



Review Paper

A Comprehensive Review of Medicinal Plants Exhibiting Anti-Diabetic Properties

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ABSTRACT

Diabetes mellitus is a metabolic disorder marked by persistent high blood sugar levels, primarily resulting from excessive hepatic glucose production, reduced insulin secretion, or impaired insulin function. Globally, approximately 60% of the population relies on traditional medicines sourced from medicinal plants. In India, diabetes has emerged as a major health concern, especially in urban settings. Despite the availability of various therapeutic strategies to manage diabetes and its complications, herbal remedies are favored due to their minimal side effects, low toxicity, affordability, and effectiveness. This review highlights several medicinal plants with proven anti-hyperglycemic properties. Nevertheless, further pharmacological and chemical studies are warranted to clarify the precise mechanisms underlying their hypoglycemic effects.

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1. INTRODUCTION

The World Health Organization (WHO) defines diabetes as a metabolic disorder characterized by chronic hyperglycemia and disruptions in the metabolism of fats, proteins, and carbohydrates due to deficiencies in insulin secretion, insulin action, or both. Diabetes mellitus is linked to progressive damage, dysfunction, and failure of various organs and is commonly associated with symptoms such as excessive thirst, frequent urination, blurred vision, and unexplained weight loss¹.

India is significantly impacted by diabetes, making alternative treatments a necessity². Diabetes ranks among the most severe endocrine metabolic disorders, leading to a wide range of complications³. Current estimates suggest that 246 million people are affected by diabetes worldwide, and its mortality rate now surpasses that of AIDS⁴. Every five seconds,

someone is diagnosed with diabetes globally, and every ten seconds, the disease claims a life⁵. The increasing prevalence over the past two decades is largely attributed to heightened stress, rising obesity rates, and sedentary lifestyles⁶.

Types of Diabetes Mellitus

1. Insulin-dependent diabetes mellitus (IDDM)
2. Non-insulin dependent diabetes mellitus (NIDDM)
3. Gestational diabetes

Importance of Plant-Based Medicines

It is estimated that approximately 80–85% of people worldwide, in both developed and developing regions, depend on traditional medicine as their

primary form of healthcare. This practice often involves the use of plant-derived extracts or their active components⁷⁻⁸. Countries like India and China are especially known for their strong traditions in herbal medicine⁹. Before the discovery of insulin in 1922, traditional remedies were the primary means of managing diabetes¹⁰⁻¹¹. Today, more than a thousand plant species are recognized for their use in community-based diabetes care, and scientific interest in medicinal plants has surged since the 1950s¹²⁻¹³.

Numerous plants have demonstrated both efficacy and safety through centuries of clinical application. Research indicates that many plants traditionally used for managing diabetes have since been validated by scientific studies¹⁴⁻¹⁶. Herbal formulations and plant-derived medicines are generally considered to be less toxic and have fewer side effects compared to synthetic drugs¹⁷⁻¹⁸. This widespread perception of safety contributes to their continued use, even when the precise active compounds remain unidentified¹⁹. The World Health Organization (WHO) actively supports the use of herbal medicines for treating various diseases, including diabetes²⁰, emphasizing their efficacy and relatively low risk of side effects. Furthermore, WHO publications and monographs offer guidance and endorse the use of plant-based treatments²¹⁻²².

Mechanisms of Anti-Diabetic Activity in Medicinal Plants²³⁻²⁴

The hypoglycemic effects of medicinal plants are due to a variety of mechanisms, such as:

- Blocking potassium channels in pancreatic beta cells and stimulating cyclic AMP (cAMP) pathways
- Inhibiting the reabsorption of glucose by the kidneys
- Stimulating insulin secretion from the beta cells of the pancreas and/or preventing the degradation of insulin
- Reducing insulin resistance
- Supplying vital trace elements like calcium, zinc, magnesium, manganese, and copper essential for beta-cell function
- Promoting the regeneration or repair of pancreatic beta cells
- Enhancing the secretion of insulin
- Increasing glycolysis (the breakdown of glucose)

Plants and Diabetes Mellitus

Natural products serve as key sources for identifying promising candidates in drug discovery, significantly contributing to the development of future medications. Due to their wide availability, minimal side effects, and affordable cost, herbal remedies are especially preferred, particularly in rural communities. This review aims to highlight some anti-diabetic plants and present important information related to these commonly used botanicals.

