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Herbal Medicines in the Management of Diabetes: A Review of Plant-Based Remedies and Efficacy

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Abstract

Diabetes mellitus, one of the major causes of death globally, is a serious health concern since it is characterised by impaired insulin function or production. Concerns about the negative consequences of traditional drugs have drawn attention to herbal remedies. The purpose of this article is to review the efficacy of plant-based remedies (herbal medications) in the management of diabetes, as documented in the various literature. This review highlights that herbal medicines offer a promising complementary approach to diabetes management, due to their affordability and multi-target mechanisms. Most evaluated plants demonstrated significant anti-diabetic effects, including improved glycaemic control, insulin sensitivity, and metabolic regulation. Notably, apple cider vinegar was most effective in reducing fasting blood glucose and HbA1C. Herbal formulations, rich in flavonoids, tannins, phenolics, and alkaloids, support pancreatic function and glucose regulation. While tea extracts showed no benefit, Aloe vera, Fenugreek, Psyllium fibre, and Nigella sativa emerged as effective adjuncts. Rigorous clinical validation remains essential for broader therapeutic acceptance.

Keywords; Diabetes Mellitus, Global Health Challenge, Herbal Medicines, Plant-Based Remedies, Anti-Diabetic, Glycaemic Control, Blood Glucose.

INTRODUCTION

Persistent hyperglycemia brought on by deficiencies in insulin production, action, or both is a hallmark of diabetes mellitus, a chronic metabolic disease. According to predictions from the International Diabetes Federation, 537 million persons aged 20 to 79 had diabetes in 2021; by 2045, that figure is expected to increase to 783 million. The annual global healthcare expenditure exceeds \$966 billion, indicating that diabetes imposes a substantial economic burden [1]. For decades, traditional medical systems have used plant-based treatments to treat symptoms similar to diabetes. According to the World Health Organisation, almost 80% of people worldwide get their main medical treatment from traditional medicine. Herbal antidiabetic drugs have garnered increased scientific attention in recent decades due to the drawbacks of traditional treatments, such as side effects, expense, and accessibility concerns in underdeveloped nations [2]. The intricate phytochemical compositions of medicinal plants, which may provide many modes of action and maybe fewer side effects than manufactured medications, are the source of their therapeutic promise in the treatment of diabetes [3]. The objective of this study is to provide a thorough examination of the pharmacological mechanisms, clinical data, and possible future therapeutic applications of herbal medications used in the treatment of diabetes [4], [5].

Diabetes treatment, management, and alternative therapies—particularly plant-based diets and herbal remedies—are receiving a lot of attention. The general public is interested in preventative and therapeutic remedies via diet and/or natural goods, and the idea of "food as medicine" is being frequently covered by the press and media. Indeed, more natural therapies are being promoted over chemical synthesis by the general public as well as national and international organisations [6].

Utilising native flora, often exclusively for local purposes, "herbal remedies" are widely used and particularly pertinent to many communities. In all four continents, ethnopharmacology—the study of ethnic medicines—has a strong body of foundation. Health is a key issue, despite regional variations in habits; hence, many cultures use herbal cures and preventative measures [7].

In middle- and low-income nations, the incidence of diabetes has been increasing more quickly, and about 5 million fatalities are attributed to the disease. Investigating alternative medicines like herbal medicine may be beneficial since this scenario seems to be costly and often unaffordable in these nations [8]. According to recent clinical studies, a number of dietary treatments based on plants or herbs have anti-diabetic properties and might be employed as main dietary components. Improved insulin resistance, direct beta-cell insulin secretion, suppression of lipid peroxidation, production of superoxide radicals, and inhibition of α -amylase and α -glucosidase activity are some of the mechanisms that may be responsible for the anti-diabetic benefits [9], [10].

Diabetes

A collection of common endocrine disorders known as diabetes mellitus, or simply diabetes, are characterised by persistently elevated blood sugar levels. Diabetes results from either the body's cells losing their sensitivity to the effects of insulin or the pancreas not making enough of the hormone. The three P's are classic symptoms: impaired vision, weight loss, polydipsia (excessive thirst), polyuria (excessive urine), and polyphagia (excessive appetite). The condition may cause problems with the kidney, nerves, eyes, and cardiovascular system, among other health issues, if treatment is not received [11].

