



Systematic Review on Indian Antidiabetic Medicinal Plants

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Abstract

Incidences and related mortality are rising for diabetes mellitus, one of the world's leading health issues across the world. Inadequate blood sugar control has detrimental effects on human health. Conventional antidiabetic medications are effective, but they also have unavoidable side effects. Conversely, medicinal plants might serve as a different source of antidiabetic substances. With an emphasis on preclinical and clinical research, Examples of therapeutic herbs that may help lower blood sugar levels. The profile of physiologically active chemicals in each plant matrix, their coordinated and combined activity, and the possible advantages are examined.

Keywords: Medicinal plants, diabetes mellitus, herbal, insulin sensitivity

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Introduction

Diabetes mellitus is a collection of metabolic diseases marked by elevated blood sugar levels by improper insulin synthesis, action, or secretion (El-Tantawy and Temraz 2018). It affects a large number of people and sixth most common cause of mortality in the twenty-first century, (Kazi 2014). The condition currently affects 2.8% of people worldwide, and by 2025, it is predicted to rise to more than 5.4% (Mukesh and Namita 2013). Early diagnosis, treatment, and lifestyle modifications are necessary for diabetes. It can be controlled with insulin, dietary changes, and traditional or synthetic medications. Although there is currently no effective treatment to cure diabetes, some synthetic medications can have negative side effects such as toxicity and drug resistance (Saxena *et al.* 2020). There is an urgent need for better treatments for diabetes which lower glucose level with less side effects. There are several glucose-lowering medications that work differently to treat diabetes. Sulfonylurea and meglitinide medications stimulate insulin secretion, while biguanides and thiazolidinediones increase glucose absorption in the peripherals of intestinal cells (Bathia, Mokarizade, and Shirali 2012). For instance, 44% of patients stop responding to sulfonylureas after 6 years of treatment. Additionally, it is claimed that medications that lower blood sugar cannot manage hyperlipidemia (Dey, Attele, and Yuan 2002). As a result, research on traditional medicinal plants has increased in response to the search for alternative hypoglycemic drugs. Compounds that were first discovered in plants, such as the imino-sugar derivative miglitol, are the source of many synthetic medications. Sugar derivatives and imino-sugars are promising antidiabetic medicines that control blood sugar levels by blocking particular enzymes involved in the metabolism of glucose (Nash *et al.* 2011). Furthermore, medical personnel or researchers must examine the adverse effects of medications as well as their interactions in vitro (Kooti *et al.* 2015). Carotenoids, flavonoids, terpenoids, alkaloids, glycosides, and other anti-diabetic compounds are found in the majority of plants (Afrisham *et al.* 2015). Certain plants may serve as alternatives to conventional medical treatments, aid in therapy, and offer preventative advantages, according to historical cultures with documentations. In order to better understand these qualities, research is looking for important bioactive compounds, antioxidants, and antidiabetics, as well as their intriguing potential health benefits. Plant treatments have anti-hyperglycemic effects because they enhance pancreatic tissue function, which is achieved by increasing insulin releases or reducing intestinal glucose absorption (Waškiewicz *et al.* 2013; Tylewicz *et al.* 2020). Further, this article's main objective is to provide an overview of several effective medicinal plants that are used to treat diabetes. It also explains how plant compounds that lower blood sugar and increase insulin production work.

Methodology

2.1 Updated Literature Review (2016–2024)

To ensure the review reflects recent advancements, an updated search was conducted covering the period from 2016 to 2024. The databases—ScienceDirect, PubMed, Wiley, Scopus, and Springer—were queried using the "diabetes," "medicinal plants," "symptom," "herbal," and "treatment" keywords. The purpose of this primary search was to gather new information about the application of medicinal plants to the treatment of diabetes. Out of

approximately 180 identified articles, 120 were excluded based on relevance criteria and full-text availability. The remaining 60 articles were included in the final analysis, bringing the total number of reviewed studies to 100.

2.2 Inclusion and Exclusion Criteria

This review included peer-reviewed studies published between 1995 and 2024 that focused on the antidiabetic effects of medicinal plants. Eligible articles were required to be in English, provide full-text access, and contain experimental data from in vitro, in vivo, or clinical studies. Studies were excluded if they were unrelated to diabetes or plant-based treatments, were review articles, lacked experimental detail, or were not available in full text. Non-English papers and duplicate entries were also omitted.

2.2.1 Medicinal plants and their antidiabetic effects

2.2.1.1 *Costus igneus*

Costus igneus, also referred to as insulin plant, fiery costus, or spiral flag, is a herbaceous plant from the Costaceae family. It is grown in India to treat diabetes mellitus (Krishnan *et al.* 2014). This plant has three primary proteins: Aglycin, Viglycin, and ILP (insulin-like protein), which excite IRs (insulin receptors) and encourage secondary stimuli to glucose uptake (Costa *et al.* 2020). In Vivo experiments by Mansi R. Hardikar *et al.* revealed that ILP activates the insulin signaling pathway in L6 myotubes, an immortalized rat skeletal myoblast cell line (Hardikar *et al.* 2016). Silver-coated nanoparticles were successfully produced and tested for oral medication delivery (Aruna *et al.* 2014). *Costus igneus*-ZnO nanoparticles were found to be more efficient than *C. igneus* leaf extract alone.

