exercises with dietary interventions, such as the consumption of *Cosmos caudatus*, could provide a dual approach to managing diabetes effectively in this demographic.¹¹

Moreover, the role of self-management education in diabetes care cannot be overlooked. Empowering patients with knowledge about their condition and the benefits of incorporating natural remedies can enhance adherence to treatment regimens and promote better health outcomes.^{12,13} As such, the exploration of *Cosmos caudatus* as a dietary supplement in conjunction with education on lifestyle modifications presents a promising avenue for improving blood sugar control in elderly patients with diabetes mellitus. Existing literature largely focuses on general dietary interventions and lifestyle modifications for diabetes management, with limited studies specifically investigating the effects of *Cosmos caudatus* on blood glucose levels in elderly patients with diabetes mellitus. Most studies emphasize synthetic pharmaceutical interventions, reflecting a gap in the understanding of the potential of traditional medicine in this demographic.

This study aimed to investigate the effects of *Cosmos caudatus* leaves on blood sugar levels in elderly patients with diabetes mellitus at Bahu Health Center, Manado City. This study is expected to provide information on the potential of *Cosmos caudatus* leaves as an alternative natural treatment for lowering blood sugar levels in elderly patients with diabetes mellitus. The results of this study are

expected to contribute to the development of more effective and safe therapies for patients with diabetes mellitus.

RESEARCH METHODS

Design

This study used a quantitative research design with a quasi-experimental one-group pre-test post-test design approach. This design is a quantitative research method commonly used to evaluate the effects of a particular intervention on the same group before and after treatment. In the context of this study, the intervention was administering *Cosmos caudatus* boiled leaves to respondents, which was carried out for seven days with blood sugar levels measured at three time points: before the intervention, after three days, and after seven days.

Sampling

The research sample consisted of 90 respondents, selected based on predetermined inclusion and exclusion criteria using a purposive sampling technique. This sample selection was important to ensure that the respondents involved in the study were representative and in accordance with the research objectives. Inclusion criteria were participants who were elderly, typically defined as individuals aged 60 years and older, participants with a confirmed diagnosis of diabetes mellitus, specifically type 2 diabetes, participants must provide informed consent to participate in the study and participants should be in a stable health condition, without acute illnesses that could interfere with blood sugar levels. Meanwhile, exclusion criteria were individuals with severe comorbidities such as advanced cardiovascular disease, chronic kidney disease, or other significant health issues that could affect blood glucose levels, participants with significant

cognitive impairment or dementia, and individuals who had recently changed their diabetes medication or treatment regimen.

In this study, participants were mandated to have maintained a stable medication regimen for a minimum of two months prior to the study, facilitating the normalization of their blood glucose levels and minimizing confounding factors stemming from medication variability. Several systematic control measures are implemented to ensure the integrity and reliability of the findings. A comprehensive review of each participant's medication history was conducted to identify concomitant medications that could potentially affect glycemic control, thereby explaining the interactions and additive effects of multiple medications on blood glucose levels. Prior to the study, participants received education about the critical nature of medication adherence and the need to maintain their habitual lifestyle practices throughout the observation period, an effort aimed at reducing the variability in behavioral factors that affect glycemic control, such as diet and physical activity. In addition, any changes in medication type or dosage that occurred during the study were comprehensively documented, with participants encouraged to promptly report adverse events or health changes, allowing researchers to adjust for unanticipated effects on glucose metabolism.

Data Collection

In this study, data were collected through primary and secondary data collection techniques, where primary data were obtained from blood sugar level measurements, whereas secondary data may include additional information regarding respondent characteristics and their health backgrounds. Blood sugar level measurements were conducted using

a valid and reliable method, which was important to ensure that the data obtained were accurate and reliable.

Intervention

The intervention involved the administration of boiled water from seven *Cosmos caudatus* leaves boiled with 300 ml of water for 5-10 minutes, to produce 250 ml of boiled water extract. The administration was carried out twice a day, in the morning and evening, at a dose of 250 ml each time. This method was designed to evaluate the effects of consuming boiled water of *Cosmos caudatus* leaves on the respondents' blood sugar levels.

