

TRADITIONAL HERBAL MEDICINES IN DIABETES MELLITUS : AN OVERVIEW

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Abstract

Diabetes is an important human disorder concerning various sides in life of people of different countries which ultimately leads to serious damage to the heart, blood vessels, eyes, kidneys and nerves. In India it is showing to be a major health problem, especially in the urban areas. Even though there is considerable progress in the treatment of diabetes by oral hypoglycaemic agents, search for newer drugs continues because the present synthetic drugs have several limitations. There are various approaches to reduce the ill effects of diabetes and its secondary complications, herbal formulations are desired due to lesser side effects and low cost. The present article gives a general idea, complications of diabetic mellitus and focuses on herbal formulations or native plants used in the treatment of diabetes which can be or are part of meals or diet to control sugar level especially in India. The herbal drugs with antidiabetic activity are not yet commercially formulated as modern medicines, even though they have been acclaimed for their therapeutic properties in the traditional systems of medicine. Therefore, this review is aimed at opening up new outlooks in realizing the therapeutic potential of Ayurveda in treatment of diabetes and other chronic diseases. All drugs which we have discussed in this review have a significant role in therapy of diabetes mellitus.

Keywords: Medicinal plant, Antidiabetic drugs, Indigenous, Herbal drugs, Diabetes.

Introduction

Diabetes mellitus alone due its considerable incidence, morbidity, and mortality, diabetes has exceeded cancer as the third "killer" of mankind's health, behind cancer, cardiovascular, and cerebrovascular illnesses³. Diabetes is a major degenerative disease chronic, metabolic disease regarded as by raised levels of blood glucose (or blood sugar) in the world today. The most common is type 2 diabetes, usually in adults, which occurs when the body becomes resistant to insulin or doesn't make enough insulin. Diabetes is affecting at least 15 million people and having worries like hypertension, atherosclerosis, Neuropathy, Nephropathy, Retinopathy, Gastropathy microcirculatory disorders, diabetic ketoacidosis and sexual dysfunction^[1]. As per WHO key facts, in the past 3 decades the prevalence of type 2 diabetes has raised dramatically in countries of all income levels. Type 1 diabetes or juvenile diabetes or insulin-dependent diabetes, is a chronic condition in which the pancreas produces little or no insulin by itself. There is a globally agreed target to halt the rise in diabetes and obesity by 2025. About 422 million people worldwide have diabetes, the majority living in low-and middle-income countries, and 1.5 million deaths are directly attributed to diabetes each year^[1,2]. Both the number of cases and the prevalence of diabetes have been steadily increasing over the past few decades. Diet and lifestyle, particularly plant-based diets, are effective tools for type 2 diabetes prevention and management. Plant-based diets are eating a pattern that focuses legumes, whole grains, vegetables, fruits, nuts, and seeds and deject most or all animal products^[3]. Various studies strongly support the role of plant-based diets, and food and nutrient components of plant-based diets, in reducing the risk of type 2 diabetes⁴. Between 2000 and 2019, there was a 3% increase in diabetes mortality rates by age. In 2019, diabetes and kidney disease due to diabetes triggered an estimated 2 million deaths. A healthy diet, regular physical activity, maintaining a normal body weight and avoiding smoking are ways to prevent or delay the onset of type 2 diabetes^[4,5]. Diabetes can be treated and its consequences avoided or delayed with diet, physical activity, education and regular screening and treatment for complications. Evidence from observational and interventional studies demonstrates the benefits of plant-based diets in treating type 2 diabetes and reducing key diabetes-related macro vascular and micro vascular complications. The World Health Organization (WHO) assessed that about 80% of people living in developing countries trust almost entirely on traditional medicines for their primary health care needs. Different parts of the plant (Leaves, seed, roots, rhizomes, bark, pods etc) are reputed for their medicinal value. Traditional medicines derived from medicinal plants are used by about 60% of the world's population. This review focuses on Indian herbal drugs and plants used in the treatment of diabetes. A list of medicinal plants with proven antidiabetic and related beneficial effects and of herbal drugs used in treatment of diabetes is compiled. Mostly all are likely to use traditional medicine, acupuncture, yoga, indigenous therapeutics. Inspiring the growing prominence and value of traditional medicine in the provision of health care nationally and globally^[6]. These include *Allium sativum*, *Eugenia jambolana*, *Momordica charantia*, *Ocimum sanctum*, *Phyllanthus amarus*, *Pterocarpus marsupium*, *Tinospora cordifolia*, *C. indica*, *Helicteres isora*, *Stevia rebaudiana*, *Gymnema sylvestre*, *Enicostemma littorale*, Blume, *Allium cepa*, *Aloe vera*, *Cajanus cajan*, *Coccinia indica*, *Caesalpinia bonducella*, *Ficus bengalensis*, *Gymnema sylvestre*, *Swertia chirayita*, *Syzgium cumini*, *Tinospora cordifolia*