2.2.1.2 *Gymnema sylvestris*

Gymnema sylvestris (GS) is a medicinal herb with anti-hyperglycemic properties and is commonly used as a supplement for diabetes patients (Rajendran, Sudeshraj, and Sureshkumar 2018). The plant GS is cultivated in the southern part of Asia and the East Indies. Although the precise mechanism is unknown, the roots and leaves of the GS plant have therapeutic qualities. Plant extracts improve glucose absorption and utilization by increasing enzyme activity and distinguishing pleasant flavor. The GS extract enhances pancreatic cell activity and increases insulin release (Rana and Avadhoot 1992). Research indicates that GS extract has blood sugar-lowering, anti-sweet, and hepatoprotective properties. A study found that GS leaf extract reduced blood cholesterol levels and reduced hypoglycemia in diabetic rats produced with streptozotocin (Devi Priya and Siril 2014).

2.2.1.3 Fenugreek

Fenugreek is known by its botanical name, *Trigonella foenum-graecum*. North Africa and Southern Europe are the primary growing regions for fenugreek. India exports large amounts of Fenugreek is widely used around the world. *Trigonella foenum-graecum* contains galactomannan (40-45%), which is responsible for its anti-hypoglycemic action (Anwar *et al.* 2011). A study found that fenugreek galactomannan reduced blood glucose levels in an alloxan-modelled specimen (Anwar *et al.* 2011). *Trigonella foenum* seeds contain large levels of saponins, specifically dioscin or diosgenin, which has been extracted. Screening for α -glucosidase inhibitory action in vitro

confirmed natural anti-diabetic drugs with minimal toxicity (Zhang *et al.* 2020). N55, a positive GLP-1 signalling modulator derived from fenugreek seeds, has been shown to be useful for diabetes treatment (Lin and Chein 2020).

2.2.1.4 Bilberry

Bilberry (*Vaccinium myrtillus*) belongs to the Ericaceae family. Bilberries can treat fever, cough, diabetes, and other diseases. There is a liver disorder. This plant is mostly found in forests in Europe and the northern United States (Kemper 1999; Rajendran, Sudeshraj, and Sureshkumar 2018). Scientific articles found that the fruit possesses anti-diabetic and hypoglycemia properties (Gupta and Amartya De 2012). The bilberry plant contains phytochemicals such as quercetin, catechins, tannins, vitamins, and pectins (Rajendran, Sudeshraj, and Sureshkumar 2018).

2.2.1.5 Ashwagandha

The botanical name for the ashwagandha plant is *Withania somnifera* (L). This herb is commonly known as Indian ginseng. Ashwagandha is from the Solanaceae plant family. Ashwagandha contains withanolides, which are a group Steroidal lactones have various pharmacological effects (Udayakumar *et al.* 2009). Ashwagandha leaves contain a steroidal lactone called withanolide. Withanolide has been shown in tests to have anti-tumor and hypoglycemic effects. Extensive research has been conducted on the plant's nutritional characteristics, particularly flavonoids. Flavonoids are commonly used to treat hypoglycemia and diabetes (Udayakumar *et al.* 2009).

2.2.1.6 Bitter melon

Memordica Charantia is a popular hypoglycemic plant found in Asia, India, and East Africa. It belongs to the Cucurbitaceae family. This plant can grow up to 5m in length and produces knobby fruits. The bitter melons It comprises chemical constituents such as alkaloids, lipids, steroids, and phenolic substances. These chemicals are responsible for anti-diabetic action. Bitter melon mostly contains triterpenoids with AMP-activated protein kinase activity. *Memordica Charantia* may have a hypoglycemic mechanism, according to research (Joseph and Jini 2013).

2.2.1.7 Salacia reticulata

The *Salacia reticulata* is commonly known as meharimula. The roots and stem contain phytochemicals that can heal a variety of diseases. Tezuka *et al.* and Yoshikawa *et al.* found that (Tezuka *et al.* 1993; Yoshikawa *et al.* 1998) salcinol and kotalanol extracted from *Salacia reticulata* block α -glucosidase. Rajashree *et al.* (Rajashree, Bhat, and Ravishankar 2011) found that combining *S. reticulata* with *Catharanthus roseus* L produced hypoglycemia and hypolipidemic effects in diabetic rats. Additionally, herbs were found to lower blood glucose levels in diabetic rats compared to the control group. The suppression of pancreatic lipase, aldose, and glucosidase

enzymes causes a drop in blood glucose levels. Yoshikawa reported that the hot water-soluble fraction of *Salacia reticulata* roots has anti-obesity properties in rats.