Preparation

Selecting the Leaves:

Fresh leaves of *Cosmos caudatus* were chosen to ensure that they were free from pests and contaminants. Leaves should be vibrant in color and sourced from a reputable supplier or a cultivated garden. By inspecting the leaves for any signs of disease or decay, only the healthiest leaves should be selected.

Preparation of decoction

Measure 300 ml of distilled water in a clean pot. Seven fresh *Cosmos caudatus* leaves were added to the pot. Bring water to a boil-over medium heat. After boiling, the heat was reduced, and the mixture was allowed to simmer for 5-10 minutes. This process extracts bioactive compounds from leaves into water. Remove the pot from the heat and let it cool for a few minutes. The decoction was strained using a clean strainer in a glass or ceramic container to obtain approximately 250 ml of boiled water. Discard the leaf remnants or preserve them for further study if their therapeutic potential is explored.

Administration of Decoction

Daily Dose: Participants are instructed to consume a total of 500 ml of the decoction per day, divided into two doses.

Morning Dose: 250 ml upon waking, preferably 30 minutes before breakfast.

Evening Dose: 250 ml approximately one hour prior to dinner.

Instructions for Participants

The participants consumed the decoction at specified times without any deviation. This schedule should be communicated and adhered to throughout the intervention period.

The participants were advised to maintain a consistent diet throughout the study period to mitigate variations in blood sugar levels due to dietary changes.

Encourage participants to remain hydrated by drinking plenty of water (but not directly before or after consuming the decoction to avoid dilution).

The participants were instructed to record their blood sugar levels according to the schedule provided.

Data Normality

The results of the normality test conducted using the Shapiro-Wilk test showed a P Value of 0.595 for blood sugar levels before administering *boiled Cosmos caudatus* leaves. After administering the decoction, on the third day, the P Value obtained was 0.205, whereas on the seventh day, the P Value was 0.366. Thus, because all P Values were greater than 0.05, it can be concluded that the data were normally distributed. Therefore, further analysis can be carried out using a parametric test, namely the Paired Sample T-Test.

RESULTS

Table 1 shows that a nitrogen (N) content of 4.49% indicates that *Cosmos caudatus* has potential as a source of vegetable protein. Nitrogen is an important element in the synthesis of amino acids, which are building blocks of proteins. Phosphorus (P) with a content of 0.45% plays an important role in the process of energy metabolism and DNA formation, and supports the growth of plant roots. Potassium (K) (3.11 %) functions in the regulation of osmosis and water balance in cells and is important for enzymatic functions. The high crude fiber content (14.58 %) indicated that *Cosmos caudatus* can contribute to digestive health. Fibers help facilitate the digestive process and reduce the risk of cardiovascular diseases. A sugar content of 5.59% indicated that this plant can also be a good source of energy. The natural sugars found in

Cosmos caudatus can provide fast energy without drastically increasing blood sugar levels. The chlorophyll content of 1.93 mg g-1fw indicates that this plant has potential as a source of natural antioxidants. Chlorophyll also plays a role in the process of photosynthesis, which is important for plant growth. The content of anthocyanins (0.19 mg g-1fw) and carotenoids (0.37 mg g-1fw) indicates the presence of pigments that have antioxidant activity. These compounds protect cells from oxidative damage. Total phenols (38.92 mg GAE g-1dw) and total flavonoids (37.05 mg GAE g-1dw) indicate that *Cosmos caudatus* is rich in phenolic compounds with antioxidant, anti-inflammatory, and anticancer properties. The antioxidant activity, measured by an IC₅₀ value of 57.28 ppm indicates that *Cosmos caudatus* has good potential in fighting free radicals. A lower IC₅₀ value indicated that the compound was more effective at inhibiting free radical activity.