and *Trigonella foenum graecum*, *M. charantia*, *Mucuna pruriens*, *T. foenum graecum*, *Murraya koeingii*, *Brassica juncea* etc^[7,8,9,10].

Pathophysiology of Diabetes^[9]

Types	Pathophysiology
Type I	Autoimmune beta cell destruction and lack of insulin production
Type II	Abnormal increased resistance for insulin action
Gestational	Glucose intolerance during pregnancy
Other type of diabetes	Genetic defect in beta cell of pancreases

Symptoms for both diabetic conditions may include^[9]

- High sugar levels in the blood;
- Uncommon thirst
- Recurrent urination
- Extreme hunger and loss of weight
- Unclear vision
- Nausea and vomiting
- Extreme faintness and fatigue
- Irritability, mood changes etc.

Complications of Diabetes Mellitus^[9]

Some major complications due to Diabetes Mellitus which may be chronic if neglected are as

- Neuropathy
- Retinopathy
- Nephropathy
- Macrovascular problems
- Gangrene
- Foot problems
- Chest pain
- Heart attack
- Gum problems etc

The three major risk factors to be controlled are Hyperglycaemia, Hypertension, Hypercholesterolemia

Basis of Diabetes Mellitus treatment^[9,10]

- Patient education from concerning the disease
- Physical exercise
- Diet
- Hypoglycemic agents

Traditional Attitudes to Remedial Care^[10,11]

Traditional medicinal methods have been in place for centuries in cultures across the globe. According to WHO, Traditional medicine is “the sum total of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether rational or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness”. When considering traditional medicine, it is important not to refer to it as less than non-traditional, “scientific” medicine, based on centuries of knowledge and experience. At the same time, it is also important to have a system in place to regulate methods that may harm patients.

Recent Regulatory Developments^[12]:

According to regulatory guidelines, herbal medicines are conventional drugs that primarily function as therapeutic formulations of medicinal plants. The World Health Organisation defines traditional medicine (including herbal remedies) as therapeutic modalities that have been in use for hundreds of years or longer prior to the development and dissemination of modern medicine, as well as other modalities that are now in use. The FDA and EME

They have recently showed a strong interest in the study of botanical medicines and have looked into the regulatory frameworks governing their usage. The natural goods business has seen a significant uptick as a result of the increased awareness, and the entry hurdles for botanicals and related products have decreased. The need for these new regulations is greater than ever because they guarantee market exclusivity for botanicals and the approval of combining bioactive compounds made from plants in synergistic ways. India and China have a clear intrinsic advantage over the rest of the globe, both as developing and developed nations.

Mechanism of Action of Herbal Anti diabetics^[13-16]

. Various mechanisms of anti-diabetic activity of herbal plant are depends upon

- Decreased Insulin resistance
- Urinal glucose reabsorption
- Blocking Beta cell potassium channel
- Stimulation of insulin secretion
- Increasing the size and number of cells in the islets of Langerhans Inhibitor of insulin degradation
- Improves Glycogenesis and hepatic glycosis
- Supply of necessary elements like calcium, zinc, magnesium, manganese and copper for the beta-cells
- Pancreatic beta cell repairing
- Inhibitory action on α -amylase, β -galactosidase and α -glycosidase
- Improvement in digestion along with reduction in blood sugar and urea.
- Avoidance of pathological conversion of starch to glucose.

