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Review Article

Pharmacological Perspectives on Medicinal Plants for Diabetes Management

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ABSTRACT

The present review is limited to the pharmacological aspects of medicinal plants with reported antidiabetic activity. The increasing interest in plant based therapies is mainly due to the limitations and possible side effects of long-term use of some synthetic antidiabetic drugs. Consequently, numerous herbal plants have been scientifically studied for their potential in controlling blood glucose levels through diverse pharmacological mechanisms. The present review summarizes experimental evidence on selected medicinal plants with antihyperglycemic activity. The plant parts used, the types of extracts, the experimental models and the pharmacological outcomes observed in these studies are given special emphasis. The plants reviewed exhibited different mechanisms of reducing blood glucose levels including stimulation of insulin secretion, improvement of insulin sensitivity, inhibition of enzymes digesting carbohydrate, facilitation of peripheral glucose uptake and offering antioxidant protection to pancreatic β -cells. In general, this review covers the pharmacological effects of medicinal plants in diabetes and their importance as plant-based therapies.

INTRODUCTION

The pancreatic β -cells secrete the hormone insulin, which is essential for preserving appropriate blood glucose levels. It promotes the uptake of glucose into body tissues where it is used for energy production. Glucose cannot get into cells well if there is no insulin or if tissues become resistant to its effects. This causes a build up of glucose in the

blood stream giving rise to the clinical features of diabetes.⁽¹⁾

Diabetes mellitus represents a long-term metabolic condition defined by persistent hyperglycaemia, which occurs either due to insufficient insulin secretion or reduced cellular response to insulin. This disorder is also associated with increased production of reactive oxygen species (ROS), which contribute to tissue damage through non-

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enzymatic protein glycosylation and glucose auto-oxidation. Several clinical and experimental studies have indicated that oxidative stress plays a major role in both the onset of diabetes as well as its long-term complications, such as neuropathy, retinopathy, and nephropathy. Elevated oxidative stress in diabetic conditions is mainly due to reduced antioxidant defences and excessive ROS production caused by prolonged hyperglycaemia.^(2,5)

Diabetes is broadly classified into type 1 diabetes, type 2 diabetes, gestational diabetes, and other specific forms that may arise from pancreatic disorders, genetic defects, drug-induced conditions, or hormonal imbalances. Type 1 diabetes, also known as insulin-dependent diabetes mellitus (IDDM), accounts for approximately 10% of all diabetes cases and commonly occurs at a younger age. It results from autoimmune destruction of pancreatic β -cells, leading to absolute insulin deficiency. The presence of anti-insulin antibodies supports its autoimmune origin and genetic predisposition. Under conditions of severe hyperglycaemia, the lack of insulin forces the body to utilize lipids as an alternative energy source, resulting in the formation of ketone bodies.^(6,10) Many plants used in traditional medicine have demonstrated the ability to reduce blood glucose levels in both laboratory and clinical studies. Researchers are continuing to study how these plants work at the molecular and biochemical levels to control diabetes. This review discusses the importance of natural remedies and plant-based therapies in managing diabetes mellitus. Easily available medicinal plants may serve as affordable and effective sources for developing new antidiabetic drugs.⁽¹⁰⁾

METHODS:

A comprehensive literature review was conducted to collect and evaluate scientific evidence related

to the pharmacological perspectives of medicinal plants in the management of diabetes mellitus. Studies included in this review were gathered from a wide range of scientific sources such as PubMed, Scopus, Google Scholar, ScienceDirect, Web of Science, EMBASE, Springer, and ResearchGate.

Different search terms related to diabetes and medicinal plants were used in multiple combinations to collect relevant information. Commonly used keywords were medicinal plants, herbal medicine, diabetes mellitus, hyperglycemia, antidiabetic activity, insulin, oxidative stress, hypoglycemic effects. Other terms related to insulin resistance, pancreatic β -cell activity, glucose regulation, enzyme inhibition, phytochemicals, bioactive constituents, mechanism of action and toxicity were also searched to obtain wider pharmacological details.

Along with database searches, the reference lists of selected articles and review papers were carefully examined to trace other useful studies associated with the topic. The final selection of articles was mainly based on the relevance of the studies to the antidiabetic properties of medicinal plants, their active compounds, possible mechanisms involved, and reported safety aspects. Only peer-reviewed articles written in English and available in full-text form were included in this review.

Medicinal Plants in Diabetes Management

Medicinal plants have been important in traditional systems of healthcare for the treatment of diabetes for many years. Other recent scientific studies have also investigated some of the plant-based compounds that may potentially help in controlling blood glucose levels, improving insulin function and decreasing oxidative stress. These positive effects make medicinal plants more



and more attractive as relatively safe and useful alternatives for diabetes treatment.