Table 1. Content of *Cosmos caudatus*

Variables	n
N	4.49 %
P	0.45 %
K	3.11 %
Crude fiber	14.58 %
Sugar	5.59 %
chlorophyll	1.93 mg g-1fw
Anthocyanins	0.19 mg g-1fw
Carotenoid	0.37 mg g-1fw
Total phenol	38.92 mg GAE g-1dw
Total flavonoid	37.05 mg GAE g-1dw
Antioxidant activity	57.28 (IC ₅₀) (ppm)

Nitrogen (N), phosphorus (P), and potassium (K).

Table 2 shows that most respondents were aged between 65-69 years, with 42 respondents (46.6%). On the other hand, respondents aged over 70 years comprised the smallest group, with a total of 21 respondents (23.4%). In terms of gender, the majority of respondents are women, with a total of 54 respondents

(60%). In terms of smoking habits, 69 respondents (76.6 %) did not smoke. In addition, most respondents have never exercised or performed healthy walking activities. Finally, all respondents had blood sugar levels above normal, which was ≥ 140 mg/dL, with a total of 90 people (100%).

Table 2. Distribution of Respondents

Variables	n	%
Age		
60-64	27	30.0
65-69	42	46.6
>70	21	23.4
Gender		
Man	36	40
Woman	54	60
Smoking Habit		
Yes	21	23.4
No	69	76.6
Exercise Habits		
Never	42	46.6
Sometimes	27	30.0
Often	12	13.4
Always	9	10.0

Table 3 shows that after administering boiled leaves of *Cosmos caudatus* on the third day, all respondents, namely 90 people (100%), were still in the category of blood sugar levels above normal, namely ≥ 140 mg/dL. However,

after administering boiled leaves of *Cosmos caudatus* on the seventh day, there was a significant change, where 84 people (92%) showed normal blood sugar levels, while 6 people (6.6%) were still in the abnormal category.

Table 3. Blood sugar levels before and after administration of *Cosmos caudatus* boiled leaves Water

Variables	n	%
Pre		
Normal 80-139 mg/dL		
Above normal ≥ 140 mg/dL	90	100
Total	90	100
Post		
Normal 80-139 mg/dL	84	93.4
Above normal ≥ 140 mg/dL	6	6.6
Total	90	100

In this study, the Paired Sample T-Test statistical test shown in Table 4 shows that consuming boiled *Cosmos caudatus* leaves twice a day, namely in the morning and evening after meals for seven days, was effective in lowering blood sugar levels in 90 respondents. The results of the statistical analysis showed that there was a significant difference between blood sugar

levels before and after the intervention, with a p value = 0.000, which means $p < 0.05$. This indicates that *C. caudatus* boiled leaves have a significant effect on lowering blood sugar levels. It can be concluded that administering *boiled C. caudatus* leaves reduces blood sugar levels in elderly patients with diabetes mellitus.

Table 4. Paired Sample T-Test

Variables	Mean	Std. Deviation	T	Sig. (2-tailed)
Pre-Post test Day 3	10,766	10,611	5,557	<0.001
Pre-Post test Day 7	73,400	20,665	19,454	<0.001

DISCUSSION

The administration of boiled leaves of *C. caudatus* showed significant effects in the management of blood sugar levels. Based on the data presented, on the third day after the administration of the decoction, all respondents (100%) were still in the category of above-normal blood sugar levels (≥ 140 mg/dL). However, after seven days, there was a significant shift, where 84 out of 90 respondents (93.4%) showed normal blood sugar levels (80-139 mg/dL), while only six people (6.6%) were still in the abnormal category. These findings indicate the potential of *Cosmos caudatus* leaves in lowering blood sugar levels, which is in line with previous studies showing that flavonoids and polyphenols in plants can contribute to controlling blood sugar levels through antioxidant mechanisms and protection of pancreatic beta cells.¹⁴

Long-term consumption could potentially sustain these positive effects without inducing severe hypoglycemia, indicating a safe profile for chronic use. The benefits of *Cosmos caudatus* may lead to further stabilization of blood sugar levels, aligning with findings from other medicinal plant decoctions that have shown potential benefits in diabetes management. Therefore, long-term consumption of *Cosmos caudatus* represents a promising avenue for managing blood sugar levels, integrating traditional practices with contemporary therapeutic needs.^{15,16}