Types of diabetes

There are many varieties of diabetes:

- **Type 1:** An autoimmune illness is type 1 diabetes. The cells of the pancreas, which produce insulin, are attacked and destroyed by the immune system. The reason of this assault remains unknown [12].
- **Type 2:** Blood sugar levels rise and your body develops resistant to insulin, resulting in type 2 diabetes. Diabetes is the most prevalent form of the disease, with approximately 90% to 95% of individuals living with the condition having type 2 [13].
- **Type 1.5:** Adults with latent autoimmune diabetes (LADA) are another name for type 1.5 diabetes.

Like type 2 diabetes, it develops gradually over the course of adulthood. Diet and lifestyle changes are ineffective in treating LADA, an autoimmune illness.

- **Gestational:** Pregnancy-related elevated blood sugar is known as gestational diabetes. This kind of diabetes is brought on by the placenta's production of hormones that block insulin [14].

Although it shares a name with diabetes mellitus, diabetes insipidus is an uncommon illness. It is a distinct condition in which the kidneys excrete an excessive amount of fluid from the body.

The Role of Plant-Based Dietary Interventions in Managing Diabetes

Weight gain is a subsequent consequence of the majority of pharmaceuticals currently employed to manage diabetes, which are designed to reduce insulin secretion and increase hepatic gluconeogenesis. Understanding the right diets and eating habits to control diabetes has been the focus of countless scientific research since nutrition has a significant influence in both the aetiology and treatment of the disease [15]. Due to their high antioxidant and fibre content, low calorie density, and nutritional density, plant-based dietary interventions—such as vegetables, fruits, whole grains, and legumes—have been linked to positive outcomes for the prevention and treatment of diabetes [16]. Plant-based diets are the best option for reducing insulin resistance, lowering low-grade inflammation, and increasing blood sugar control—all of which are symptoms of diabetes. Following these diets has been shown to increase cells' capacity to utilise insulin, which leads to better metabolic health, including lower blood pressure, low cholesterol, lower blood sugar, and better weight management [17]. Furthermore, it has been noted that plant-rich diets, whether they take the form of general lifestyle modifications or particular eating patterns like vegetarianism or Mediterranean diets, reduce the incidence of diabetes complications including "retinopathy, proteinuria, neuropathy, or coronary artery disease" [18]. Notable is the promotion of a comprehensive diabetes management strategy that prioritises physical activity and nutritious diets. Compared to existing standards that have not yet taken into account various alternative dietary alternatives, a plant-based diet seems to have all the qualities of such a customised and all-encompassing approach, going deeper [19].

Major herbal medicines in diabetes management

1. **Gymnema sylvestre (Gurmar):** The antidiabetic properties of *Gymnema sylvestre*, which is referred to as "sugar destroyer" in Hindi, have been the subject of extensive research. Gymnemic acids, the main bioactive substances, are structurally identical to glucose molecules. These substances may obstruct the receptors for sweet tastes and disrupt the intestinal absorption of glucose. In both type 1 diabetes and type 2 diabetes patients, clinical investigations have shown a substantial decrease in HbA1c, postprandial glucose, and fasting blood glucose levels [8].
2. **Momordica charantia (Bitter Melon):** Among the substances with hypoglycemic action found in bitter melon are "vicine, charantin, and polypeptide-p (plant insulin)". These substances function via a variety of pathways, including as greater insulin production, increased skeletal muscle uptake of glucose, and suppression of intestinal glucose absorption. Glycaemic control has improved modestly but steadily in clinical studies [2].
3. **Trigonella foenum-graecum (Fenugreek):** Galactomannan, a kind of soluble fibre found in abundance in fenugreek seeds, delays the absorption of carbohydrates and increases glucose tolerance. Additionally, the seeds contain the amino acid 4-hydroxyisoleucine, which promotes insulin production in a glucose-dependent way. A number of clinical studies have shown substantial decreases in HbA1c, postprandial glucose, and fasting glucose levels [20].
4. **Cinnamomum verum (Cinnamon):** Procyanidin polymers, cinnamaldehyde, and cinnamic acid are among the bioactive substances found in cinnamon. By enhancing muscle cell absorption of glucose and stimulating insulin signalling pathways, these substances improve insulin sensitivity. Improvements in insulin sensitivity and fasting glucose are moderate, according to meta-analyses of clinical studies [21].
5. **Allium sativum (Garlic):** Improved insulin sensitivity and enhanced insulin secretion are the mechanisms by which sulphur compounds, including "allicin and S-allyl cysteine", exhibit hypoglycemic effects in garlic. Garlic also has cardiovascular-protective properties, which is important for diabetics who are more likely to have cardiovascular problems [19].

