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Systematic Literature Review: A Systematic Review on the Effectiveness of Herbal Medicines in Blood Sugar Regulation for Type 2 Diabetes

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ABSTRACT

Type 2 diabetes mellitus (DMT2) is a chronic disease caused by insulin resistance and disorders in blood glucose regulation. Herbal therapy is increasingly in demand because of its potential to lower blood glucose levels through various mechanisms. This study reviewed the effectiveness of herbal plants in controlling blood glucose levels based on experimental and quasi-experimental studies. The method used was a systematic review of scientific articles in the last five years obtained from ScienceDirect, PubMed, and Google Scholar databases. Of the 9,379 articles selected, only 10 met the inclusion criteria. The results of the analysis showed that several plants, such as purple sweet potato, black garlic, bay leaves, mangosteen peel, cinnamon, binahong leaves, brown rice, red betel leaves, and star fruit leaves, had a significant effect in lowering blood glucose levels. The main mechanisms that play a role include increased insulin sensitivity, inhibition of the enzyme alpha-glucosidase, antioxidant effects, and reduced glucose absorption in the intestine. The findings highlight the potential of these herbs as a complementary approach in managing blood glucose levels in DMT2 patients. Further research with more rigorous clinical trials is needed to determine the optimal dosage, side effects, and interactions with pharmacological drugs. These studies could provide deeper insights into the clinical applicability and safety of herbal treatments for diabetes. These findings support the potential use of herbs as a natural strategy in diabetes control.

INTRODUCTION

Every year, about 41 million people die from Non-Communicable Diseases (NCDs), which is equivalent to 71% of total deaths worldwide. Of these, more than 15 million people between the ages of 30 and 69 died from NCDs, with 85% of them coming from lower-middle-income countries. The four types of diseases that are the leading cause of death due to NCDs include cardiovascular disease (17.9 million deaths), cancer (9.3 million deaths), respiratory diseases (9.3 million deaths), and diabetes (1.5 million deaths) each year (WHO, 2024). Diabetes, specifically Type 2 Diabetes Mellitus (DMT2), is increasingly recognized as a major global health crisis, with prevalence steadily rising worldwide (Mukhlis, Suradi, et al., 2023; Mukhlis, 2025b). Type 2 diabetes mellitus (DMT2) is a metabolic disorder whose prevalence continues to increase globally, contributing to high morbidity and mortality rates due to its chronic complications (WHO, 2016).

Globally, diabetes now affects over 460 million people, with a significant burden in developing countries where healthcare resources are limited. Type 2 diabetes mellitus is now a global crisis that threatens the world's health and economy. Globally, about 1 in 11 adults have type 2 diabetes, with about 75% of sufferers living in developing countries. The International Diabetes Federation (IDF) estimates that in 2019, as many as 463 million people in the world aged 20-79 years had diabetes, equivalent to 9.3% of the total population in that age range (IDF Diabetes Atlas, 2021). In the Southeast Asian region, including Indonesia, the prevalence of diabetes mellitus reached 11.3%, making it the third highest in the region. Globally, Indonesia ranks 7th out of 10 countries with the highest number of diabetics, with a total of 10.7 million people. In addition, the prevalence of diabetes mellitus in Indonesia has increased from 6.9% to 10.9% in the population aged 15 years and above (Kemenkes RI, 2020). A sedentary lifestyle, such as a lack of physical activity or exercise, can lead to fat accumulation

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and decrease the effectiveness of insulin in controlling blood sugar levels. Obesity, especially excess fat in the abdominal area, is one of the main risk factors because it can lead to insulin resistance and worsen the metabolic balance in the body. With such a high prevalence and the rising complications associated with diabetes, there is a growing interest in exploring alternative, complementary therapies like herbal medicine to support the management of blood sugar levels in diabetic patients. The combination of these factors can increase a person's risk of developing diabetes, so it is important to adopt a healthy lifestyle to prevent or manage the condition (Murtiningsih et al., 2021).