Common Herbal Medicines Used to Treat Diabetes^[15-24]

Sr no	Botanical name	Family	Parts used	Uses of ethnomedical plant
1	<i>Abroma augusta</i>	Sterculiaceae	Root	Hypoglycemic and antilipidemic
2	<i>Acacia arabica</i>	Fabeceae	Bark	Ameliorate the derangement in lipid metabolism in diabetes
3	<i>Acalypha wilkesiana</i>	Euphorpiaceae	Leaves	Hypoglycemic and antioxidant
4	<i>Acer saccharum (maple)</i>	Sapindaceae	Juice	α -Amylase and α -glucosidase inhibition
5	<i>Acorus calamus</i>	Acoraceae	Leaves/bark	α -Glucosidase inhibition and hypolipidemic
6	<i>Aegle marmelos</i>	Rutaceae	Leaves/bark/root	Antioxidant and anti-cataract activity
7	<i>Azelia africana</i>	Fabaceae	Stem bark	Antidiabetic and hematological effect
8	<i>Alhagi camelorum</i>	Fabaceae	Aerial part	α -Glucosidase inhibition
9	<i>Allium sattivum</i>	Alliaceae	Bulb	Antidiabetic
10	<i>Aloe vera</i>	Xanthorrhocaceae	Leaves	Hypoglycemic
11	<i>Alpinia officinarum</i>	Zingiberaceae	Rhizomes	α -Glucosidase inhibition
12	<i>Amaranthus spinosus,</i> <i>Amaranthus caudatus,</i> <i>Amaranthus viridis</i>	Amaranthaceae	Leaves	α -Amylase inhibition, antioxidant and anticholesterolic
13	<i>Ananthamoola</i> <i>Hemidesmus indicus</i>	Asclepiadiacea	root	repairs the concentrations of electrolytes, glucose metabolizing enzymes, hepatic microsomal protein and hepatic cytochrome P-450-dependent mono-oxygenase enzyme systems
14	<i>Annona squamosa</i>	Annonaceae	Fruits	Antidiabetic
15	<i>Anogeissus acuminata</i>	Combretaceae	Whole plant	Antioxidant
16	<i>Areca catechu</i>	Arecaceae	Seed	Antidiabetic
17	<i>Artemis sphaerocephala</i> <i>krasch</i>	Compositae	Gum/seed powder	Antidiabetic
18	<i>Artemisia dracunculus</i> (L.)	Asteraceae	Aerial part	Antidiabetic
19	<i>Artemisia herba-alba</i> <i>asso</i>	Asteraceae	Whole plant	Antihyperglycemic and antihyperlipidemic
20	<i>Artemisia pallens</i>	Asteaceae	Leaves and Flower	Antidiabetic
21	<i>Ascophyllum nodosum</i>	Algae	-	α -Glucosidase inhibition and α -amylase

22	<i>Ashwagandha, winter cheery Withania somnifera</i>	Solanaceae	Roots	Reduced blood sugar levels
23	<i>Asiatic ginseng Panax ginseng</i>	Araliac	Roots	blood glucose levels via slowing the absorption of carbohydrates, enhancing glucose transport, and modulating insulin secretion.
24	<i>Asiatic sweet leaf Symplocos Paniculata</i>	Symplocaceae	Leaves/ stems	inhibitors of protein tyrosine phosphatase 1B (PTP1B)
25	<i>Aspidosperma macrocarpon</i>	Apocynaceae	Steam/Bark Root wood	α -Amylase inhibition
26	<i>Atractylodes macrocephala</i>	Asteraceae	Whole plant	α -Glucosidase inhibition
27	<i>Azadirachta indica</i>	Meliaceae	Leaves, flower ,seed	Antidiabetic and antihypertension
28	<i>Banana Musa sapientum Kuntz</i>	Musaceae	Fruits/ flowers	Lowers Blood glucose and glycosylated hemoglobin levels.
29	<i>Banyan tree Ficus bengalensis</i>	Moraceae	Bark	increases insulin secretion
30	<i>Aloe barbadensis Mil</i>	Liliaceae	Leaves	Insulin production and release are stimulated.
31	<i>Barringtonia racemosa</i>	Lecythidaceae	Seed	α -Glucosidase and α -amylase inhibition
32	<i>Bauhinia forficata</i>	Leguminosae	Leaves	Antidiabetic
33	<i>Belamcanda chinensis</i>	Irdaceae	Leaves	Hypoglycemic
34	<i>Benincasa hispida</i>	Cucurbitaceae	Fruit	Ameliorat the derangement in lipid metabolism in diabetics.
35	<i>Benincasa hispida</i>	Cucurbitaceae	Fruit	Antidiabetic
36	<i>Berberis vulgaris</i>	Berberidaceae	Leaves	Hypoglycemic
37	<i>Beta vulgaris</i>	Amaranthaceae	Root	Antidiabetic
38	<i>Betal, betal wine Piper betle</i>	Piperaceae	Leaf	glucose metabolism, anti-hyperglycemic
39	<i>Bilwa, bael fruit Aegle marmelos</i>	Rutaceae	Leaf Extract	Decrease cholesterol and blood urea level
40	<i>Bitter gourd Momordica charantia</i>	Cucurbitaceae	fruit	stimulates GLP-1 and insulin secretion
41	<i>Bitter kola, false kola Garcinia kola</i>	Clusiaceae	Seed	Hypoglycemic and Hypolipidemic
42	<i>Black tea Camellia sinensis</i>	Theaceae	Leaves	Leaves help to lower blood sugar levels.
43	<i>Borerhavia diffusa</i>	Nyctaginaceae	Whole plant	Antidiabetic
44	<i>Brassica juncea</i>	Brassicaceae	Seed	Hypoglycemic