Flavonoids substantially influence insulin sensitivity via various biochemical pathways. For instance, compounds such

as myricetin enhance insulin responsiveness by restoring insulin receptor (IR) and insulin receptor substrate 1 (IRS1) expression within the PI3K/AKT signaling cascade, which is vital for glucose metabolism.¹⁷ Additionally, flavonoids such as naringin and hesperidin decrease fasting blood glucose levels by modulating key hepatic enzymes involved in gluconeogenesis, specifically by up-regulating glucokinase and down-regulating glucose-6-phosphatase and phosphoenolpyruvate carboxylase.¹⁷ Moreover, flavonoids exhibit anti-inflammatory properties that further improve insulin sensitivity by suppressing pro-inflammatory cytokines like TNF- α and IL-6, which are linked to insulin resistance.¹⁸

Flavonoids, such as quercetin, found in *Cosmos caudatus*, have been shown to have positive effects on lowering blood sugar levels. Studies have shown that these compounds may help improve the function of pancreatic beta cells, which play a key role in insulin production.¹⁴ In addition, the presence of antioxidants in *Cosmos caudatus* can reduce oxidative stress which often contributes to the development of diabetes mellitus.¹⁴ Therefore, consuming boiled *Cosmos caudatus* leaves can be an alternative for managing diabetes, especially in individuals who have difficulty controlling their blood sugar levels.

Flavonoids, particularly quercetin, have attracted attention for their potential role in diabetes management, particularly due to their effects on blood glucose levels and pancreatic function. Quercetin, a prominent flavonoid found in a variety of

plants, including *Cosmos caudatus*, has been shown to improve the function of pancreatic beta cells, which are crucial for insulin production. This effect is supported by studies showing that flavonoids can stimulate insulin secretion and improve the overall function of these cells, thereby contributing to better glycemic control.^{19,20}

Quercetin activates the AMP-activated protein kinase (AMPK) pathway, which enhances glucose uptake in skeletal muscle by increasing the expression of glucose transporter proteins such as GLUT4 and by modulating insulin receptor signaling pathways.^{21,22} Additionally, quercetin has been reported to alleviate oxidative stress and inflammation under hyperglycemic conditions by regulating various signaling pathways, including the activation of SIRT1, which affects mitochondrial function and insulin sensitivity.²³ Moreover, quercetin promotes the secretion of insulin from pancreatic beta cells while inhibiting glucose absorption in the intestines, thus contributing to glycemic control.²⁴ By modulating the expression of pro-inflammatory markers, quercetin diminishes the adverse effects of chronic inflammation associated with insulin resistance, fostering a more favorable metabolic environment.²⁵

Additionally, the antioxidant properties of quercetin and other flavonoids play a key role in reducing oxidative stress, a condition that is often exacerbated in patients with diabetes. Oxidative stress is known to damage pancreatic cells and disrupt insulin signaling pathways, leading to increased blood glucose levels.²⁶ By scavenging free radicals and enhancing antioxidant defenses, flavonoids may help protect against cell damage associated with diabetes, thereby improving metabolic health.²⁷

It is important to note that successful blood sugar management depends not only on the consumption of

herbal plants but also on patient compliance with treatment and healthy lifestyle changes. Studies have shown that compliance with treatment has a significant impact on blood sugar control.²⁸ Therefore, although the results obtained from administering the *Cosmos caudatus* boiled leaves are very promising, a holistic approach that includes education on diet, physical activity, and adherence to treatment is still needed to achieve optimal blood sugar control.

In this study, the Paired Sample T-Test showed that administering *boiled leaves of Cosmos caudatus* twice a day significantly reduced blood sugar levels in 90 elderly patients with diabetes mellitus. The results of the analysis showed a p value of 0.000, which means $p < 0.05$, indicating a significant difference between blood sugar levels before and after the intervention. *Boiled leaves of Cosmos caudatus* had a significant effect on lowering blood sugar levels.

