

Chapter 7

Plants useful in secondary complications in diabetic patients

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Abstract: Diabetes mellitus is a long-term metabolic condition that can lead to a variety of complications affecting different organ systems. The present chapter delves into the healing potential of 30 medicinal plants that have been highlighted in peer-reviewed studies for their roles in managing the secondary complications. These plants, related to various botanical families, such as Amaryllidaceae, Zingiberaceae, Fabaceae and Apocynaceae, have shown effectiveness against issues like diabetic nephropathy, retinopathy, neuropathy, diabetic foot ulcers, cardiovascular disease, peripheral artery disease and even neuropsychiatric conditions like depression and dementia. Notable bioactive compounds, including allicin from garlic (*Allium sativum*), curcumin from turmeric (*Curcuma longa*), andrographolide from neem (*Andrographis paniculata*) and eugenol from cloves (*Syzygium aromaticum*), provide protective benefits through their antioxidant, anti-inflammatory, neuroprotective and cytoprotective properties. The findings of the study highlight the important ethnopharmacological significance of these plants and suggest their potential use as complementary treatments in the clinical management of diabetic complications.

Keywords: Cytoprotective, ethnopharmacology, healing potential, neuropsychiatric

Introduction

Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia due to impaired insulin secretion, defective insulin action or both (Galicia-Garcia *et al.*, 2020; Antar *et al.*, 2023). With an estimated 537 million adults affected worldwide, it represents one of the most pressing global public health challenges of the modern era (Hossain *et al.*, 2024; Chen *et al.*, 2026). While the primary metabolic disturbances of DM are well documented, the secondary complications arising from prolonged glycemic dysregulation contribute most significantly to patient morbidity, mortality and healthcare burden (Tomic *et al.*, 2022). These complications span both microvascular and macrovascular systems (Antar *et al.*, 2023). Microvascular complications include diabetic nephropathy, a leading cause of end-stage renal disease; diabetic retinopathy, the foremost cause of new-onset blindness in working-age adults and peripheral neuropathy, affecting nearly half of all individuals with long-standing DM (Yapisslar and Gurler, 2024). Macrovascular complications encompass cardiovascular disease, peripheral artery disease and cerebrovascular disorders, all accelerated by dyslipidaemia and chronic systemic inflammation (Poledniczek *et al.*, 2023; Roy, 2025). Patients may additionally suffer from diabetic foot ulcers, impaired wound healing, xerostomia, sexual dysfunction, bone disorders and neuropsychiatric conditions such as depression and dementia (Bahari, 2015; Raja *et al.*, 2023). Conventional pharmacological management of these complications, though effective, is frequently limited by adverse effects, therapeutic gaps and high economic cost, particularly in low- and middle-income countries bearing the greatest diabetic burden (Nikpour *et al.*, 2022; Butt *et al.*, 2024). This has generated considerable scientific interest in plant-based therapeutic alternatives. Traditional medicine systems, including Ayurveda, Unani and Traditional Chinese Medicine, have long employed medicinal plants for diabetic ailments and modern pharmacological research has progressively validated these practices (Murudkar *et al.*, 2022; Rizvi *et al.*, 2022). Bioactive phytoconstituents such as polyphenols, flavonoids, alkaloids, terpenoids and organosulfur compounds have demonstrated antioxidant, anti-inflammatory, neuroprotective, nephroprotective and cardioprotective properties in experimental and clinical settings (Riaz *et al.*, 2023; Rodriguez-Negrete *et al.*, 2024). The present documentation reviews 30 scientifically reported medicinal plants with established relevance to the secondary complications of diabetes mellitus, detailing their botanical identity, targeted complications, mechanisms of therapeutic action and supporting literature, to provide a consolidated evidence-based reference for researchers and clinicians in this field.

Methodology

The present chapter dives deep into a thorough review of published literature sourced from peer-reviewed journals and electronic databases like PubMed, Google Scholar, Scopus and ScienceDirect. Keywords such as "medicinal plants", "diabetic complications", "diabetic neuropathy", "diabetic nephropathy", "diabetic retinopathy" and "phytochemicals" were used to guide the search. The gathered data have been organized and presented in a clear way to showcase the therapeutic potential, active phytoconstituents and mechanisms of action of plants that can help manage secondary complications in diabetic patients (Jena *et al.*, 2025; Kumar, 2025).

