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Herbal Medicines in the Management of Diabetes: Ethnobotanical Insights and Pharmacological Perspectives

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A B S T R A C T

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia due to defects in insulin secretion, insulin action, or both. Despite the availability of synthetic antidiabetic drugs, their long-term use is often associated with adverse effects and limited efficacy in managing complications. In recent decades, there has been a growing interest in the use of herbal medicines as complementary or alternative therapeutic options for diabetes management. This review provides comprehensive ethnobotanical insights into medicinal plants traditionally used across different cultures for their antidiabetic potential. It highlights key herbal species, their traditional uses, and the phytoconstituents responsible for glycemic control. Furthermore, the review discusses the pharmacological mechanisms underlying their antidiabetic activities, including insulin mimetic effects, β-cell protection, inhibition of carbohydrate-hydrolyzing enzymes, and antioxidant actions. Several plant-derived compounds such as flavonoids, alkaloids, saponins, and terpenoids have shown promising results in preclinical studies. By integrating ethnobotanical knowledge with pharmacological evidence, this review underscores the potential of herbal medicines as effective and safer alternatives for diabetes management and encourages further research and clinical validation.

Keywords: Herbal medicine, Diabetes mellitus, Ethnobotany, Plant-based therapy, Phytochemicals and Pharmacological mechanisms

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INTRODUCTION

Diabetes Mellitus (DM) is a heterogeneous group of chronic metabolic disorders characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. It encompasses a complex interplay of genetic, epigenetic, environmental, and immunological factors that disrupt glucose homeostasis and affect lipid and protein metabolism.[1] The classification of diabetes includes Type 1 Diabetes Mellitus (T1DM), an autoimmune destruction of pancreatic β-cells leading to absolute insulin deficiency; Type 2 Diabetes Mellitus (T2DM), which involves a progressive insulin secretory defect on the background of insulin resistance; gestational diabetes mellitus (GDM); and other specific types resulting from genetic defects, endocrinopathies, or pharmacologic interventions. The pathophysiology of diabetes involves intricate molecular signalling pathways, chronic low-grade inflammation, and oxidative stress, which contribute to β-cell dysfunction and insulin resistance.[2] In the long term, chronic hyperglycemia is associated with microvascularcomplications such as nephropathy, retinopathy, and neuropathy, as well as macrovascular complications including coronary artery disease, cerebrovascular disease, and peripheral arterial disease. The global burden of diabetes continues to escalate, driven by increasing obesity rates, sedentary lifestyles, and population aging, positioning it as a major public health challenge with significant socioeconomic implications. Advancements in genomics, metabolomics, and personalized medicine are redefining the understanding and management of diabetes, enabling stratified therapeutic approaches and early intervention strategies. However, despite substantial progress, optimal glycemic control and prevention of complications remain elusive for many patients, underscoring the need for continued research and innovation in diabetes care and prevention.[3]

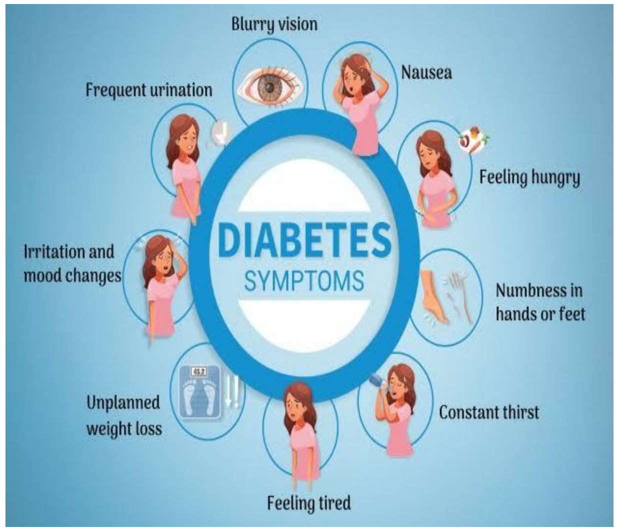

Figure1: Common symptoms of Diabetics

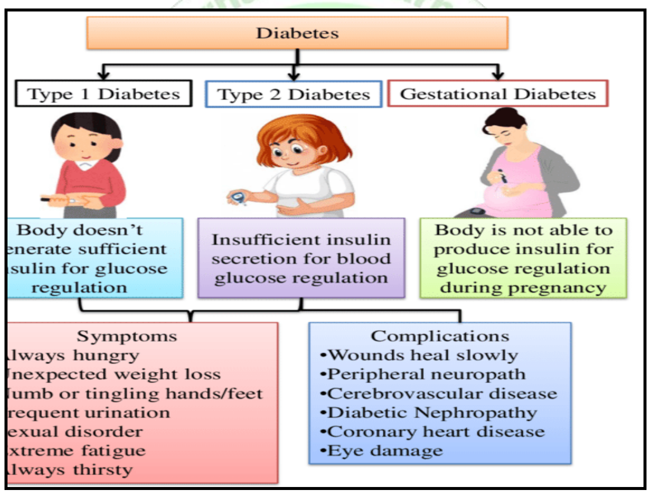

Figure 2: Types of Diabetics

Types of Diabetes Mellitus

Type 1 Diabetes Mellitus (T1DM)