Diabetes is thought to occur due to a combination of various risk factors that can affect the body's metabolism and the balance of blood sugar levels. One contributing factor is high levels of uric acid in the blood, which can interfere with insulin function and increase the risk of insulin resistance. In addition, poor sleep quality and duration also negatively affect the regulation of hormones that regulate blood sugar, thereby increasing a person's chances of developing diabetes (Sumah, 2019) . Smoking habits are another factor that plays a role because the content of toxic substances in cigarettes can damage the body's cells, including those that play a role in insulin production (Mukhlis, 2025a; Mukhlis & Saidah, 2025). Depression is also associated with an increased risk of diabetes, as stress and mental disorders can trigger hormonal changes and unhealthy eating habits (Ismail et al., 2021).

Cardiovascular diseases, such as heart and blood vessel disorders, are often closely related to diabetes, as both are affected by similar lifestyle and metabolic factors (Patimang, 2022). Dyslipidemia, which is characterized by abnormal blood fat levels, can also worsen the body's metabolic condition and accelerate the development of diabetes (ZA et al., 2022). In addition, high blood pressure or hypertension can increase pressure on blood vessels and disrupt optimal blood circulation, thereby worsening insulin sensitivity. As we age, the risk of diabetes also increases because the body's function in regulating blood sugar levels tends to decrease with the aging process (Yuliadarwati et al., 2021). Ethnic factors also play a role in a person's tendency to develop diabetes, as certain ethnic groups are genetically more susceptible to the disease. A family history of diabetes is one of the strong indicators, as genetic factors can affect how the body processes glucose (Rediningsih & Lestari, 2022).

A sedentary lifestyle, such as lack of physical activity or exercise, can lead to fat accumulation and reduce the effectiveness of insulin in controlling blood sugar levels. Obesity, especially excess fat in the abdominal area, is one of the main risk factors because it can cause insulin resistance and worsen the metabolic balance in the body. The combination of these factors can increase a person's risk of developing diabetes, making it important to adopt a healthy lifestyle to prevent or manage the condition (Murtiningsih et al., 2021).

In the management of type 2 diabetes mellitus, pharmacological therapies such as oral antidiabetic drugs and insulin are often used to control blood sugar levels. However, long-term use of these conventional therapies can cause a variety of side effects, such as hypoglycemia, impaired liver and kidney function, and drug resistance. Therefore, alternative treatment based on medicinal plants or herbs is starting to gain attention as a more natural and potential method for controlling blood sugar levels in diabetics (Sukmawati et al., 2021).

Medicinal plants or herbs have various working mechanisms in helping manage diabetes. One of the main mechanisms is to stimulate increased insulin secretion by the pancreas so that the body can be more effective in regulating glucose in the blood. In addition, herbal plants can also increase the sensitivity of the body's cells to insulin, allowing glucose to be more easily absorbed and used as an energy source (Dewi et al., 2022). Some medicinal plants also function to inhibit the production of glucose in the liver, which naturally produces glucose as an energy reserve. By reducing excess glucose production, blood sugar levels can be more stable. In addition, herbal plants can increase glucose absorption, thereby helping to lower blood sugar levels more efficiently (Andayani, Y., et al 2021). In addition to helping control blood sugar levels, herbal plants also play a role in overcoming various complications caused by diabetes, such as nerve damage, blood vessel disorders, and other metabolic problems (Mukhlis, Arifin, Ridwan, & Zulbaidah, 2025; Mukhlis, Arifin, Ridwan, Zulbaidah, et al., 2025). Some types of herbal plants have been shown to have antidiabetic activity that can support the management of the disease naturally. Diabetes mellitus itself is a metabolic disorder characterized by high blood glucose levels. This disease can affect the quality of life of its sufferers because it is chronic

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and will accompany them throughout life, especially if the treatment is not appropriate. Therefore, the use of herbal plants as a companion therapy can be a promising alternative in helping to control blood sugar levels and prevent complications (Priambodo et al., 2022).

This study aims to conduct a systematic literature review regarding the effectiveness of herbal medicines in controlling blood sugar levels in patients with type 2 diabetes mellitus. By reviewing various studies that have been conducted, it is hoped that this study can provide a deeper understanding of the role of medicinal plants in diabetes management and become a scientific basis for the development of more effective and safe herbal therapies in the future.