Results and discussion

The present investigation noted a total of 30 medicinal plants from 25 different botanical families for their potential benefits in treating secondary complications related to diabetes (Table 1; Plate 1; Figure 1). These plants were grouped into seven categories based on the complications they address, such as, diabetic nephropathy (like *Allium sativum*, *Phyllanthus emblica* and *Trigonella foenum-graecum*), retinopathy (including *Curcuma longa*, *Andrographis paniculata* and *Zingiber zerumbet*), neuropathy (featuring *Gymnema sylvestre*, *Withania somnifera*, *Momordica dioica* and *Momordica charantia*), diabetic foot and wound healing (such as *Aloe vera* and *Azadirachta indica*), cardiovascular and peripheral vascular diseases (like *Moringa oleifera*, *Terminalia arjuna* and *Centella asiatica*), neuropsychiatric conditions (including *Crocus sativus* and *Punica granatum*) and other related complications (like *Tribulus terrestris* and *Ferula asafoetida*). The main mechanisms of action identified were antioxidant properties, anti-inflammatory effects, cytoprotection, glycemic control and the prevention of advanced glycation end product buildup. Among the plants reviewed, diabetic nephropathy and retinopathy were the most commonly targeted complications.

Table 1: Plants traditionally used for secondary complications in diabetes

Plant name	Common name	Family	Complications	Medicinal significance	Sources
<i>Allium sativum</i> L.	Garlic (E)	Amaryllidaceae	Diabetic nephropathy	Contains sulfur compounds like allicin, which protect kidney tissues through anti-	Buendia <i>et al.</i> , (2023)

				inflammatory and antioxidant properties.	
<i>Aloe vera</i> (L.) Burm.f.	True aloe (E)	Asphodelaceae	Diabetic foot ulcer, wound healing and tissue regeneration	It significantly enhances bone regeneration and soft tissue healing. It also reduces severe joint and muscle pain associated with related inflammatory conditions.	Sandhiya, (2025)
<i>Andrographis paniculata</i> (Burm.f.) Wall. ex Nees	Green Chireita (E)	Acanthaceae	Diabetic retinopathy	Contains andrographolide, which helps mitigate blood-retinal barrier breakdown and inflammation.	Tabari <i>et al.</i> , (2022)
<i>Azadirachta indica</i> A.Juss.	Neem (H)	Meliaceae	Diabetic foot	Due to its potent antimicrobial properties, the extract is used for wound irrigation to reduce infection and promote healing.	Jayalakshmi <i>et al.</i> , (2021)
<i>Centella asiatica</i> (L.) Urb.	Indian pennywort (E)	Apiaceae	Peripheral artery disease	Stimulates collagen production, aiding in the healing of blood vessel walls and tissues.	Samuel <i>et al.</i> , (2022)
<i>Cinnamomum burmanni</i> (Nees & T.Nees) Blume	Cinnamon (E)	Lauraceae	Diabetic nephropathy	Acts as an anti-diabetic agent that prevents the	Moreira <i>et al.</i> , (2023)

				accumulation of advanced glycation end products in the kidneys, which are major drivers of damage.	
<i>Cissus quadrangularis</i> L.	Hadjod (H)	Vitaceae	Bone and joint issues	Traditionally used to strengthen bone tissue and speed up healing.	Azam <i>et al.</i> , (2023)
<i>Commiphora wightii</i> (Arn.) Bhandari	Guggul (E)	Burseraceae	Peripheral artery disease	Recommended in Ayurveda for its lipid-lowering and anti-inflammatory effects, which support overall vascular health.	Alwadhi, (2021)
<i>Crocus sativus</i> L.	Saffron (E)	Iridaceae	Depression	It reduces the severity of depression similarly to synthetic antidepressants, improves glycemic indices and increases mood-regulating neurotransmitters in the brain.	Siddiqui <i>et al.</i> , (2018)
<i>Curcuma longa</i> L.	Turmeric (E)	Zingiberaceae	Diabetic retinopathy	Curcumin from turmeric help prevent retinal swelling, improve visual acuity, and decrease levels of vascular	Wang <i>et al.</i> , (2025)