Type 1 diabetes is a chronic autoimmune disease where the body's immune system mistakenly attacks and destroys insulin-producing beta cells in the pancreas, leading to an absolute deficiency of insulin. This results in elevated blood glucose levels (hyperglycemia) because insulin is crucial for glucose uptake into cells and overall metabolic regulation. Without sufficient insulin, the body cannot effectively utilize glucose for energy, and it can lead to serious complications if not managed with insulin therapy.[4]

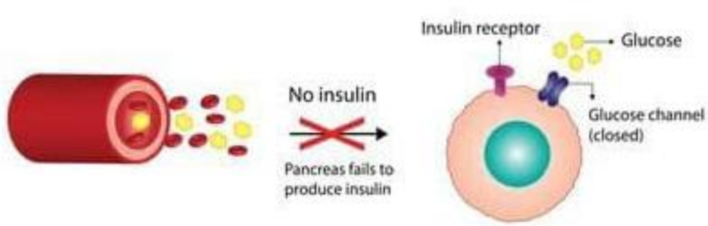

Figure 3: Type 1 Diabetes mellitus

Etiology and Autoimmune Mechanisms

T1DM is an organ-specific autoimmune disease characterized by selective destruction of pancreatic β-cells. The genetic predisposition is most strongly associated with HLA class II alleles (e.g., HLA-DR3, DR4, DQ2, DQ8), although over 50 non-HLA loci have also been implicated through genome-wide association studies (e.g., INS, PTPN22, CTLA4). Environmental triggers, such as viral infections (particularly enteroviruses), early dietary exposures (e.g., cow's milk proteins, gluten), and microbiotadysbiosis, may initiate or accelerate autoimmunity. The autoimmune process involves: Infiltration of pancreatic islets by CD4+ and CD8+ T-cells Generation of islet-specific autoantibodies (GAD65, IA-2, insulin autoantibodies, ZnT8) Impaired central and peripheral tolerance mechanisms.[5]

β-Cell Destruction and Consequences.

Metabolic destruction of β-cells leads to an absolute insulin deficiency, resulting in: Impaired glucose uptake in skeletal muscle and adipose tissue Increased hepatic gluconeogenesis and glycogenolysis Enhanced lipolysis and ketone body production this metabolic dysregulation culminates in diabetic ketoacidosis (DKA), particularly in undiagnosed or insulin-deprived Iindividuals.[6,7]

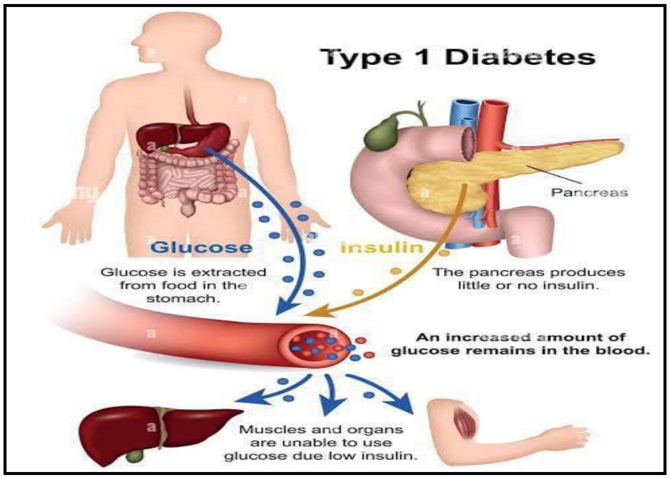

Figure 4: Pathogenesis of type 1diabetes

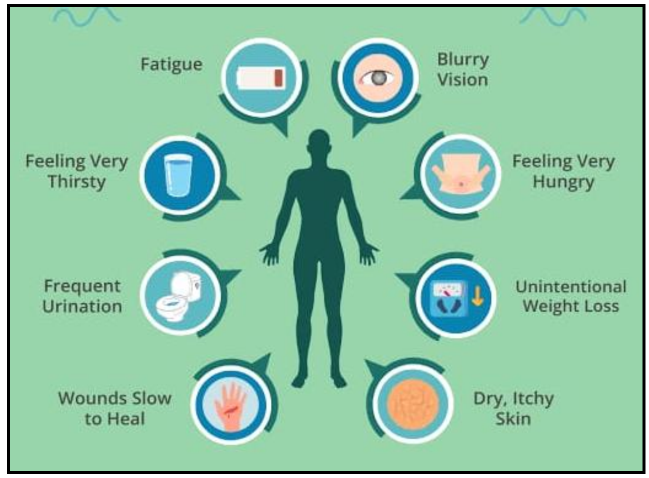

Figure 5: Symptoms of type 1diabetes

Type 2 Diabetes Mellitus (T2DM)

Type 2 diabetes is a chronic metabolic disorder characterized by elevated blood glucose levels due to either insufficient insulin production, insulin resistance in target cells (like muscle, fat, and liver), or a combination of both. This leads to the body's inability to effectively utilize glucose for energy, causing it to accumulate in the bloodstream.[1]