Azadirachta indica (Meliaceae)

Commonly known as Neem, this tree is native to India, Burma, Bangladesh, Sri Lanka, Malaysia, Pakistan, and various tropical and subtropical regions. Both low (0.5g three times daily) and high (2g three times daily) doses of powdered leaves and bark, as well as aqueous and alcoholic extracts of *Azadirachta indica*, have demonstrated significant blood sugar-lowering effects at higher doses. These extracts may also be effectively used in combination with standard oral hypoglycemic medications²⁵⁻²⁶.

Momordica charantia (Cucurbitaceae)

Also referred to as Bitter Melon or Karela, this plant is commonly cultivated in Asia, Africa, and the Caribbean. The fruit, seeds, and extracts (aqueous and alcoholic) of *Momordica charantia* are widely used in traditional medicine for their hypoglycemic effects. Clinical studies suggest that daily administration of the fresh juice (50–100 ml), fruit extracts, or dried powder can significantly reduce blood glucose levels in diabetic patients, either alone or as an adjunct to conventional therapies²⁷⁻²⁸.

Trigonella foenum-graecum (Fabaceae)

Known as Fenugreek, this annual herb is found throughout southern Europe and Asia. The seeds are rich in soluble fiber and other bioactive compounds that help regulate blood sugar. Studies have shown that the consumption of 10–25 grams of powdered seeds daily, either mixed with food or taken with water, can lead to substantial reductions in fasting blood glucose and improved glucose tolerance in people with diabetes²⁹⁻³⁰.

Gymnema sylvestre (Apocynaceae)

Commonly called Gymnema or Gurmar, this woody climbing shrub is native to India and Africa. The leaves contain gymnemic acids, which have been shown to reduce the absorption of sugar from the intestine and promote insulin secretion. Supplementation with leaf extracts (200–400 mg daily) has resulted in decreased blood glucose and HbA1c levels in clinical studies, making it a valuable adjunct to diabetes management³¹⁻³².

Ocimum sanctum (Lamiaceae)

Widely known as Holy Basil or Tulsi, this plant is native to India and has been used in Ayurvedic medicine for centuries. The leaves and extracts possess significant antioxidant and hypoglycemic properties. Clinical research has shown that daily use of Tulsi leaf extract (up to 2.5g) can help lower fasting and postprandial blood glucose levels in diabetic individuals³³⁻³⁴.

Syzygium cumini (Myrtaceae)

Commonly known as Jamun or Indian Blackberry, this tree is widely distributed throughout India and Southeast Asia. The seeds, leaves, and

bark of *Syzygium cumini* have been traditionally used for managing diabetes. Scientific studies have shown that seed powder (1–3g per day) or extracts can significantly decrease blood glucose and glycosylated hemoglobin levels, making it a supportive natural option for diabetic patients³⁵⁻³⁶.

***Allium sativum* (Amaryllidaceae)**

Popularly known as Garlic, this widely used culinary plant has also demonstrated hypoglycemic activity. The sulfur-containing compounds in garlic bulbs can enhance insulin secretion and improve glucose uptake by cells. Daily consumption of fresh garlic cloves (2–3 cloves) or standardized extracts has been shown to reduce fasting blood sugar levels and improve lipid profiles in diabetic individuals³⁷⁻³⁸.

***Cinnamomum verum* (Lauraceae)**

Also referred to as True Cinnamon or Ceylon Cinnamon, this spice is obtained from the bark of the tree native to Sri Lanka and southern India. The active compounds in cinnamon are known to increase insulin sensitivity. Regular intake of cinnamon powder (1–6g daily) has been associated with reduced fasting blood glucose and improved glycemic control in several clinical trials³⁹⁻⁴⁰.

***Phyllanthus emblica* (Phyllanthaceae)**

Known as Indian Gooseberry or Amla, this fruit is valued for its rich vitamin C content and potent antioxidant properties. Studies have shown that Amla fruit extract (500mg–1g daily) can lower blood sugar levels and protect pancreatic beta-cells from oxidative damage, supporting diabetes management⁴¹⁻⁴².