RESEARCH METHODS

This study used a systematic review method to evaluate the effectiveness of herbal plants in lowering blood glucose levels in people with Type 2 Diabetes Mellitus (DMT2). The article selection process is strictly conducted to ensure only relevant and high-quality studies are analysed in this meta-analysis.

The types of research used were systematic reviews and meta-analyses. The population in this study included individuals with DMT2 who had received an intervention in the form of herbal plant consumption. The research sample is in the form of articles that meet the inclusion criteria, namely research published in the period 2020–2025 in English or Indonesian, available in full text form, and included in the categories of research articles, clinical trials, and randomized controlled trials (RCTs). The inclusion criteria were chosen to focus on recent studies (2020–2025) to ensure the relevance of the findings, as earlier studies may not reflect current trends in herbal treatments or may lack modern methodologies. The focus on English and Indonesian articles was intended to include the most widely accessible studies within the context of global and local research. Articles published before 2020 or that do not meet the inclusion criteria are excluded to maintain the focus on the most relevant and high-quality evidence.

Literature searches were conducted through the ScienceDirect, PubMed, and Google Scholar databases, which were chosen for their wide scope and high relevance in the field of health and medicine. Data sources include credible international journals such as the Journal of Ethnopharmacology, Phytomedicine, BMC Complementary Medicine and Therapies, and the Journal of Herbal Medicine. Search strategies use keywords such as "Type 2 Diabetes Mellitus," "Herbal Therapy," "Blood Glucose Levels," "Traditional Medicine," "Medicinal Plants," and "Alternative Medicine."

The selection of articles in this systematic review follows strict stages. Of the total 9,379 articles identified through the ScienceDirect, PubMed, and Google Scholar databases, 3,821 articles were removed due to duplication. Furthermore, the titles and abstracts of 5,558 articles were screened, resulting in 65 articles that were eligible for further review.

After an in-depth analysis, 55 articles were excluded for various reasons, such as not meeting the inclusion criteria (24 articles), discussing the combination of herbal and pharmacological drugs (15 articles), not reporting the impact on blood glucose levels (6 articles), or not involving Indonesian herbal plants (10 articles). The rationale for excluding articles that discussed the combination of herbal and pharmacological drugs was to ensure a focus solely on the effectiveness of herbal plants in isolation, as this was the primary focus of the review. Similarly, the exclusion of articles not involving Indonesian herbal plants was necessary to narrow the scope to relevant herbal treatments in the local context, particularly for regions where these plants are commonly used. Finally, only 10 studies met all the criteria and were included in this meta-analysis.

The selected studies were then analyzed to evaluate the effectiveness of herbal plants in lowering blood glucose levels in DMT2 patients. This analysis considers the mechanism of action of each plant as well as its potential use in natural therapies as part of complementary diabetes management.

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The following PRISMA diagram illustrates the entire process of the selection study to ensure transparency in the selection of articles analyzed.

RESULTS AND DISCUSSION

This study evaluated the effectiveness of various herbal plants in managing blood glucose levels in patients with type 2 diabetes mellitus (DMT2). Various bioactive compounds contained in plants such as purple sweet potato, black garlic, bay leaves, mangosteen peel, cinnamon, binahong leaves, brown rice, red betel leaves, and star fruit leaves have shown significant hypoglycemic effects based on previous research data.

The results of the experiment showed that the consumption of boiled purple sweet potatoes for 14 days was able to significantly reduce blood sugar levels ($p = 0.000 < \alpha = 0.05$). Black garlic also showed a decrease in blood glucose levels from 300.87 mg/dL to 251.47 mg/dL after the intervention. The effectiveness of bay leaves in lowering blood sugar levels is supported by studies that show adecrease from 260 mg/dL to 179 mg/dL after seven days of consumption of bay leaf decoction. Mangosteen and cinnamon peel also have a positive effect by significantly lowering blood glucose levels ($p < 0.05$). Binahong leaves showed a decrease in blood sugar levels of up to 56.4 mg/dL after four days of decoction consumption, while brown rice consumption for one week helped 19 out of 33 respondents achieve normal blood glucose levels (≤200 mg/dL). The decoction of red betel leaves and star fruit leaves also showed its effectiveness with an average reduction in blood sugar levels of 45 mg/dL and strong statistical significance ($p < 0.001$ and $p = 0.029$, respectively).