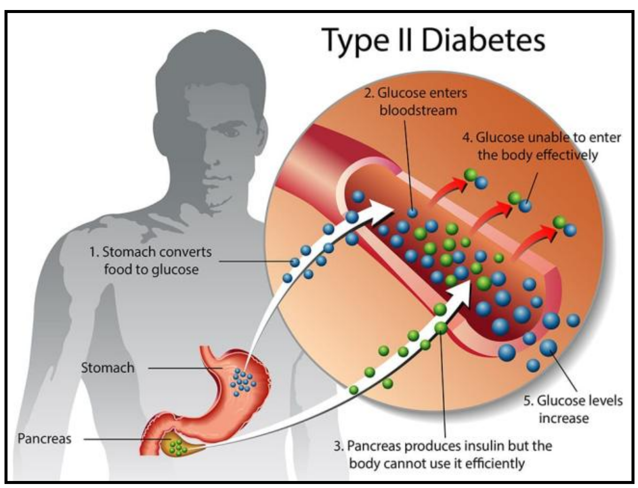

Figure 6: Type 2 Diabetes mellitus

Etiology and Genetic Risk Factors.

T2DM arises from a multifactorial interplay between genetic susceptibility and lifestyle influences, such as sedentary behaviour, obesity (especially visceral), and dietary excess. Unlike T1DM, it is not autoimmune-mediated. Key susceptibility genes include TCF7L2, FTO, PPARG, and KCNJ11, which affect β-cell function, adipogenesis, and insulin Sensitivity.[8]

Type 2 diabetes arises from a combination of genetic predisposition and lifestyle factors, with insulin resistance and impaired insulin secretion being the primary mechanisms. Essentially, cells become less responsive to insulin, and the pancreas struggles to produce enough insulin to compensate, leading to elevated blood sugar levels.[9]

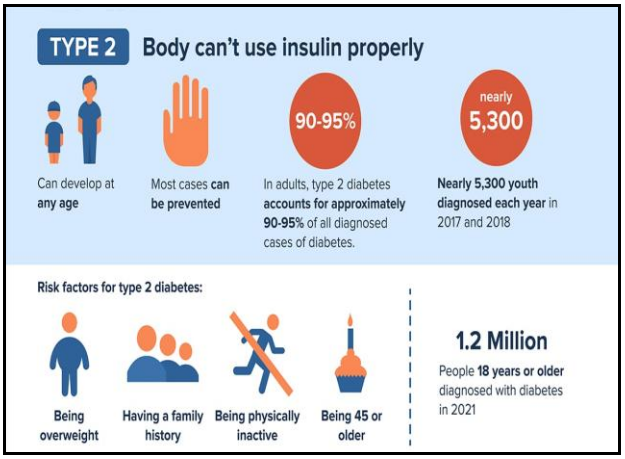

Figure 7: Risk Factors of type 2 diabetes

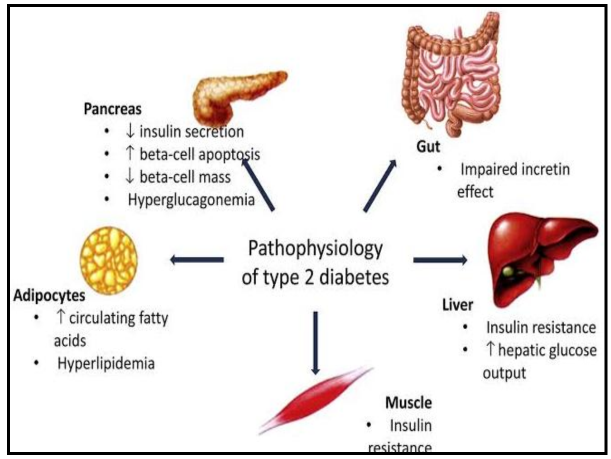

Figure 8: Pathophysiology of type 2 diabetes

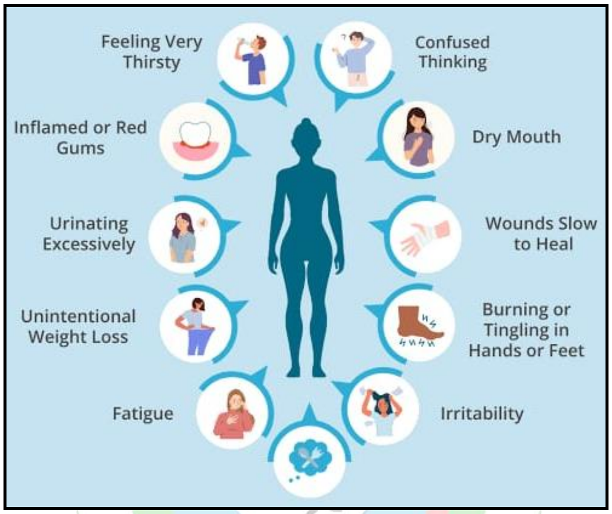

Figure 8: Symptoms of type 1I Diabetes Mellitus

Gestational Diabetes mellitus

Gestational Diabetes Mellitus (GDM) is defined as glucose intolerance of variable severity with onset or first recognition during pregnancy. It typically arises in the second or third trimester and resolves after delivery in most cases. However, it is associated with an increased risk of developing type 2 diabetes later in life. It is caused by hormones produced during pregnancy that can make the body less effective at using insulin leadind to buildup of glucose in the blood.[10]