				endothelial growth factor.	
<i>Eleusine coracana</i> (L.) Gaertn.	Finger millet (E)	Poaceae	Diabetic ketoacidosis	Ferulic acid in this grain is reported to have renal protective effects by improving glycemic control and reducing structural changes in the kidney.	Chaudhary and Mudgal, (2020)
<i>Ferula asafoetida</i> L.	Asafoetida (E)	Apiaceae	Pancreatic tissue damage	It contributes to preserving the integrity of pancreatic beta-cells, assisting in better insulin regulation.	Abu-Zaiton, (2010)
<i>Ginkgo biloba</i> L.	Maidenhair tree (E)	Ginkgoaceae	Diabetic nephropathy	It has been found to improve renal tissue structure and reduce urinary albumin excretion in diabetic patients.	Zhang <i>et al.</i> , (2013)
<i>Gymnema sylvestre</i> (Retz.) R.Br. ex Sm.	Gurmar (E)	Apocynaceae	Diabetic neuropathy	It helps lower blood sugar and may reduce the uncomfortable sensations of nerve damage.	Fatani <i>et al.</i> , (2015)
<i>Hibiscus × rosa-sinensis</i> L.	Hibiscus (E)	Malvaceae	Xerostomia (dry mouth)	Reduces oxidative stress to improve salivary gland function.	Montalvo-Gonzalez <i>et al.</i> , (2022)

<i>Linum usitatissimum</i> L.	Flaxseed (E)	Linaceae	Diabetic foot	Rich in omega-3 fatty acids, it helps repair damaged blood vessels and improves vascular health, which is critical for preventing foot complications.	Goyal <i>et al.</i> , (2014)
<i>Momordica charantia</i> L.	Bitter gourd (E)	Cucurbitaceae	Diabetic neuropathy	Improve insulin function and may reduce the decline in nerve function.	Richter <i>et al.</i> , (2023)
<i>Momordica dioica</i> Roxb. ex Willd.	Spiny gourd (E)	Cucurbitaceae	Diabetic neuropathy	Reduces blood sugar level and oxidative stress.	Sharma <i>et al.</i> , (2024)
<i>Moringa oleifera</i> Lam.	Drumstick (E)	Moringaceae	Cardiovascular disease	Protects cardiac antioxidant status and lowers blood pressure and cholesterol.	Alia <i>et al.</i> , (2022)
<i>Phyllanthus emblica</i> L.	Amla (H)	Phyllanthaceae	Diabetic nephropathy	Contains gallic and ellagic acids that effectively scavenge free radicals and help normalize plasma creatinine and uric acid levels.	Das <i>et al.</i> , (2025)
<i>Pterocarpus marsupium</i> Roxb.	Indian kino tree (E)	Fabaceae	Cardiovascular disease	Clinically established for its potent antidiabetic and cardioprotective effects.	Thalkari <i>et al.</i> , (2019)

<i>Pueraria montana</i> var. <i>lobata</i> (Willd.) Maesen & S.M. Almeida ex Sanjappa & Predeep	Kudzu vine (E)	Fabaceae	Diabetic retinopathy	Contains Pueraria, which may protect against retinal cell death and suppress cell damage.	Kang <i>et al.</i> , (2019)
<i>Punica granatum</i> L.	Pomegranate (E)	Lythraceae	Dementia	The flower powder supplementation can improve learning and memory impairment caused by diabetes. The compound helps in reducing oxidative stress, which is a common factor in both conditions.	Cambay <i>et al.</i> , (2011)
<i>Rubia cordifolia</i> L.	Indian madder (E)	Rubiaceae	Diabetic retinopathy and neuropathy	Traditionally used for its calming effect on the nervous system and to treat symptoms like retinopathy and neuropathy.	Bana <i>et al.</i> , (2023)
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Arjuna (H)	Combretaceae	Cardiovascular disease	Widely used for congestive heart failure, coronary artery disease, and protecting the heart from injury.	Ramesh and Palaniappan, (2023)
<i>Tribulus terrestris</i> L.	Puncture vine (E)	Zygophyllaceae	Sexual dysfunction	Increase testosterone levels and improve	Stefanescu <i>et al.</i> , (2021)