LITERATURE REVIEW

(Mitaki et al., 2025) [22] In the East African Community (EAC), this systematic study evaluates the viability, safety, effectiveness, and "efficiency of phytotherapy in the

treatment of diabetes". Using data we gathered and examined from the literature, we demonstrated how the mechanisms of action of seven medicinal herbs lower blood sugar and insulin sensitivity. The hypoglycemic effects of these medicinal herbs may be attributed to their phytochemical characteristics, which mostly consist of alkaloids, tannins, and flavonoids. High blood sugar control is less effective with *Caesalpinia bonducella* seed extract. The possibility of using phytotherapy to treat diabetes in EAC requires further preclinical research.

(P. Sen et al., 2025) [23] This study looks at the available data on the use of herbal medications to treat diabetes, emphasising their safety profiles, clinical effectiveness, and mechanisms of action. According to a thorough examination of traditional medicinal plants, many herbs exhibit hypoglycemic effects via a variety of pathways, such as increased insulin production, better insulin sensitivity, suppression of enzymes that break down carbohydrates, and improved glucose absorption. Promising outcomes have been shown in preclinical and clinical research for notable herbs, including "*Momordica charantia*, *Gymnema sylvestre*, *Trigonella foenum-graecum*, and *Cinnamomum verum*". Potential herb-drug interactions, a lack of high-quality clinical studies, and standardisation problems are still major obstacles, nevertheless. In order to establish herbal medications as evidence-based supplements to traditional diabetes treatment, this review summarises existing information and points out areas that need further investigation.

(Rajesham et al., 2024) [14] The goal of this research is to investigate how "patients' quality of life (QoL)" is evaluated using allopathic and herbal methods. We also describe the pathophysiology, aetiology, and epidemiology of diabetes, highlighting its increasing prevalence worldwide and related risk factors. The results of our research of SF-36 health profiles show that herbal therapy improves overall quality of life (QoL) by emphasising patient comfort, especially in areas linked to general health (GH) and treatment satisfaction (TS). When compared to synthetic medication, QOLID data further supports these results by showing that herbal medicine increases treatment satisfaction, energy, and reduces symptom irritation. Herbal treatment is noteworthy for showing better quality of life in most particular categories, with the exception of diet satisfaction (DS), indicating areas that need further study and therapeutic development.

(S. Kumar et al., 2023) [21] The objective of the current systematic review and network meta-analysis was to

compare and assess the effects of herbal formulations on the management of type 2 diabetes by integrating direct and indirect evidence. The study's final analysis included 44 trials with 3130 individuals on six herbs. Fasting blood glucose (FBG) was considerably lowered by "apple cider vinegar (ACV)" (standardised mean difference), cinnamon, curcumin, and fenugreek when compared to a placebo. Remarkably, fenugreek seeds and ACV were the only ones that were proven to be particularly beneficial in lowering HbA1C. When compared to other herbs, ACV was the most effective in lowering FBG. There are a number of herbs that may be useful as adjuvant treatment for type 2 diabetics' glycaemic management. Incorporating these botanicals into the standard care of health personnel should be promoted as a means of managing type 2 diabetes.

(Sriraman et al., 2023) [24] In an effort to comprehend the perspectives and the experiences of health professionals and patients regarding herbal treatments for the self-management of type 2 diabetes. But since they thought medical experts were narrow-minded, they were hesitant to talk about herbal remedies with them. Their choices of therapy were influenced by their own experiences (grounded in trial and error), as well as the accessibility, affordability, and practicality of both conventional and herbal remedies. The majority of medical experts were either unwilling to talk about herbal medications or advised against using them due to ignorance and worries about their effectiveness, quality, and possible side effects. Health professionals and individuals with type 2 diabetes may be able to communicate more effectively about herbal medications if they have access to evidence-based information.