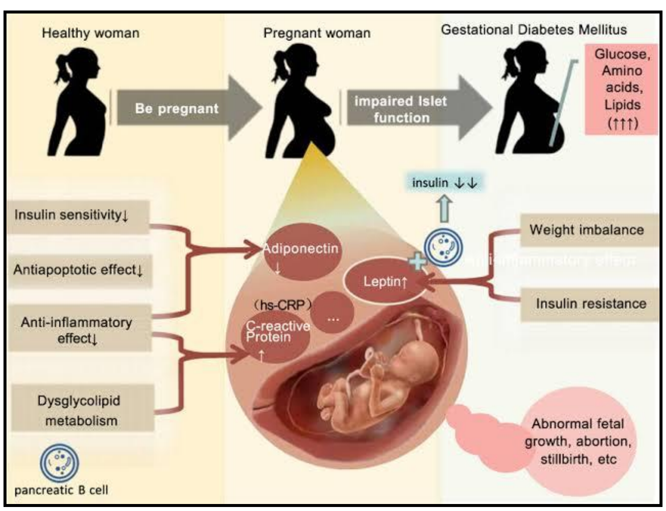

Figure 8: Gestational Diabetes Mellitus

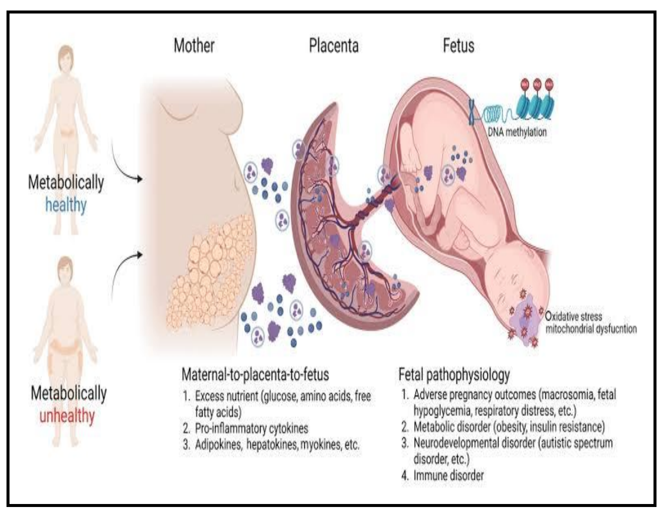

Figure 8: Pathophysiology of type III diabetes

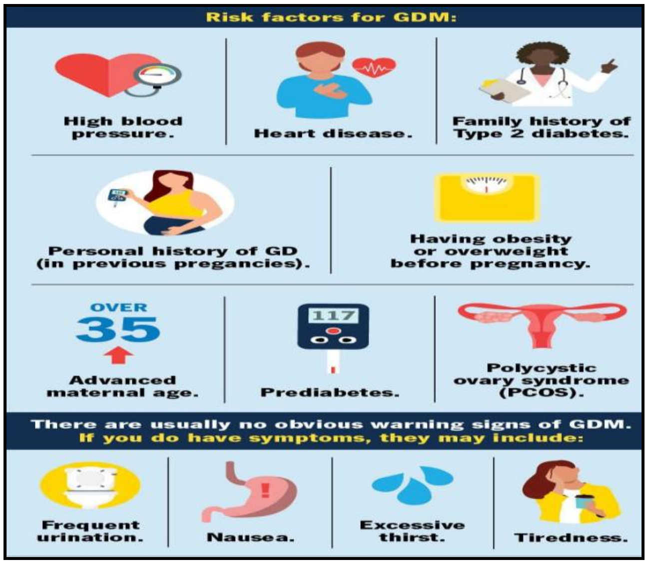

Figure 9: Risk factors of GDM

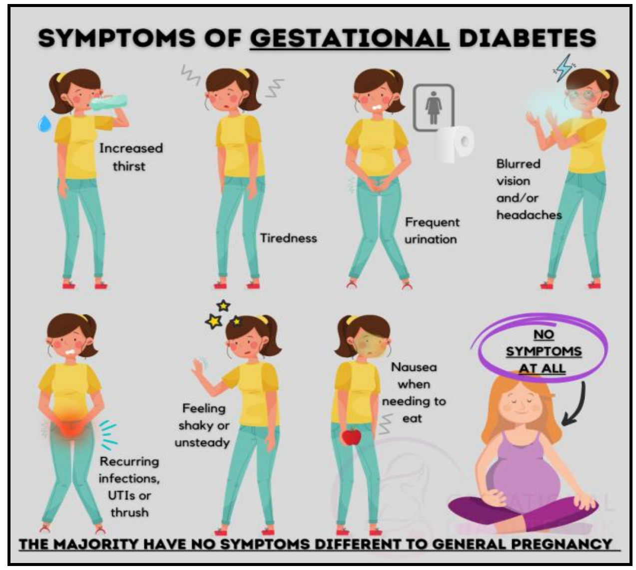

Figure 10: Symptoms of GDM

Treatment of Diabetes Mellitus

The treatment of diabetes mellitus (DM) is multifaceted, involving a combination of lifestyle modifications, pharmacotherapy, and emerging therapeutic strategies. The primary goals of diabetes treatment are to maintain glycemic control, prevent complications, and improve quality of life.