				sexual behaviour in diabetic conditions.	
<i>Trigonella foenum-graecum</i> L.	Fenugreek (E)	Fabaceae	Diabetic nephropathy	It reduces renal oxidative stress and blood sugar levels. Its active component, 4-hydroxyisoleucine, helps regulate inflammatory responses in the kidney.	Niu <i>et al.</i> , (2025)
<i>Vitis vinifera</i> L.	Grape	Vitaceae	Peripheral artery disease	Rich in proanthocyanidins, used to treat poor circulation symptoms like leg heaviness and tingling.	Jin <i>et al.</i> , (2013)
<i>Withania somnifera</i> (L.) Dunal	Ashwagandha (H)	Solanaceae	Diabetic neuropathy	It can help relax strained muscles and improve blood flow to nerves, which may reduce pain and fatigue.	Paul <i>et al.</i> , (2021)
<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm.	Pinecone ginger (E)	Zingiberaceae	Diabetic retinopathy	Its constituent, zerumbone, shows strong potential in preventing retinal vascular leakage.	Yong <i>et al.</i> , (2024)

(E: English; H: Hindi & S: Sanskrit)

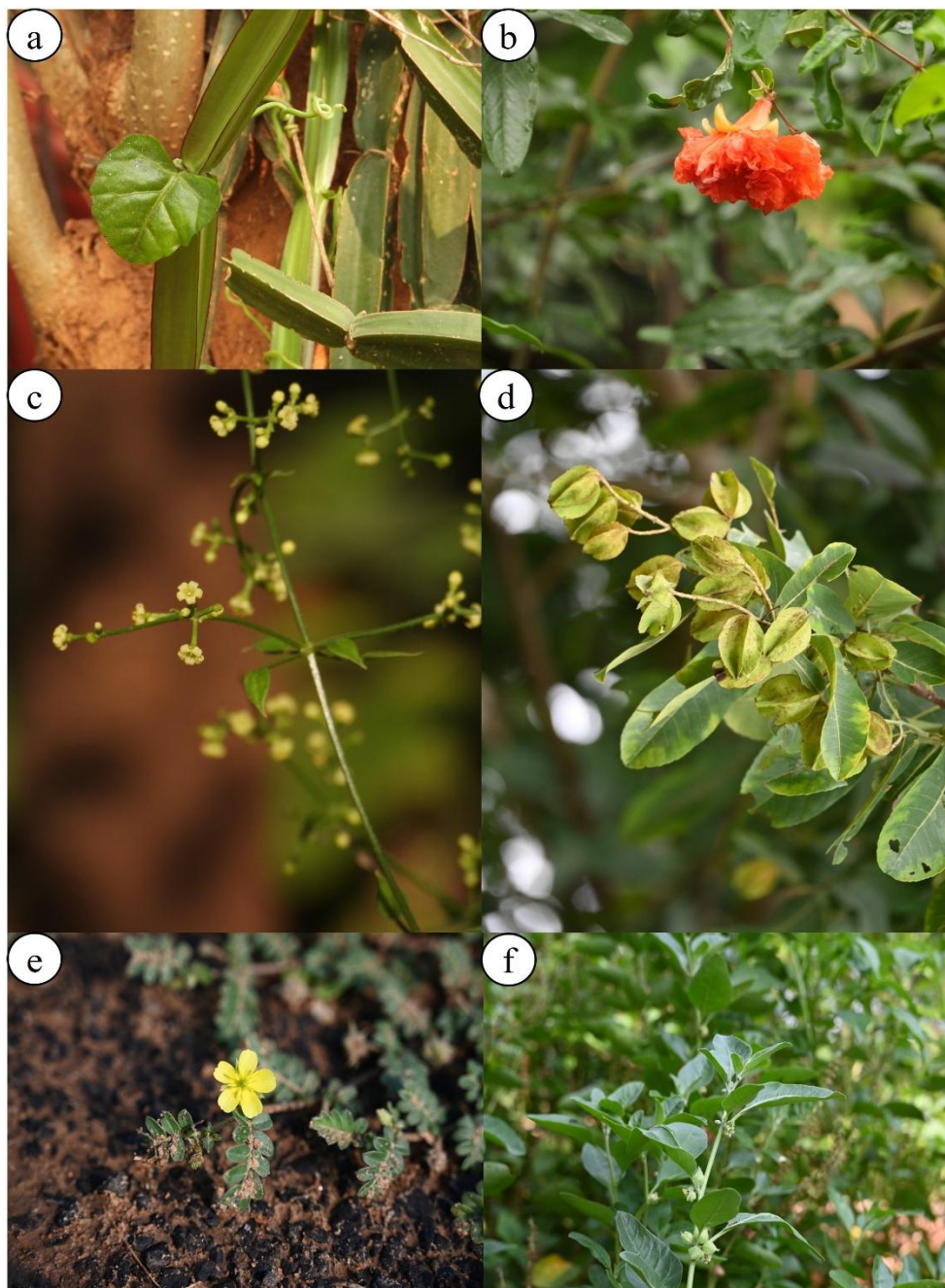


Plate 1: Some common plants used in secondary complications of diabetes, such as, (a) *Cissus quadrangularis*, (b) *Punica granatum*, (c) *Rubia cordifolia*, (d) *Terminalia arjuna*, (e) *Tribulus terrestris* and (f) *Withania somnifera*

The plants reviewed in the study suggest that oxidative stress and chronic inflammation are key players in most secondary complications of diabetes. For instance, polyphenol-rich plants like *Phyllanthus emblica* and *Ginkgo biloba* do a great job of neutralizing harmful reactive oxygen species in the kidneys and eyes. Meanwhile, *Curcuma longa* and *Andrographis paniculata* work to suppress inflammation (Pipitone *et al.