Table 1. Summary of medicinal plants with antidiabetic activity and their proposed mechanisms of action

Plant name	Family	Plant part used	antidiabetic mechanism	Reference
<i>Momordica cymbalaria</i>	Cucurbitaceae	Leaves	α -Amylase inhibition, antioxidant activity	[11]
<i>Costus pictus</i>	Costaceae	Leaves	Increases insulin secretion, improves glucose use	[12]
<i>Artocarpus heterophyllus</i>	Moraceae	Fruits, seeds, leaves and bark	Enhances insulin release, inhibits carbohydrate-digesting enzymes	[13]
<i>Barleria grandiflora</i>	Acanthaceae	Leaves	Lowers blood glucose, antioxidant effect	[14]
<i>Moringa oleifera</i>	Moringaceae	Bark and leaves	Antihyperglycemic and antioxidant activity	[15]
<i>Jatropha integerrima</i>	Euphorbiaceae	Leaves	Lowers blood sugar and protect pancreatic cells	[16]
<i>Pongamia pinnata</i>	Fabaceae	Leaves	Inhibits α -amylase and α -glucosidase	[17]
<i>Phanera strychnifolia</i>	Fabaceae	Aerial parts	Enhances insulin secretion and glucose transport	[18]
<i>Ajuga integrifolia</i>	Lamiaceae	Leaves	Inhibits α -amylase, improves glucose uptake	[19]
<i>Centella asiatica</i>	Apiaceae	Leaves	Inhibits carbohydrate-digesting enzymes	[20]
<i>Crassula capitella</i>	Crassulaceae	Leaves and inflorescences	Antioxidant activity, enzyme inhibition	[21]
<i>Carica papaya</i>	Caricaceae	Seeds	Lowers blood glucose and oxidative stress	[22]
<i>Carissa</i> spp.	Apocynaceae	Stem	Improves glycemic control	[23]
<i>Clerodendrum infortunatum</i>	Lamiaceae	Leaves, Flowers	α -Amylase inhibition, antioxidant effect	[24]
<i>Dioscorea bulbifera</i>	Dioscoreaceae	Bulbs	Lowers blood glucose, antioxidant activity	[25]

Momordica cymbalaria

Momordica cymbalaria (Athalakkai) belongs to the family, Cucurbitaceae and is distributed throughout South India. It has been traditionally used for medicinal purpose like blood glucose regulation, antioxidant effect, anti-inflammatory effect, wound healing, fever reduction. Bioactive compounds present in the leaves such as phenolics, flavonoids, alkaloids, saponins, terpenoids etc. are responsible for these therapeutic properties. Different extraction methods like cold maceration, Soxhlet, reflux and ultrasonic techniques have

been used for extraction of these compounds. Cold maceration method has shown comparatively high antioxidant and antidiabetic activity as it could preserve phenolic and flavonoid contents better. The antidiabetic effect is mainly due to the inhibition of the alpha-amylase enzyme which delays the breakdown of carbohydrates and decreases the absorption of glucose and thus helps in controlling blood sugar levels. In conclusion, this plant is highly promising as a natural source for plant-based antidiabetic therapies. Further



studies are needed to isolate active constituents and mechanisms of action.^[11]

Costus pictus

Costus pictus, often referred to as the “insulin plant,” is well-known for its antidiabetic potential. Research conducted on diabetic rats induced with streptozotocin showed that treatment with methanolic extract of the plant helped changes associated with diabetes. Treatment was found the lower blood sugar 2 levels and improved several metabolic to lower blood glucose levels by nearly one-third while also improving liver and kidney function markers, including SGOT, SGPT, ALP, urea, and creatinine. The plant contains several bioactive constituents, including flavonoids, steroidal saponins, diosgenin, and β -sitosterol glycosides, These compounds are thought to play role in the medicinal effects of t an important he plant. They may support insulin secretion, help the body use glucose more effectively, decrease glucose production in the liver, and offer antioxidant benefits that assist in controlling oxidative stress and maintaining normal glucose metabolism. Overall *Costus pictus* has demonstrated beneficial antihyperglycemic, liver-protective, and kidney-protective properties, suggesting that it could be useful as a natural plant-based treatment approach for diabetes management.^[12]

Artocarpus heterophyllus Lam.