1. Lifestyle Modifications

Lifestyle interventions form the cornerstone of diabetes management for all types of diabetes, especially Type 2 DM. These include:

- **Dietary Management**: A balanced diet with controlled carbohydrate intake, low glycemic index foods, and increased fiber is recommended. Medical Nutrition Therapy (MNT) tailored to individual needs plays a crucial role.
- **Physical Activity**: Regular exercise enhances insulin sensitivity and aids in weight management. The American Diabetes Association (ADA) recommends at least 150 minutes per week of moderate-intensity aerobic physical activity.
- **Weight Management**: Achieving and maintaining a healthy body weight is critical, especially in overweight and obese patients with Type 2 DM.[11]

2. Pharmacological Therapy

Pharmacological management varies depending on the type and severity of diabetes.

a. Type 1 Diabetes Mellitus

Insulin Therapy: Lifelong exogenous insulin is required. Modern insulin regimens include basal-bolus therapy and insulin pumps to mimic physiological insulin secretion.

b. Type 2 Diabetes Mellitus

Oral Hypoglycemic Agents: These include:

- **Metformin**: First-line agent due to its efficacy, safety, and cardiovascular benefits.
- **Sulfonylureas** (e.g., glibenclamide, glipizide): Stimulate insulin secretion.
- **Thiazolidinediones** (e.g., pioglitazone): Improve insulin sensitivity.
- **DPP-4 Inhibitors**, **SGLT2 Inhibitors**, and **GLP-1 Receptor Agonists**: Newer agents with additional cardiovascular and renal benefits.
- **Insulin Therapy**: May be added in advanced or uncontrolled cases.[12]

3. Emerging Therapies

1. **Incretin-Based Therapies**: GLP-1 receptor agonists and DPP-4 inhibitors enhance insulin secretion and suppress glucagon.
2. **SGLT2 Inhibitors**: Promote renal glucose excretion and have demonstrated cardiovascular and renal protection.
3. **Dual and Triple Therapy Approaches**: Combining multiple agents to target different pathophysiological aspects.
4. **Bariatric Surgery**: An effective option in morbidly obese Type 2 DM patients with inadequate glycemic control.
5. **Gene and Stem Cell Therapy**: Under investigation for potential long-term cures.

4. Adjunctive Treatments

- **Antihypertensive**, **statins**, and **antiplatelet agents** are often necessary to manage associated cardiovascular risks.
- **Patient Education and Self-Monitoring**: Continuous glucose monitoring (CGM), education about hypoglycemia, and lifestyle choices significantly improve outcomes.[13]

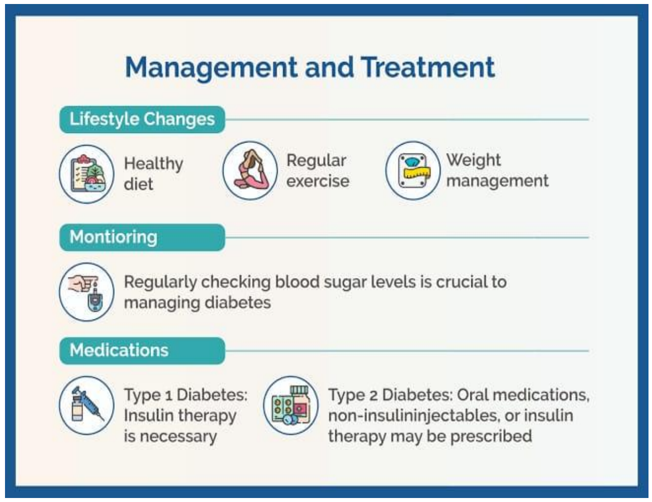

Figure 11: Management and treatment of Diabetes mellitus

Plant-Based Therapeutics in Diabetes Management

Numerous medicinal plants have been traditionally employed in the management of diabetes mellitus, owing to their rich phytochemical constituents such as alkaloids, flavonoids, terpenoids, phenolics, and saponins. These bioactive compounds exert antihyperglycemic effects through diverse mechanisms, including enhancement of insulin secretion, improvement of insulin sensitivity, inhibition of carbohydrate-digesting enzymes, and modulation of glucose uptake.[14]