The positive effects of herbal-based interventions on blood sugar control in patients with diabetes mellitus have been documented in various studies. For example, Alqathama et al. highlight that a significant portion of type II diabetes patients believe in the efficacy of herbal medicine for managing blood glucose levels, suggests a strong perception of its benefits among users.²⁹ In addition to the direct effects of herbal interventions on blood glucose levels, the psychological and social dimensions of diabetes management are also critical. Mindfulness-based interventions, for example, have been shown to reduce perceived stress and improve glucose tolerance among diabetic patients.³⁰

In addition, the systematic review conducted by Vivó-Barrachina et al. provides a comprehensive overview of randomized controlled trials that confirm the effectiveness of certain natural products in diabetes management, reinforcing the idea that herbal-based

treatments can be beneficial for blood sugar regulation.³¹ Similarly, the study by Chen et al. discusses the misconceptions surrounding diabetes knowledge among patients, which can affect their treatment choices, including the use of herbal remedies.³² This highlights the importance of educating patients about the potential benefits and risks of herbal treatments.

A comprehensive approach to diabetes management that incorporates dietary modifications and herbal remedies has been shown to improve clinical outcomes in patients. Research indicates that engaging in physical activities plays a crucial role in regulating blood glucose levels in individuals with type II diabetes mellitus.^{33,34} This suggests that a multifaceted intervention strategy that includes both physical exercise and dietary changes can produce superior results in diabetes management.

Furthermore, the therapeutic potential of herbal treatments, specifically the use of *Cosmos caudatus* leaves, is supported by biochemical evidence indicating that the active compounds within these leaves can effectively lower blood glucose levels. These compounds are known to enhance insulin sensitivity and diminish insulin resistance, contributing to better glycemic control.³⁵ The integration of herbal products into diabetes care is increasingly recognized, with many patients reporting positive effects from their use, which aligns with the growing trend of using complementary and alternative medicine in managing chronic conditions such as diabetes.³⁶ *Cosmos caudatus* is rich in phytochemicals such as flavonoids and ascorbic acid, which contribute to its antioxidant activity. These compounds are known to mitigate oxidative stress, a key factor in the pathogenesis of diabetes mellitus.³⁷

The relationship between a family history of diabetes, sedentary behavior,

and the incidence of diabetes mellitus has been well documented in recent research. Sudrajat et al. highlighted that a family history of diabetes and prolonged sedentary behavior significantly correlated with the onset of diabetes mellitus, with sedentary behavior specifically noted to be associated with increased risk when individuals engage in it for six or more hours daily.³⁸ This finding is consistent with other studies that have established sedentary behavior as a critical risk factor for diabetes, indicating that reducing sedentary time can improve insulin sensitivity and potentially mitigate the risk of developing diabetes.^{39,40}

CONCLUSION

The use of *Cosmos caudatus* offers significant pragmatic applications for healthcare providers and patients with diabetes. The findings of this study indicate that the consumption of boiled *C. caudatus* leaves may serve as a beneficial adjunctive therapy for managing blood glucose levels, particularly in elderly patients with diabetes mellitus. Healthcare providers can recommend *Cosmos caudatus* as a dietary intervention, highlighting its potential for improving glycemic control without the need for pharmacological agents. Moreover, the rich composition of bioactive compounds in *Cosmos caudatus* suggests a holistic approach to health promotion, potentially enhancing the overall dietary quality of individuals with diabetes. This dietary inclusion can also empower patients with diabetes with accessible, cost-effective means to manage their condition, fostering a proactive approach to personal health management. Future research investigating the mechanisms underlying these effects, along with larger-scale studies, is imperative to further substantiate these

findings and facilitate the integration of *the Cosmos caudatus* into clinical practice.