Artocarpus heterophyllus (jackfruit) is one of the tropical plants belonging to the family Moraceae which has been reported for its nutritional and medicinal importance . The plant contains various parts such as fruits, seeds, leaves and bark which are rich in bioactive compounds such as flavonoids, phenolics, tannins, saponins and phytosterols. The constituents possess several pharmacologic actions, of which the antidiabetic

effect is of particular interest. Research shows that extracts of this plant possess the ability to reduce blood glucose levels by stimulating insulin secretion, increasing peripheral glucose uptake and inhibiting carbohydrate-digesting enzymes such as α -amylase and α -glucosidase. Its antioxidant properties also help reduce oxidative stress associated with diabetes. Furthermore, jackfruit seeds are a source of dietary fiber and resistant starch, which can contribute to the control of the glycemic index by the delay of glucose absorption in the intestine. These results suggest that *Artocarpus heterophyllus* has potential as a natural source of antidiabetic nutraceuticals and plant-based therapies.^[13]

Barleria grandiflora

Barleria grandiflora, commonly known as Dev Koranti or Shwet Keshariya, is a medicinal plant from the Acanthaceae family widely distributed in India. Ethanolic extracts of the plant can help lower blood glucose levels and enhance liver function markers like SGOT, SGPT, and ALP, according to studies done on streptozotocin-induced diabetic rats. Compared to the diabetes control groups, the treated groups performed better. In addition to lowering blood sugar, the extract seems to boost antioxidant defense mechanisms, which may help lessen difficulties associated with diabetes.^[14]

Moringa oleifera

Moringa oleifera, widely known as the drumstick tree and a member of the Moringaceae family, has been extensively researched for its therapeutic and antioxidant properties, particularly in diabetes management. The effects of its bark and leaves methanolic extracts have been evaluated in studies using streptozotocin-induced diabetic rat models. The plant extracts were orally administered at the doses of 150 and 300 mg/kg for



14 days and metformin was used as the standard drug. The results showed that the treated groups had lower blood glucose levels with improved lipid profiles and better biochemical parameters compared with the untreated diabetic groups. Tissue analysis of the pancreas and liver also supported these findings, as the extracts seemed to provide protection against the tissue damage associated with diabetes. The bark extract exhibited the maximum antidiabetic response among the tested samples. Overall, these observations indicate that *Moringa oleifera* has considerable potential for controlling diabetes and its related complications.^[15]

Jatropha integerrima

Jatropha integerrima, a medicinal plant belonging to the Euphorbiaceae family, is known for its antioxidant and therapeutic properties. Its antidiabetic potential has been studied using methanolic leaf extracts in streptozotocin-induced diabetic rat models. Oral administration of the extract at doses of 200 and 400 mg/kg for 21 days resulted in a significant decrease in fasting blood glucose levels and improved glucose tolerance compared to untreated diabetic groups. The treatment also positively influenced lipid metabolism by reducing total cholesterol, triglycerides, LDL, and VLDL levels, while increasing HDL levels. In addition, enhanced antioxidant enzyme activity, including superoxide dismutase and catalase, was observed. Histopathological studies indicated partial recovery of pancreatic islet structure, suggesting protective effects on β -cells. These results highlight the potential of *Jatropha integerrima* as a natural source with antidiabetic, antihyperlipidemic, and antioxidant benefits, supporting its role in managing diabetes and associated metabolic disorders.^[16]

***Pongamia pinnata* Pierre**

Pongamia pinnata (L.) Pierre, commonly known as Karanja, belongs to the Fabaceae family and has been traditionally used in traditional Indian medicinal systems for treating various diseases, including diabetes. A study by Swarnkar et al. (2026) evaluated the antidiabetic potential of *P. pinnata* leaf extracts using *in silico*, *in vitro*, and *in vivo* approaches. GC-MS analysis identified several phytoconstituents in the extracts, among which 2,7-diphenyl-1,6-dioxopyridazopyrrolopyridazine showed strong binding affinity toward α -amylase and α -glucosidase enzymes, suggesting inhibition of carbohydrate metabolism. In streptozotocin-induced diabetic rats, ethanolic and ethyl acetate extracts (200 and 400 mg/kg) led to a marked decrease in blood glucose levels and demonstrated stronger antihyperglycemic effects than metformin. Histopathological examination further showed improvement in pancreatic and renal tissue architecture. These findings indicate that *P. pinnata* leaf extracts possess promising antidiabetic potential, possibly mediated through inhibition of carbohydrate-digesting enzymes and modulation of glucose metabolism.^[17]