***Aloe vera* (Asphodelaceae)**

Aloe vera is a succulent plant commonly found in arid regions across the world. The gel and juice from *Aloe vera* leaves contain compounds that exhibit hypoglycemic and anti-inflammatory properties. Clinical evidence suggests that regular consumption of *Aloe vera* juice (10–20ml daily) can aid in lowering fasting blood glucose and improving lipid profiles in people with type 2 diabetes⁴³⁻⁴⁴.

***Mangifera indica* (Anacardiaceae)**

Commonly known as Mango, the leaves of *Mangifera indica* are traditionally used in the management of diabetes in several Asian countries. The aqueous extract of mango leaves (200–400 mg/kg) has demonstrated significant hypoglycemic effects in experimental animal studies, improving glucose tolerance and reducing fasting blood sugar⁴⁵.

***Pterocarpus marsupium* (Fabaceae)**

Also known as Indian Kino or Vijaysar, this tree is native to India and Sri Lanka. The heartwood is traditionally used for diabetes management.

Scientific studies have reported that its aqueous and alcoholic extracts can regenerate pancreatic beta-cells and reduce blood glucose levels⁴⁶.

***Ficus racemosa* (Moraceae)**

Popularly called the Cluster Fig or Gular, the bark, leaves, and fruits are used in various formulations to manage diabetes. Extracts of the bark (250–500 mg/kg) have shown significant antihyperglycemic effects in experimental models⁴⁷.

***Tinospora cordifolia* (Menispermaceae)**

Known as Guduchi or Giloy, this climbing shrub is widely used in Ayurveda for various ailments, including diabetes. The stem and root extracts have been found to enhance insulin secretion and improve glucose utilization⁴⁸.

***Coccinia indica* (Cucurbitaceae)**

Commonly called Ivy Gourd or Kundru, the leaves and fruits are used in traditional medicine to lower blood sugar. Clinical and experimental studies have shown that extracts (100–300 mg/kg) possess notable hypoglycemic effects⁴⁹.

***Aegle marmelos* (Rutaceae)**

Commonly known as Bael, this plant is traditionally used in Indian medicine for managing diabetes. The leaves, fruits, and bark contain compounds such as marmelosin and aegeline, which have demonstrated the ability to lower blood glucose levels and improve pancreatic function in both experimental and clinical studies.

2.CONCLUSION

In the present review, we have compiled a list of medicinal plants exhibiting antidiabetic activity, emphasizing the advantages of herbal remedies over conventional synthetic drugs. Herbal medicines are widely regarded as less toxic, associated with fewer side effects, more cost-effective, and readily accessible compared to many synthetic pharmaceuticals. Diabetes mellitus continues to pose a significant and rapidly growing global health challenge, affecting populations in both developed and developing countries. Despite ongoing research and the development of various synthetic antidiabetic agents, the incidence and prevalence of diabetes are still on the rise.

According to World Health Organization (WHO) guidelines, the use of plant-derived hypoglycemic agents in traditional and modern medicine holds great promise. The antidiabetic effects attributed to these medicinal plants are primarily due to their ability to stimulate pancreatic beta-cell function, enhance insulin secretion, increase glucose uptake in peripheral tissues, or reduce intestinal absorption of glucose. Many plants are also rich in antioxidants, which help to protect pancreatic cells from oxidative stress-induced damage.

Furthermore, several phytochemicals present in these plants—such as alkaloids, flavonoids, glycosides, terpenoids, and saponins—have been identified as active constituents responsible for their blood glucose-lowering effects. In addition to regulating glucose metabolism, these herbal drugs may also exhibit lipid-lowering, anti-inflammatory, and immunomodulatory activities, thereby addressing some of the complications associated with diabetes.

Overall, the integration of medicinal plants into diabetes management not only helps in maintaining glycemic control but also provides a holistic approach by improving overall health and reducing the risk of adverse effects linked to synthetic drugs. Further scientific exploration and clinical validation of these herbal medicines are essential for the development of safe and effective antidiabetic therapies.

3. CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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