AUTHOR CONTRIBUTION

EP contributed to the conceptualization and overall project supervision. JWT played a pivotal role in the methodology design and project administration. ST was responsible for data curation, which encompassed the acquisition of data access and management of ethical approvals. MAK led the preparation of the original draft, undertaking the writing and critical revisions to enhance the manuscript's clarity and coherence. JAK, ENT, RDW, SA, BB, and FB participated in the review and approval processes of the final manuscript, ensuring that each contribution was aligned with the overall objectives of the study.

ETHICAL CONSIDERATION

This research has passed the ethical test from the Manado Ministry of Health Polytechnic on June 10, 2024 with the number IRB-2024-0229.

CONFLICT OF INTEREST

No Conflict of Interest

REFERENCES

1. Dilworth L, Facey A, Omoruyi F. Diabetes Mellitus And Its Metabolic Complications: The Role Of Adipose Tissues. *Int J Mol Sci.* 2021;22(14):1–18.
2. Mohaghegh P, Rafiei F, Sadeghi Sedeh B, Ansari M. Factors Affecting Blood Sugar Levels In Type 2 Diabetic Patients Referred To Imam Reza Clinic Of Arak, Iran. *J Of Shahrekord Univ Of Medic Sci.* 2022;24(3):122–6.
3. Edussuriya Asj, Subhashini Sys, Amarasinghe Kds, Kumari Gsd, Perera Kmon, Munidasa Kgpk. Experiences Of Patients On Natural Herbal Treatments For Diabetes Mellitus At The Diabetes Clinic In Base Hospital - Matara, Sri Lanka. *J Patient Exp.* 2021;8(1):1–5.
4. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, Et Al. Global And Regional Diabetes Prevalence Estimates For 2019 And Projections For 2030 And 2045: Results From The International Diabetes Federation Diabetes Atlas, 9th Edition. *Diab Res Clin Pract.* 2019;157(11):1–10.
5. Nasihah M. The Potential Of Ngokilo Leaves Extract (Stachytarpheta Mutabilis. Vahl) As A Lowering Of Blood Glucose Levels Of White Mice (Rattus Norvegicus). *Biolink.* 2021; 7(2):204–14.
6. Cai Xt, Zhu Q, Liu Ss, Wang Mr, Wu T, Hong J, Et Al. Associations Between The Metabolic Score For Insulin Resistance Index And The Risk Of Type 2 Diabetes Mellitus Among Non-Obese Adults: Insights From A Population-Based Cohort Study. *Int J Gen Med.* 2021;14(11):7729–40.
7. Anjastya Ha, Yuniartika W. Spiritual Spiritual Therapy (Dhikr) Can Decrease Blood Sugar Levels In Diabetes Mellitus Patients In The Intensive Care Unit (Icu): A Study Literature. *Klasics.* 2022;2(01):16–26.
8. Dea Firdaus M, Artanti N, Hanafi M, Rosmalena R. Phytochemical Constituents And In Vitro Antidiabetic And Antioxidant Properties Of Various Extracts Of Kenikir (Cosmos Caudatus) Leaves. *Pharmacognosy J.* 2021;13(4):890–5.
9. R.A. Tanzila, Ni Made Elva Mayasari, Dita Azzahra Maso. The Effect Of Medium Intensity Physical Activity On Blood Glucose Levels In Diabetes Mellitus. *Inter J Of Islamic And Comple Medic.* 2020;1(1):37–40.