Table 2: Prominent antidiabetic plants

No	Biological Name	Family	Parts Used	Phytoconstituents	Types of Diabetics Treated	Description
1	Boerhavia Diffusa	Nyctaginaceae	Leaves Seeds	Flavanoids Xanthones purine	Type-2 diabetes	Boerhavia diffusia eathanolic extract shows strong antidiabetic potential via alpha-glucosides.[15]
2	Enicostemma hyssopifolium	Gentianaceae	Gentianaceae	Flavanoids Swertiamarin	Type-2 diabetes	Spondiasmombin extract shows antidiabetic and hypolipidemic effect.[16]
3	Spondiasmombin	Anacardiaceae	Leaves	Vitamins Minerals Flavanoids	Type-2 diabetes	Spondiasmombin extract shows reduce blood glucose via pancreatic or extra-pancreatic mechanism.[17]
4	Helicteres Angustifolia	Malvaceae	Root	Flavanoids Alkaloids ,steroids Tannins	Type-2 diabetes	Eathanolic extract of H.angustifolia root shows strong antidiabetic ativity.[18]
5	Ficusracemosa	Moraceae	Stem Bark	Flavanoids Alkaloids Steroids,Tannins	Type-1 Diabetes	Shows antidiabetic activity by inhibiting alpha-amylase.[19]
6	Nigelllasativa	Ranunculaceae	Seeds	Thymoquinone P Cymene Carvacrol	Type-1 Diabetes	Nigella sativa oil shows antidiabetic effect by normalizing biomarker and boosting antioxidant status.[20]
7	Beberis Aristata	Berberidaceae	Barks	Alkaloids Tannins Sugars Starch	Type-2 diabetes	Prtroleum ether and eathanol extract of Berberisaristata bark shows dose-dependent antidiabetic activity.[21]
8	Syzygiumcumini	Mytaceae	seeds	Glycosides Alkaloids Flavanoids	Type-2 diabetes	Syzygiumcumini seeds shows antidiabetic potential.[22]
9	Momordicacharantia	Curcubitaceae	Fruits	Flavanoids Glycosides Phenolic acids	Type-2 diabetes	Momordicacharantia shows anti-diabetic, antioxidantz effect protected pancreatic tissue.[23]
10	Gymnemayunnanense	Apocynaceae	Leaves	TriterpeneSaponins Flavones	Type-2 diabetes	Gymnemayunnaense shows strong antidiabetic potential for antidiabetic drug

						develop.[24]
11	Ocimum sanctum	Lamiaceae	Roots	Eugenol Rosmarinic acid Apigenin	Type-1 diabetes	Ocimum sanctum root extract reduce blood and improves glucose,lipids profile in diabetic rat.[25]
12	Panax ginseng	Araliaceae	Leaves Stems	Ginsenosides Polysaccharides Peptides	Type-2 diabetes	GBGO5-FF enhances glucose transport,antidiabetic potential.[26]
13	Opuntiaficusindica	Cactaceae	Stem	Phenols Anthocyanins Carotenes	Type-2 diabetes	Nopal extract improvess glucose tolerance,lower blood glucose in diabetic rat.[27]
14	Linum usitatissimum	Linaceae	Seeds Leaves Stem	Flavanoids Phenols Sterols	Type-2 diabetes	Flaxseed extract shows strong antidiabetic and hyperlipidemic effect.[28]
15	Physalis Angulata	Solanaceae	Fruits	PhysalinsFlavanoids Alkaloids	Type-2 diabetes	Physagulin-F shows strong antidiabeticeffct and improve weight in diabetic rats,comparable to glibenclamide.[29]
16	Bracylaena Elliptica	Asteraceae	Leaves	Flavanoids Alkaloids Saponins	Type-2 diabetes	Brachylaenaelliptica shows insulin-independent antidiabetic activity by enhancing glucose uptake and beta-cell proliferation.[30]
17	Moringa Oleifera	Moringaceae	Seeds	Alkaloids Flavanoids Phenolic Acids	Type-1 Diabetes	Moringa seed powder shows antidiabetic,nephroprotective effect by improving biomarkers and organ health.[31]
18	Azadirachta Indica	Meliaceae	Roots	AzadirachtinNimbidinFlavanoids	Type-1 Diabetes	The alcoholic extract of neem root bark shows antidiabetic activity.[32]
19	Coccinia Indica	Cucurbitaceae	Fruits	Flavanoidssaponins Sterols	Type-2 Diabetes	Cocciniaindica fruit pectin shows hypoglycemic effect.[33]
20	Morus alba	Moraceae	Leaves	Flavanoids Alkaloids Phenolic Acids	Type-2 Diabetes	MLF,MLP improve insulin resistance,morusin and kuwanon C shows antidiabetic potential.[34]
21	Vatairea Macrocarpa	Dipterocarpaceae	Stem Bark	TriterpenesStilbenoids Phenols	Type-2 Diabetes	Vataireamacrocarpa extract shows long-term antidiabetic potential.[35]
22	Chiliadenusiphionoides	Asteraceae	Aerial parts	Eucalyptol Monoterpene O-cymene	Type-2 diabetes	Chiliadenusiphionoides extract boosts insulin secretion and shows antidiabetic potential.[36]
23	Costus Igneus	Costaceae	Leaves	Flavanoids Alkaloids Kotalanol	Type-2 diabetes	Costusigneus leaf powder lowers fasting and postprandial blood glucose level.[37]
24	Abrus Precatorius	Fabaceae	Leaves	Flavanoids Alkaloids	Type-2 Diabetes	About precatorius leaf shows insulin-enhancing antidiabetic effect.[38]
25	Lawsoniainermis	Lythraceae	Leaves	Lawsone, flavonoids, phenalics	Type1&2 Diabetes	Lawsonia extract shows dose-dependent antidiabetic activity,strongest with methanolic extract.[39]
26	Carthamus tinctorius	*Asteraceae*	Leaves,flower ,roots	Tannins , flavonoids ,coumarine	Type-2 Diabetes	Carthamustinctoriushydroalcoholic extract shows benifical antidiabetic effect.[40]
27	Ricinuscommunis	*Euphorbiaceae*	Seeds ,root ,leaves	Flavonoids, Alkaloids, Glycoides, Tannis, Steroids, Saponins.	Type 1&2 Diabetes	Ethanol extract shows antidiabetic and organ-protective effect.[41]