(Adatorwovor et al., 2021) [25] Diabetes patients' insulin sensitivity is significantly influenced by their dietary choices. The purpose of an 8-week pilot research was to determine if a diet low in plant-based foods will enhance biochemical indicators in diabetic people. Small group discussions, weekly culinary demonstrations, and educational lectures were all part of the nutritional program. Thirteen (53%) of the thirty-two persons with diabetes (types 1 and 2) who made up the sample completed the study. Biochemical indicators improved after our 8-week dietary program, and attitudes towards adopting plant-based diets improved as well.

(Willcox et al., 2021) [20] to evaluate the glycaemic control of medicinal plants in people with Type 2 Diabetes (T2DM). Meta-analyses of randomised controlled clinical studies evaluating the impact of medicinal plants on T2DM patients' HbA1c and/or FPG were included. For lowering HbA1c, a

number of medicinal herbs seem to be just as successful as traditional antidiabetic medications. Thorough studies with a minimum 3-month follow-up are required to determine how potential plant-based preparations affect diabetes.

(Kooti et al., 2016) [26] This systematic review aims to investigate diabetes and provide an overview of the many therapies for the condition, with a particular emphasis on herbal therapy. Reactive oxygen species rise and oxidative stress are the primary causes of diabetes, which may have serious consequences. The natural antioxidants found in many plants, including flavonoids, tannins, and vitamins C and E, may lower blood glucose levels and preserve the function of β -cells. In comparison to synthetic medications, medicinal plants are more cost-effective, have fewer adverse effects, and are more successful in treating diabetes mellitus, according to published studies.

RESEARCH GAP

Despite growing evidence supporting the anti-diabetic potential of various herbal medicines, significant research gaps remain. Many studies lack standardized methodologies, consistent dosing, and large-scale clinical validation, limiting the generalizability of findings. Most available data are derived from preclinical or small-scale trials, with limited information on long-term safety, efficacy, and herb-drug interactions. Additionally, regional differences in plant availability and preparation methods further complicate reproducibility. There is also a scarcity of comparative studies evaluating herbal formulations against standard pharmacotherapy. Addressing these gaps through well-designed, high-quality clinical trials is crucial to establish herbal medicines as credible, evidence-based interventions for diabetes management.

RESEARCH OBJECTIVE

- In this article examine the Herbal Medicines in the Management of Diabetes.
- Study the Role of Plant-Based Dietary Interventions in Managing Diabetes.
- Study the Major herbal medicines in diabetes management.

RESEARCH METHODOLOGY

This review paper employs a qualitative research methodology, utilizing secondary data to explore the efficacy of plant-based remedies in managing diabetes. The study involves a comprehensive literature review, critically examining peer-reviewed academic journals, scholarly articles, official health reports, and relevant case studies

published between 2015 and 2025. Sources were selected based on relevance, credibility, and contribution to the understanding of herbal medicines' role in glycaemic control, insulin sensitivity, and metabolic regulation. The analysis focuses on identifying commonly used medicinal plants, their bioactive compounds, and therapeutic mechanisms, aiming to synthesize current knowledge and highlight areas for further clinical research.

CONCLUSION

This review highlights the potential of herbal medicines as complementary therapies for the management of diabetes, particularly in East African Communities (EAC) where the high cost of conventional treatments poses significant challenges. The majority of the studied plants exhibit strong anti-diabetic properties, including improved metabolic regulation, enhanced insulin sensitivity, and better glycaemic control. Herbal formulations, such as apple cider vinegar, were particularly effective in reducing fasting blood glucose and HbA1c, though not significantly affecting insulin resistance or HOMA-IR. Aloe vera, Psyllium fiber, Fenugreek seeds, Nigella sativa, and the Chinese formula Jinqi Jiangtang emerged as promising adjunct therapies. In contrast, tea and tea extracts were found ineffective. The polypharmacological action of herbal remedies—owing to bioactive compounds such as flavonoids, tannins, phenolics, and alkaloids—offers a broader mechanism of action compared to single-target synthetic drugs, potentially enhancing pancreatic function and glucose absorption regulation. Although the findings support the integration of herbal medicines alongside standard pharmacotherapy and lifestyle changes, rigorous clinical validation remains critical. Overall, medicinal plants hold promise as accessible, safe, and effective alternatives or complements in diabetes care, especially in resource-limited settings, but further high-quality trials are necessary to confirm their therapeutic efficacy and safety profiles.

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