10. Nelyanti Da, Ta'adi T, Anwar Mc. The Effectiveness Of Acupressure And Smart Gymnastic On Fasting Blood Sugar Levels Among Patients With Type II Diabetes Mellitus. *Inter J Of Nurs And Health Serv.* 2020;3(6):687–94.
11. Mu'minah N, Suherman Ws, Krismantoro T, Nasution Sf. The Influence Of Tai Chi Gymnastics And Diabetic Gymnastics On Decreasing Blood Sugar Levels In The Elderly Type 2 Diabetes Mellitus. *Inter J Of Phys Educ, Sports And Health.* 2024;11(1):25–8.
12. Bakara Dm, Kurniyati. Self-Management Education To Control Blood Sugar Levels And HbA1c Value For Type 2 Diabetes Patients. *Malaysian J Of Nurs.* 2022;14(01):84–9.
13. Mohamed A, Staite E, Ismail K, Winkley K. A Systematic Review Of Diabetes Self-Management Education Interventions For People With Type 2 Diabetes Mellitus In The Asian Western Pacific (Awp) Region. *Nurs Open.* 2019;6(4):1424–37.
14. Hidayah K, Suwondo A, Kusmiyati Y. The Effectiveness Of Kenikir Extract (*Cosmos Caudatus*) To Increase The Hormone Prolactin In Puerperal Mothers. *Eduvest - J Of Univ Stud.* 2023;3(10):1865–70.
15. Barzkar F, Baradaran Hr, Khamseh Me, Vesal Azad R, Koohpayehzadeh J, Moradi Y. Medicinal Plants In The Adjunctive Treatment Of Patients With Type-1 Diabetes: A Systematic Review Of Randomized Clinical Trials. *J Diabetes Metab Disord.* 2020;19(2):1917–29.
16. Batubara K, Sinaga E, Sianturi Mibr, Siregar Hk. The Effect Of Manggist Skin Juice On The Stability Of Blood Sugar Levels In Diabetes Mellitus (Dm) Patients. *Malahayati Nurs J.* 2023;5(11):3848–55.
17. Tao F, Wang P, Dai Z, Zhang C, Li D, Fan H, Et Al. Neohesperidin Dihydrochalcone Improves Hyperglycemia And Insulin Resistance In Diabetic Zebrafish. *Acs Food Scie & Tech.* 2023;3(9):1548–58.
18. Naz A, Khan M, Kibria S. Unlocking The Insightful Antidiabetic Effects Of Lemongrass (*Cymbopogon Citratus*): A Comprehensive Review. *Phytonutrients.* 2024;3(8):90–104.
19. Babu Pva, Liu D, Gilbert Er. Recent Advances In Understanding The Anti-Diabetic Actions Of Dietary Flavonoids. *J Nutr Biochem.* 2013; 24(11):1777–89.
20. Al-Ishaq Rk, Abotaleb M, Kubatka P, Kajo K, Büsselberg D. Flavonoids And Their Anti-Diabetic Effects: Cellular Mechanisms And Effects To Improve Blood Sugar Levels. *Biomolecules.* 2019;9(9):430–9.
21. Tan Y, Tam Cc, Rolston M, Alves P, Chen L, Meng S, Et Al. Quercetin Ameliorates Insulin Resistance And Restores Gut Microbiome In Mice On High-Fat Diets. *Antioxidants.* 2021; 10(8):1–17.
22. Zhang R, Qiu X, He C, Deng R, Huo C, Fang B. From Life's Essential 8 To Metabolic Syndrome: Insights From Nhanes Database And Network Pharmacology Analysis Of Quercetin. *Front Nutr.* 2024;11(10):1–16.
23. Cui Z, Zhao X, Amevor Fk, Du X, Wang Y, Li D, Et Al. Therapeutic Application Of Quercetin In Aging-Related Diseases: Sirt1 As A Potential Mechanism. *Front Immunol.* 2022; 13(7):1–26.
24. Sun J, Pan Y, Li X, Wang L, Liu M, Tu P, Et Al. Quercetin Attenuates Osteoporosis In Orchiectomy Mice By Regulating Glucose And Lipid Metabolism Via The Gprc6a/Ampk/