*, 2023). There are some specific actions tied to certain complications, such as *Cinnamomum burmanni* helping with nephropathy by inhibiting advanced glycation end products (AGEs) (Budiastuti *et al.*, 2025), *Ferula assa-foetida* preserving beta cells and *Crocus sativus* modulating neurotransmitters in cases of diabetic depression (Shaikh *et al.*, 2025). However, there are still some hurdles to overcome, like the lack of standardized extracts, insufficient pharmacokinetic data and a shortage of large-scale clinical trials. Moving forward, future research must focus on well-designed randomized controlled trials and thorough pharmacokinetic profiling to back up these promising plant-based treatments.

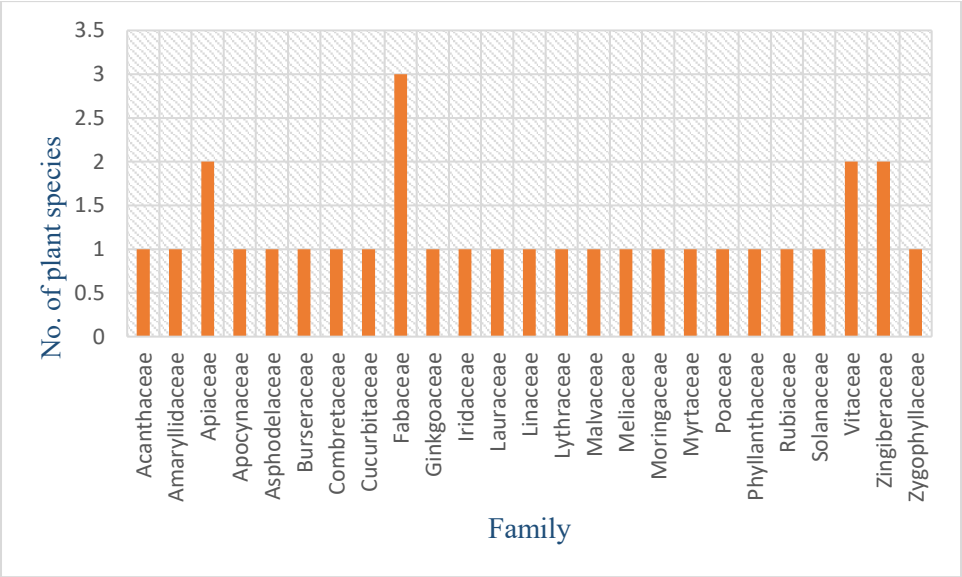


Figure 1: Several plant species used in diabetic complications

Conclusion

The present study documented 30 plant species that showcase impressive therapeutic potential for tackling the secondary complications of diabetes mellitus. They work through various mechanisms, such as antioxidant effects, anti-inflammatory properties, cytoprotection and glycemic control,

addressing a wide range of complications from nephropathy and retinopathy to cardiovascular issues and neuropathy. When integrated as evidence-based complementary therapies and with further clinical validation, these plants could significantly enhance the overall management of diabetic complications.

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