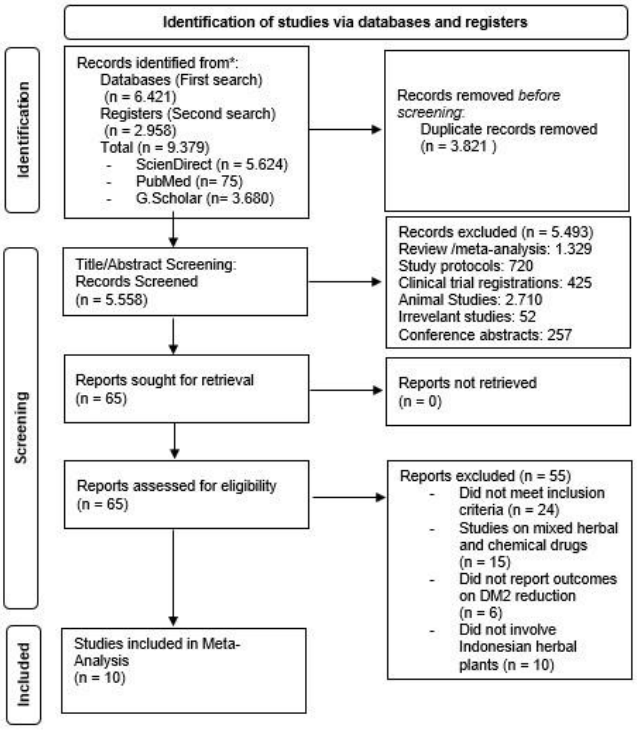

Figure 1. Diagram Prisma

These findings confirm that various herbal plants may play a role in the regulation of blood glucose levels through various metabolic mechanisms (Mukhlis et al., 2024; Mukhlis, Maryam, et al., 2023). The anthocyanins in purple sweet potatoes have antioxidant effects that protect pancreatic beta cells from oxidative stress as well as improve insulin sensitivity. Black garlic, which contains S-allyl cysteine (SAC), helps reduce insulin resistance and increase glucose absorption by cells. Bay leaves work by inhibiting the enzyme alpha-glucosidase, which slows down the breakdown of carbohydrates into glucose, while mangosteen peel with its xanthone content improves insulin sensitivity and reduces glucose absorption in the intestines.

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Cinnamon works through increased expression of GLUT-4 which helps in the transport of glucose into cells as well as the inhibition of gluconeogenesis in the liver. Binahong leaves contain saponins that mimic the function of insulin and flavonoids that protect pancreatic beta cells. The fiber in brown rice contributes to the slowing down of carbohydrate absorption, while its flavonoids stimulate insulin secretion. Red betel leaves and star fruit leaves play a role in inhibiting the enzyme α-glucosidase and increasing insulin receptor sensitivity.

The results of this study are consistent with previous literature showing the effectiveness of herbal therapy in the management of diabetes. Research by Sumara et al. (2023) supports the potential of purple sweet potato as a nutritional therapy, while Pangestu & Setyawan (2020) confirm the hypoglycemic effects of black garlic. Studies by Pratama et al. (2020) and Irmawati et al. (2022) are also in line with the findings that bay leaves can help lower blood sugar levels. The results of studies on cinnamon, brown rice, and other herbal plants show compatibility with the mechanisms that have been proposed in various studies.

The implication of the results of this study is that herbal therapy may be a promising alternative in DMT2 management, especially for individuals seeking a natural and sustainable approach (Mukhlis, Janwari, et al., 2023; Mukhlis & Abdullah, 2025). However, this therapy should be combined with a healthy diet and an active lifestyle to achieve optimal results.