- Mtor Signaling Pathway. *Front Endocrinol (Lausanne)*. 2022;13(4):1–13.
25. Tura A, Herfs V, Maaßen T, Zuo H, Vardanyan S, Prasuhn M, Et Al. Quercetin Impairs The Growth Of Uveal Melanoma Cells By Interfering With Glucose Uptake And Metabolism. *Int J Mol Sci*. 2024; 25(8):1–19.
 26. Menati L, Meisami A, Zarebavani M. The Potential Effects Of Dietary Flavones On Diabetic Nephropathy; A Review Of Mechanisms. *J Renal Inj Prev*. 2020;9(2):E09–E09.
 27. Zhou M, Konigsberg Wh, Hao C, Pan Y, Sun J, Wang X. Bioactivity And Mechanisms Of Flavonoids In Decreasing Insulin Resistance. *J Enzyme Inhib Med Chem*. 2023; 38(1):1–11.
 28. Sari Yo, Permatasari D, Mariza W, Fitria N, Lailiani R. Application Of Home Medication Review (Hmr) On Patient Adherence In Type 2 Diabetes Mellitus (T2dm) Blood Sugar Management. *J Sains Farm & Klinis*. 2023;9(Sup):160–7.
 29. Alqathama A, Alluhiabi G, Baghdadi H, Aljahani L, Khan O, Jabal S, Et Al. Herbal Medicine From The Perspective Of Type Ii Diabetic Patients And Physicians: What Is The Relationship? *Bmc Complement Med Ther*. 2020;20(1):1–9.
 30. Zeinabeh Mz, Atefeh A, Masumeh Ghp, Tania D, Mojgan S, Katayoun A. The Effect Of Mindfulness-Based Stress Reduction Counseling On Blood Glucose And Perceived Stress In Women With Gestational Diabetes. *Rev Brasileira De Ginec E Obste / Rbgo Gynec And Obst*. 2023;45(09): 517–23.
 31. Vivó-Barrachina L, Rojas-Chacón Mj, Navarro-Salazar R, Belda-Sanchis V, Pérez-Murillo J, Peiró-Puig A, Et Al. The Role Of Natural Products On Diabetes Mellitus Treatment: A Systematic Review Of Randomized Controlled Trials. *Pharmaceutics*. 2022;14(1):1–12.
 32. Chen Cc, Chen Cl, Ko Y. The Misconceptions And Determinants Of Diabetes Knowledge In Patients With Diabetes In Taiwan. *J Diabetes Res*. 2020;2020(6):1–5.
 33. Desi, Kalesaran Afc, Kaunang Wpj. Knowledge, Physical Activity, And Control Of Type 2 Diabetes Mellitus At Lansot Primary Health Center Tomohon, Indonesia. *Int J Community Med Public Health*. 2023;10(11): 4075–81.
 34. Purković M, Vukašinović D, Radak U. The Importance Of Physical Activity In Diabetes. *Biomedicinska Istraživanja*. 2021;12(2):125–38.
 35. Çinar D, Yava A, Olgun N, Koyuncu A, Eti Aslan F. Use Of Herbal Products And Food Supplements Of Type 2 Diabetes Patients. *Health & Res J*. 2022;8(3):202–13.
 36. El Bayoumy I. Herbal Use And Perceptions Among Patients With Type 2 Diabetes Mellitus In Kuwait. *Clin Res Notes*. 2022;3(1):01–7.
 37. Saleh I, Aziz Sa, Melati M, Andarwulan N. Morpho-Physiology And Metabolite Content Of *Cosmos Caudatus* Kunth. And *Yellow And Orange Cosmos Sulphureus* Cav. *Biodiversitas*. 2023;24(10):5739–46.
 38. Sudrajat A, Romadhona M, Manurung S, Suratun S, Yarden N, Lusiani D, Et Al. Relationship Between Family History, Diet And Sedentary Behavior With The Incidence Of Diabetes Mellitus. *Asian J Of Dental And Health Sci*. 2023;3(2):26–31.
 39. Ra Js. Sex Differences In Factors Associated With Prediabetes In Korean Adults. *Osong Public Health Res Perspect*. 2022;13(2):142–52.
 40. Koyama T, Kuriyama N, Ozaki E, Tomida S, Uehara R, Nishida Y, Et Al. Sedentary Time Is Associated With Cardiometabolic Diseases In A Large

Japanese Population: A Cross-
Sectional Study. J Atheroscler
Thromb. 2020;27(10):1097–107.