Phanera strychnifolia

Phanera strychnifolia, commonly known as Yanang Daeng, is a therapeutic plant classified 13 under the Fabaceae family and has been traditionally used across Southeast Asia to manage metabolic disorders. Studies have demonstrated that the aqueous extract of *P. strychnifolia* exhibits significant antihyperglycemic activity in high-fat diet by streptozotocin. Oral dosing notable reduction of the 5 and diabetic rat models induced extract (100 and 200 mg/kg for 14 days) resulted in a in fasting blood glucose in t levels and improved tissue-level changes observed he pancreas and liver. The extract also enhanced insulin production and increased the expression of glucose transporter proteins GLUT2 and GLUT4,



indicating improved glucose uptake and utilization. These pharmacological effects are mainly attributed to active phytochemical constituents including 3,5,7-trihydroxychromone-3-O- α -L-rhamnopyranoside and 3,5,7,3',5'-pentahydroxyflavanonol-3-O- α -L-rhamnopyranoside, which inhibit α -amylase and α -glucosidase enzymes. Additionally, toxicity studies reported no significant adverse effects after prolonged use, suggesting that *P. strychnifolia* may serve as a promising natural therapeutic candidate for diabetes management.^[18]

Ajuga integrifolia

Ajuga integrifolia, commonly known as Bugleweed (locally called Harmagussa in Afaan Oromo and Akorarach in Amharic), is classified as a medicinal plant under the Lamiaceae family and is traditionally used in Ethiopia to treat diabetes and other ailments. The antidiabetic activity of the plant was studied using both laboratory methods and diabetic mice models. Phytochemical studies showed the presence of compounds such as flavonoids, phenols, alkaloids and saponins. The hydromethanol extract showed promising α -amylase inhibitory activity which could be useful for delaying the digestion of carbohydrates. The extract was given orally at doses of 500 and 1000 mg/kg for 14 days to streptozotocin-induced diabetic mice. The fasting blood glucose levels were significantly reduced after treatment. The aqueous fraction showed better antihyperglycemic activity than the other fractions tested. The extract also helped improve glucose tolerance in oral glucose-loaded models and produced a mild blood glucose-lowering effect in normal mice. These effects may be linked to increased insulin secretion, better glucose uptake and utilization, reduced activity of carbohydrate-digesting enzymes, and antioxidant properties of the plant. Acute toxicity studies did not show any major

harmful effects, with the LD50 reported to be above 5000 mg/kg, indicating that the extract is relatively safe. Overall, *Ajuga integrifolia* demonstrates strong potential as a natural therapeutic option for diabetes management, supporting its traditional use.^[19]

Centella asiatica

Centella asiatica (L.) Urban, commonly known as Gotu Kola or Brahmi, is recognized as a medicinal plant belonging to the Apiaceae family and has been traditionally used in Ayurveda and other systems for managing metabolic disorders. In this research, polysaccharides isolated from its leaves were evaluated for their structural characteristics and antidiabetic potential. The purified fraction (P50-2 A), identified as an acidic heteropolysaccharide with a molecular weight of 3014 kDa, demonstrated significant inhibitory activity against α -amylase and α -glucosidase enzymes in a dose dependent manner, indicating its ability to regulate carbohydrate metabolism. Structural analysis revealed that it is an arabinogalactan composed of multiple monosaccharides, including galactose, arabinose, glucose, and uronic acids, which contribute to its biological activity. The polysaccharide also exhibited a semi-crystalline structure with a porous morphology, potentially enhancing its interaction with enzymes. These findings suggest that *Centella asiatica* polysaccharides possess promising antidiabetic potential, likely mediated through enzyme inhibition and modulation of glucose metabolism, and could serve as a natural therapeutic option for diabetes management.^[20]

Crassula capitella

Crassula capitella, commonly known as Red Pagoda or Campfire plant, is a succulent species belonging to the Crassulaceae family and has shown promising antioxidant and antidiabetic



potential. Methanolic extracts of its leaves and inflorescences contain bioactive compounds such as terpenoids, flavonoids, and phenolics. The extracts exhibited significant antioxidant activity in DPPH and ABTS assays, along with inhibitory effects on α -amylase and α -glucosidase enzymes, indicating their role in controlling postprandial hyperglycemia. The inflorescence extract showed comparatively stronger activity, likely due to its higher phenolic and flavonoid content. These findings suggest that *Crassula capitella* could act as a potential natural therapeutic option for diabetes management, although further in vivo and clinical studies are required.^[21]