Table

Table 1. Hasil Review Studi terkait Tanaman Obat dan Pengaruhnya terhadap Regulasi Glukosa Darah

No.	Article Title	Author	Year of Publication	Methodology	Intervention (Herbs Used)	Intervention (Herbs Used)	Conclusion
1.	Bawang Merah Menurunkan Kadar Gula Darah Penderita Diabetes Mellitus	Mariza Elvira, Vetri Nathalia	2020	Pre Experimental Design, one-group pretest-posttest, sample 10 people	Shallot	Shallots lower blood sugar levels (p value = 0.001 < 0.05).	Shallots have a significant effect on lowering blood sugar levels.
2.	Pengaruh Pemberian Black Garlic terhadap Perubahan Kadar Gula Darah pada Pasien Diabetes Mellitus Tipe II	Tri Yuli Idi Pangestu, Annaas Budi Seyyawan	2020	Pre eksperimen, one group pretest-posttest, sample 15 people	Black garlic	Black garlic lowers blood sugar levels (p value = 0.000 < 0.05).	Black garlic is effective in lowering blood sugar levels in patients with type II diabetes.

Table 1. Continuation

No.	Article Title	Author	Year of Publication	Methodology	Intervention (Herbs Used)	Intervention (Herbs Used)	Conclusion
3.	Pengaruh Kayu Manis (Cinnamomun cassia) terhadap Kadar Glukosa Darah pada Penderita Diabetes Mellitus Tipe 2	Nurhalina Sari, Diah Astika Winahyu, Dias Dumaika, Nadia Nur Azizah	2023	Eksperimen pre-post pada satu kelompok, sample 10 responden	Cinnamon (Cinnamomun cassia) 1 g/day for 4 weeks	Decreased blood glucose levels from 348.4 mg/dl to 230.8 mg/dl with a p-value of 0.028	Regular consumption of cinnamon has an effect on reducing blood glucose levels in type 2 DM patients
4.	Pengaruh Konsumsi Tisane Daun Belimbing Wuluh	Sutomo, Nasrul Hadi Purwanto	2023	Static group comparison design, 44 responden (22 kelompok	The Scarlet Witch (Averrhoa bilimbi L.)	The experimental group experienced a significant	Consumption of star fruit leaves is effective in lowering blood sugar levels and

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	terhadap Perubahan Kadar Gula dalam Darah pada Penderita Diabetes Mellitus Tipe 2			eksperimen, 22 kontrol), teknik sampling probability sampling (simple random sampling)		decrease in blood sugar levels compared to the control group (p=0.029)	can be used as complementary therapy in patients with type 2 diabetes mellitus
5.	Pengaruh Kulit Manggis Terhadap Penurunan Kadar Gula Darah pada Penderita Diabetes Mellitus	Anik Enikmawati, Ana Mar'atus Sholihah, Siti Sarifah	2022	Quasi-eksperimental, Pretest-Posttest Design, 12 responden	Mangosteen peel decoction	A significant decrease in blood sugar levels after giving a stew of mangosteen peel.	Mangosteen peel is effective in lowering blood sugar levels in diabetics.
6.	Pengaruh Rebusan Daun Binahong (Anredera cordifolia) Terhadap Kadar Gula Darah Penderita Diabetes Mellitus Tipe 2	Fitri Handayani, Yesi Hasneli, Gamya Tri Utami	2021	Quasi-experimental, One Group Pretest-Posttest Design, 15 responden	Boiled leaves (15 grams)	A significant decrease in blood sugar levels after the administration of binahong leaf decoction.	Binahong leaf decoction is effective in lowering blood sugar levels in people with type 2 diabetes.
7.	Pengaruh Penerapan Rebusan Daun Salam terhadap Kadar Gula Darah pada Penderita Diabetes Mellitus Tipe 2 di Desa Kopek Kecamatan Godong Kabupaten Grobogan	Nurisda Eva Irmawati, Dwi Indarti, Komsiyah, Mustika Marahayu	2022	Quasi-experiment with Non-Equivalent Control Group design, sample of 36 respondents	Bay leaf decoction	The majority of respondents experienced a decrease in blood sugar levels, 17 out of 18 respondents in the intervention group showed normal blood sugar levels after treatment	The administration of bay leaf decoction had a significant effect in lowering blood sugar levels in patients with type 2 DM (p-value = 0.000)