28	Murrayakoenigii	Rutaceae	*Rutaceae*	Alkaloids, Flavonoids, Saponins, Phenols, Tanins	Type-2 Diabetes	MK extract shows hypoglycemic, renal, and endocrine protective effect in diabetic rats.[42]
29	Solanumincanum	*Solanaceae*	Root	alkaloids, saponins, flavonoids, steroids,tanins, glycosides,	Type-2 Diabetes	Solanumincanum root extract shows strong antidiabetic potential.[43]
30	Sarcopoteriumspinosum	Rosaceae	Roots, leaves, fruits.	Triterpinoids, flavonoids,	Type-2 Diabetes	S.spiosumextract shows unique antidiabetic potential.[44]
31	Combretummicranthum	*Combretaceae*	Leaf	Flavonoids, phenolic acids, alkaloids, fatty acids, terpinoids, amino acids,	Type 1&2 Diabetes	Combretummicranthum shows broad antidiabetic potential.[45]
32	Agrimoniaeupatoria	Rosaceae	Leaves, flower, roots	Tanins, flavonoids, cowmarins	Type-2 Diabetes	A.eupatoria, C.cardunculus shows antidiabetic effect.[46]
33	Caesalpiniavolkensi	Fabaceae	Seeds, leaves, bark	Flavonoids, phenolics, terpenoids, saponins, alkaloids	Type-2 Diabetes	Caesalpiniavolkensii shows antidiabetic potential.[47]
34	Allium sativum	*Amaryllidaceae*	Fruits	Allicin, diallyi disulfides, flavonoids, saponins	Type-2 Diabetes	Plant is a promising antidiabetic candidate.[48]
35	Acacia nilotica	Fabaceae	leaves, seeds	Alkaloids, flavonoids, saponins, tannins, terpenoids, steroids, carbohydrates	Type-2 Diabetes	A.nilotica lignin shows antidiabetic potential.[49]
36	Artemisia pallens	Asteraceae	Leaves and bulbs	Essential oils,Flavonoids and Alkaloids	Type-2 diabetes	Ethanolic extracts of artemisiapallens exhibits promising anti diabetic activities.[50]
37	Grewiaasiatica	Malvaceae	Bark and fruits	Flavanoids ,Tannins, anthocyanins and phenols	Type-2 diabetes	G.asiatica extract lowers glucose, preserving weight in diabetic rats.[51]
38	Capsicum Annuum	Solanaceae	Fruits , seeds, Leaves	Capsaicinoids, Carotenoids and flavonoids	Type-2 diabetes	DJ and quercitrin show strong antidiabetic effect by improving carbohydrate metabolism.[52]
39	Parkia biglobos	Fabaceae	Leaves and seeds	Polyphenols, Flavonoids ,tannins	Type-1 and type 2 diabetes	Aqueous and methanolic extracts of p.biglobos reduce the blood glucose level.[53]
40	Ziziphusmucronatawilld	Rhamnaceae	Leaves and fruits	Cyclopeptide alkaloids	Type-2 diabetes	Ziziphusmucronata increase glucose uptake.[54]
41	Eugenia caryophyllata	Myrtaceae	Dried flower buds	Eugenol, eugenol acetate, beta caryophyelene, flavonoids phenolic acids	Type-2 diabetes	Ethanol extracts of E.Caryophyllata exhibit alpha glucosidase action.[55]
42	Balanitesaegyptiaca	Zygophyllaceae	Fruit , mesocarp	Alkaloids, flavonoids , saponins and tannins	Type-1 and type 2	An aqueous extract of mesocarps of the fruits of b.agyptiaca exhibit prominent anti diabetic activity.[56]
43	Vernoniaamygdalina	Asteraceae	Leaves	Polyphenols, flavonoids, alkaloids , saponins and steroids	Type-1 And type 2 diabetes	Stimulate muscle glucose uptake.[57]
44	Aloe barbadensis	Asphodelaceae	Leaf pulp and latex	Anthraquinones, flavonoids, tannins, sterols,	Type-2 diabetes	The methanol extract of Aloe vera demonstrated effective inhibition of the glycation reaction of proteins.[58]