Carica papaya L

Carica papaya L., commonly known as Papaya, is a tropical plant belonging to the Caricaceae family with potential antidiabetic activity. In this study, the chloroform extract obtained from papaya seeds and lipids was tested for its antidiabetic activity using alloxan-induced diabetic rat models. The extract produced a significant reduction in fasting blood glucose levels and also improved body weight over a period of 21 days, with higher doses showing better effectiveness. The extract also helped to improve the lipid profile by reducing total cholesterol, triglycerides, and LDL levels while increasing HDL levels. It further showed protective effects on liver and kidney functions by bringing altered biochemical parameters closer to normal values. Toxicity studies revealed no significant harmful effects, with an LD₅₀ value greater than 5000 mg/kg, indicating that the extract appears to be safe. The study findings demonstrate that *Carica papaya* may offer beneficial antidiabetic and antioxidant effects, suggesting its usefulness as a natural remedy for controlling diabetes and associated oxidative stress.^[22]

Carissa spp

Carissa species (Family: Apocynaceae), commonly known as karonda, is a medicinal plant widely used in traditional medicine. In vivo evaluation of the ethanolic stem extract revealed its possible antidiabetic effect in streptozotocin-treated rat models. A significant decline in blood glucose levels was observed following oral administration of the extract and improved overall glycemic control compared to diabetic control animals. The treatment was also found to strengthen the antioxidant defense system by increasing the levels of key antioxidant enzymes such as superoxide dismutase, catalase, and glutathione, while reducing markers associated with oxidative stress. Improvements in glycosylated hemoglobin and other serum biochemical parameters were also observed, suggesting better control of metabolic activity. Histopathological examination further indicated that the treatment helped protect the normal structure of pancreatic tissues. The study highlights the potential of *Carissa* in diabetes care, as it showed beneficial effects against elevated blood glucose levels and oxidative stress.^[23]

Clerodendrum infortunatum L

Clerodendrum infortunatum L. belongs to Family Lamiaceae and commonly known as bhant or hill glory bower, is a medicinal plant widely distributed in tropical regions of India and Southeast Asia. An in vitro study evaluated the antidiabetic potential of leaf and flower extracts prepared using different solvents. The study results indicated that both extracts possessed noticeable α -amylase inhibitory activity, which may help in controlling the rise in blood glucose levels after meals. Extracts prepared with polar solvents, particularly distilled water and isopropyl alcohol, showed better antidiabetic effects when compared with chloroform extracts. The stronger activity of these extracts could be attributed to the



presence of important phytochemicals such as flavonoids, phenolic compounds, and tannins. The results provide evidence that *Clerodendrum infortunatum* possesses beneficial antihyperglycemic properties, reinforcing its traditional application in the treatment of diabetes. [24]

Dioscorea bulbifera

Dioscorea bulbifera (Family: Dioscoreaceae), commonly known as air potato, is a medicinal plant traditionally used for diabetes management. The antidiabetic activity of the bulb ethanolic extract was studied in an in vivo experimental model using alloxan-induced diabetic Wistar rats. The extract was administered orally at two different doses for 21 days which showed a marked reduction in blood glucose levels and improvement in hyperglycemia compared to untreated diabetic group. Moreover, it exhibited hepatoprotective and nephroprotective effect and improved the lipid profile parameters. The extract also enhanced antioxidant defense by increasing the levels of enzymes such as superoxide dismutase, catalase and glutathione along with a reduction in oxidative stress markers. The effects are attributed to the bioactive compounds such as flavonoids, alkaloids and phenolic constituents that may enhance glucose utilization and may reduce oxidative stress. In conclusion, the results provide a basis for the potential of *Dioscorea bulbifera* (air potato) as a natural antidiabetic agent in the management of diabetes and its complications. [25]

CONCLUSION

The present review concludes that a wide variety of medicinal plants, including *Ajuga integrifolia*, *Carissa* species, *Clerodendrum infortunatum*, *Dioscorea bulbifera*, and several others, possess notable antidiabetic potential supported by

scientific findings. Both laboratory and animal-based studies have demonstrated that these plants can help lower blood glucose levels, improve glucose tolerance, and support overall metabolic function. Their antidiabetic activity is mainly associated with mechanisms such as inhibition of α -amylase and α glucosidase enzymes, increased insulin secretion and sensitivity, improvement in lipid profiles, and reduction of oxidative stress. Protective effects on important organs such as the pancreas, liver, and kidneys may also contribute to better management of diabetes-related complications. Bioactive compounds including flavonoids, phenolic compounds, alkaloids, and saponins are thought to play a major role in producing these therapeutic benefits. Overall, this review emphasizes the potential of these medicinal plants as affordable and effective natural alternatives for diabetes management. However, additional clinical studies and proper standardization are still necessary to confirm their safety, efficacy, and therapeutic use in humans.

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