Table 1.
Continuation

No.	Article Title	Author	Year of Publication	Methodology	Intervention (Herbs Used)	Intervention (Herbs Used)	Conclusion
8.	Pemanfaatan Herbal: Ubi Jalar Ungu (Ipomoea Batatas L.) Rebus Sebagai Makanan Selingan Dalam Menurunkan Kadar Glukosa Darah Pasien Diabetes Mellitus Tipe II	Retno Sumara, Nugroho Ari Wibowo, Eni Sumarliyah, Lutfiyatun Nisa	2023	One-group pretest-posttest, Sample 35 people	Boiled purple sweet potatoes (300g/day for 14 days)	Significant decrease in blood sugar levels (p = 0.000)	Boiled purple sweet potatoes are effective in lowering blood sugar levels
9.	Pemberian Nasi Beras Merah (Oriza Nivara) dan Nasi Beras Hitam (Oriza Sativa L.	Laode Ardiansyah, Nawawi	2021	Quasi-experiment with pre-post test design, sample of 66 respondents	Brown rice (Oriza Nivara) and black rice (Oriza Sativa L. Indica)	Significant decrease in blood glucose levels after consumption of brown and black rice for	The administration of brown and black rice rice was effective in lowering blood glucose levels in

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	Indica) terhadap Perubahan Kadar Glukosa pada Penderita Diabetes Mellitus					one week with p-value = 0.000	DM patients, but there was no significant difference between the two types of rice.
10.	Konsumsi Rebusan Daun Sirih Merah Efektif terhadap Perubahan Kadar Gula Darah Penderita Diabetes Mellitus	Yesi Septina Wati, Ririn Muthia Zukhra, Ika Permanasari	2020	Quasi-experiment with pre-post test design, sample of 30 respondents	Red betel leaf decoction (Piper crocatum)	Significant decrease in blood sugar levels after consumption of red betel leaf decoction with p-value = 0.001	Red betel leaf decoction can be used as a non-pharmacological therapy in the treatment of diabetes mellitus.

CONCLUSION

The conclusion must contain confirmation of the problems that have been analyzed in the results and discussion sections. Write a conclusion concisely and clearly. It is not recommended that the conclusion be written in several parts or points. The conclusion is intended to help readers understand why your research is important to them after they have finished reading the manuscript. A conclusion is not simply a summary of the main topics discussed or a restatement of your research problem, but rather a synthesis of the important points. It is important that the conclusion does not leave any questions unanswered.

Based on the findings, it can be concluded that various herbs such as purple sweet potato, black garlic, bay leaves, mangosteen peel, cinnamon, binahong leaves, brown rice, red betel leaves, and star fruit leaves have significant potential in controlling blood sugar levels in patients with Type 2 Diabetes Mellitus (DMT2). These herbs contain bioactive compounds such as flavonoids, anthocyanins, tannins, and polyphenols that work through the mechanism of inhibition of the enzyme alpha-glucosidase, increased insulin sensitivity, antioxidant effects, and inhibition of glucose absorption in the intestines.

Clinical studies show that consumption of these herbs for a duration of 7 days to 4 weeks can significantly lower blood sugar levels, making them an effective adjuvant therapy or non-pharmacological alternative in the management of DMT2. These findings reinforce the role of herbs as part of natural and sustainable diabetes control strategies. However, further research with more rigorous clinical designs is still needed to determine the optimal dose, potential side effects, and interactions with pharmacological drugs to ensure long-term effectiveness and safety. Future studies should also explore the integration of herbal therapies with conventional treatments and investigate their cost-effectiveness, particularly in low-resource settings, to support their widespread adoption. Additionally, personalized treatment strategies based on individual patient characteristics, such as genetic factors or comorbid conditions, could further optimize the role of herbal therapies in the management of Diabetes Mellitus.

CONFLICT OF INTEREST

This article has gone through an independent and objective review process. The editor in charge has no history of writing collaborations with authors in previous publications. To ensure impartiality, the peer review process is carried out by other editors who have no direct connection to the authors.

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