45	Acacia catechu	Fabaceae	Hardwood and Bark	Tannins, flavonoids, phenolic compounds, Catechin	Type-2 diabetes	The extract showed strong antidiabetic effects, outperforming crude extracts in managing diabetes.[59]
46	Galegaofficinalis	Fabaceae	Whole plants	Guanidine derivatives like galegine	Type-2 diabetes	Galegaofficinalis shows antidiabetic activity.[60]
47	Agaricusbisporus	Agaricaceae	Fruiting body or fleshy part	Phenolic compounds, terpenoids And polysaccharides	Type-2 diabetes	Plants and mushrooms may help treat obesity and T2DM, with modern tools revealing their active compounds.[61]
48	Nigerian plant	Fabaceae	Leaves, stem,	Alkaloids, tannins, saponins, flavonoids	Type-1 and type 2 diabetes	plant-based treatments offer safer glucose control by enhancing insulin or limiting absorption.[62]
49	Sennasuranttensis	Fabaceae	Leaves	Flavourids, Anthraquinones	Type-2 diabetes	Avaram flower extract shows strong anti diabeticpotential with myo-inosiotol 4-C-methyl as key compound.[63]
50	Ravenalamadagascarieusm	Strelitziaceae	Leaves	Flavonoids,phenolic,compounds,Terpenoids	Type-2 diabetes	Ravenalamadagascariensis leaf extracs, shows reduced blood glucose levels.[64]
51	Carica papaya	Caricaceae	Leaves	Alkaloids,Flavonoids,Phenolic acid,Saponins,Tannins	Type-2 diabetes	Carica papaya leaf extract safely lower blood glucose without affecting body weight.[65]
52	Phyllanthusenblica	Phyllanthacae	Fruits	Tannins, Flavonoids, Phenolic acid,Gallic acid, Ellagic acid	Type-1 and type 2 diabetes	Amla shows potential in managing diabetes and lipids by their potential to secrete insulin.[66]
53	Annonasquamora	Annonaceae	Leaves	Alkaloids, Flavonoids,Phenolic acid	Type-1 and type-2 diabetes	ethanol leaf extract of A.squamous L. has hypoglycemic activity.[67]
54	Abelmoschusesceluntus	Malvaceae	Seeds	Flavonoids,phenolic,compound,polysaccharides	Type-2 diabetes	H.esculentus seeds show anti-diabetic,lipid-lowring, And antioxidant effect.[68]
55	Trigonella	Fabaceae	Leaves	Saponins, Alkaloids, Flavonoid	Type-2 diabetes	Fenugreek shows antidiabetic effects, lowering glucose, HbA1c.[69]
56	Ceibapentandra	Malvaceae	Brain	Flavonoids,Terpinoids, Saponins	Type-2 diabetes	P. bark extract lowering blood glucose in diabetic rats without showing toxicity.[70]
57	Aegle marmelos	Rutaceae	Leaves	Alkaloids, Tannins,Terpinoids,Terois, Phenols glycoside	Type-2 Diabetes	baelpatra extract significantly reducd blood and urine glucose levels in NIDDM patients.[71]
58	Syzygiumsamarangense	Myrtaceae	Levaes	Flavonoids,Phenolictannins, Anthocyanins	Type-1 and Type-2 Diabetes	Jamblang lowers fasting glucose in rats.[72]
59	Urticadioica	Urticaceae	Leaves	Flavonoids,Phenolic,Lignam,Terpenes	Type-2 diabetes	UD extract plus exercise lowers diabetes markers, boosts insulin.[73]
60	Rosa Rubiginosa	Rosaceae	Flowers	Flavonoids, Anthocyanins, Tannins, Essential oil	Type-2 Diabetes	Browned rose extracts reduce HbA1c, aid liver function, independent of polyphenols.[74]
61	Musa acuminata	Musaceae	Pseudostem	Flavonoids, Quercetin,	Type-2	Banana pseudostem inhibit

				Catechin	Diabetes	carbohydrate hydrolysis enzyme.[75]
62	Terminaliabrownii Fresen	Combretaceae	Bark	Polyphenols,Ttrepenoids	Type-1 and type 2	T. brownii decrease postprandial hyperglycemia via alpha amylase inhibition.[76]
63	Ipomoea batas	Convolvulacea	Leaves	Anthocyanins, Phenolic Acid, Flavonoids,Tanni	Type-2 Diabetes	ethanolic extract of I. batatas L. showed superior glucose reduction.[77]
64	Chloroxylonswietenia DC	Rutacea	leaves	Sesquiterpenes, Flavonoids,Terpenoids	Type-2 Diabetes	Ethanolic leaf extracts showed in vitro antidiabetic activity.[75]
67.	Hemionitisarifolia	Pteridaceae	Whole plants	Phenols, saponins, tannins and carbohydrates	Type-1 diabetes	Hemionitisarifolia possesses significant anti-diabetic and glucose-lowering effects in rats.[76]
68	Bauhinia forficata	Fabaceae	Leaves	Terpenes , saponins and flavanoids	Type-1 diabetes	Bauhinia forficata leaf decoction significantly reduced blood glucose, urinary glucose.[77]

CONCLUSION:

Herbal medicines continue to play a vital role in the management of diabetes mellitus, especially in regions where traditional knowledge is deeply rooted in healthcare practices. This review highlights the rich ethnobotanical heritage and the growing pharmacological evidence supporting the use of medicinal plants with antidiabetic potential. Numerous plant-derived compounds such as flavonoids, alkaloids, terpenoids, and saponins have demonstrated significant hypoglycemic activity through various mechanisms, including insulin stimulation, enzyme inhibition, antioxidant effects, and β-cell protection. While preclinical studies are promising, there remains a critical need for well-designed clinical trials, standardization of herbal formulations, and detailed safety evaluations. Integrating traditional knowledge with modern scientific approaches offers a sustainable pathway for the development of safer, more accessible, and cost-effective therapeutic options for diabetes. Future research should focus on isolating bioactive compounds, elucidating molecular targets, and exploring synergistic effects to fully realize the therapeutic potential of herbal medicines in diabetes care.

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CONFLICT OF INTERESTS

We have No conflict interest.

AUTHOR CONTRIBUTIONS

Equal contribution for all authors.

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