2.2.1.8 Allium sativum

Garlic (*Allium sativum* Linn.) belongs to the Alliaceae family and is often used as a remedy for many infectious diseases. *Allium sativum* is widely grown around the world and originated in Asia before spreading globally. *Allium sativum* has substantial amounts of S-binding components, including alliin. *Allium sativum* contains volatiles like allicin and lipid-soluble sulfur compounds such as diallyl disulfide, ajoene, diallyl trisulfide, diallyl sulfide, and dithiols, which contribute to its distinct odor, flavor, and biological and therapeutic qualities. (Younas and Hussain 2014). Diabetes is commonly associated with dyslipidemia, a significant risk factor for cardiovascular disease. Based on existing data, *Allium sativum* is known to effectively treat diabetes and dyslipidemia. When compared to placebo, monitor, or baseline groups, garlic treatment significantly reduced serum Triglycerides (19–36%) and fasting blood glucose (18–56%). Combining garlic with metformin improves glycemic control and lipid profile in Type 2 diabetes patients (Ghorbani 2013).







2.2.1.9 Ocimum sanctum





Ocimum sanctum, popularly known as holy basil, is a Southeast Asian Ayurvedic herb with a long history of cultural use (Singh and Chaudhuri 2018). *O. sanctum* contains many chemical compounds that have been reported. The primary chemicals include eugenol methyl ether, caryophyllene, germacrene D, -elemene, and copaene. Eugenol methyl ether is a major component in *O. sanctum* (Saaban *et al.* 2019) Polyphenolic substances in methanol extract and its effective fractions (ethyl acetate/butanol) have been linked to anti-diabetic activity (Mousavi, Salleh, and Murugaiyah 2020; Jamshidi, Da Costa, and Cohen 2018).

2.2.1.10 Zingiber officinale

The product is made from fresh and dried roots of the Zingiberaceae plant, which is grown in India, Southeast Asia, Mexico, and other areas. The entire world (Banerjee *et al.* 2011). Zingerone was discovered to be a significant chemical ingredient and a stronger antioxidant than BHA (Singh *et al.* 2008). Ginger inhibits the alpha-glucosidase enzyme. is beneficial for treating type 2 diabetes (Hasimun *et al.* 2016). A methanolic extract of plant rhizomes has been shown to help regulate weight, lower fat content, and glucose levels (Ali *et al.* 2008). According to research, eating 1.2 g of ginger per day for 90 days can successfully treat type 2 diabetes by reducing LDL, total cholesterol, and blood sugar (Carvalho *et al.* 2020).

Table 1. List of Antidiabetic Medicinal plants and Their Effects.

Plant	Comman Name	Antidiabetic Effect	Reference
 <p><i>Costus igneus</i></p>	Insulin plant	Reduced blood glucose; improved liver enzyme levels	(Adriani <i>et al.</i> 2022; Hardikar <i>et al.</i> 2016)
 <p><i>Gymnema sylvestre</i></p>	Gurmar	Lowers blood glucose, Improves lipid profile.	(Rana and Avadhoot 1992)
 <p><i>Trigonella foenum-graecum</i></p>	Fenugreek	Improves insulin sensitivity , Stimulates insulin secretion	(Anwar <i>et al.</i> 2011)
 <p><i>Vaccinium myrtillus</i></p>	Bilberry	Improves lipid profile, Protects against oxidative stress-induced β -cell damage	(Gupta and Amartya De 2012)
 <p><i>Withania somnifera</i></p>	Ashwagandha	Decreased fasting and postprandial glucose, Reduced HbA1c and lipid levels	(Udayakumar <i>et al.</i> 2009)
 <p><i>Memordica Charantia</i></p>	Bitter melon	Improves insulin sensitivity, Lowers HbA1c and triglyceride levels	(Joseph and Jini 2013)

<p><i>Salacia reticulata</i></p> 	Meharimula	Delays carbohydrate digestion and glucose absorption, Enhances insulin sensitivity	(Rajashree, Bhat, and Ravishankar 2011)
<p><i>Allium sativum</i></p> 	Garlic	Lowers HbA1c and cholesterol, Improves glucose tolerance	(Ghorbani 2013)
<p><i>Ocimum sanctum</i></p> 	Holy Basil	Lowers HbA1c, Improves lipid profile (cholesterol, triglycerides)	(Singh and Chaudhuri 2018)
<p><i>Zingiber officinal</i></p> 	Ginger	Lowers HbA1c, Improves lipid profile	(Carvalho et al. 2020)

Conclusion

This review article discussed the medicinal plants that are often used in the treatment of diabetes. The plant parts, such as the leaf, have specialized extracts, such as acetone extract, that are more efficient. It has also been observed that various studies are being conducted in India and overseas with the goal of developing an effective diabetes medication. In India, various medicinal plants have been traditionally used in a variety of ways to treat diabetes. For the discovery of novel potential antidiabetic chemicals, appropriate information about medicinal plants is required. This article is intended to provide accurate information about medicinal plants with antidiabetic properties. The knowledge given here on medicinal plants may be useful for further research on diabetes.

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