45	<i>Buchholzia coriacea</i>	Capparaceae	Seed	Hypoglycemic
46	<i>Caesalpinia ferrea Martius</i>	Leguminosae	Bark	Hypoglycemic activity
47	<i>Camellia sinensis</i>	Theaceae	Fruit peel/leaves	α -glucosidase and α -amylase inhibition, antihyperglycemic
48	<i>Capparis deciduas</i>	Capparaceae	Fruit	Hypoglycemic/antidiabetic
49	<i>Carilla Fruit</i>	Casearia esculenta	Root	Reduces blood glucose level of both Type 1 & type 2 diabetes
50	<i>Cassia auriculata</i>	Caesalpinaceae	Aerial part	Antioxidant
51	<i>Catharanthus roseus</i>	Apocynaceae	Leaves/bark/root	Antioxidant and anticataract activity
52	<i>Catunaregam tormentosa</i>	Rubiaceae	Whole plants	Antioxidant and antihyperglycemic
53	<i>Centaurium erythraea</i>	Gentianaceae	Whole plant/leaves	Antihyperglycemic, antihyperlipidemic, antioxidant and prevent β -cell damage
54	<i>Chaenomeles sinensis</i>	Rosaceae	Fruit	
55	<i>Chiliadenus iphionoides</i>	Asteraceae	Shrub	Increased β -cells numbers and Insulin secretion
56	<i>Chilli pepper</i>	Capsicum annum	Fruit	cholesterol lowering effect
57	<i>Cinnamomum cassia, Cinnamomum zeylanicum</i>	Lauraceae	Leaves/bark	α -Glucosidase inhibition, antioxidant and antidiabetic
58	<i>Coccinia cordifolia</i>	Cucurbitaceae	Herb	Hypoglycemic
59	<i>Coccinia indica</i>	Cucurbitaceae	Leaves	Antioxidant, antihyperglycemic and antilipidemic
60	<i>Cocos nucifera</i>	Arecaceae	Coconut kernel protein	Antidiabetic
61	<i>Codonopsis pilosula</i>	Campanulaceae	Whole plant	α -Glucosidase inhibition
62	<i>Coffea arabica, Coffea canephora</i>	Rubiaceae	Beans/seed	α -Amylase isoenzyme inhibition
63	<i>Combretum micranthum</i>	Combretaceae	Leaves	Antidiabetic
64	<i>Commbratum micranthum</i>	Combretaceae	Leaves	Hypoglycemic and antidiabetic
65	<i>Commiphora mukul</i>	Burseraceae	Gum resin	Antihyperglycemic and antioxidant
66	<i>Coriandrum sativum</i>	Apiaceae	Seed	Hypolipidemic and hypoglycemic
67	<i>Corus kousa</i>	Cornaceae	Leaves	Antihyperglycemic

68	<i>Costus pictus</i>	Zingiberaceae	Leaves	α -Glucosidase and α -amylase inhibition
69	<i>Crêpe ginger</i>	<i>Costus speciosus</i>	rhizome	Repairs pancreatic β -cells, increasing insulin sensitivity
70	<i>Cucumis melo var. utilissimus Duthie</i>	Cucurbitaceae	Fruit	Antioxidant and hyperglycemic
71	<i>Cucurbita maxima</i>	Cucurbitaceae	Fruit	Antioxidant and hyperglycemic
72	<i>Cuminum cyminum</i>	Apiaceae	Seed	Aldose reductase and α -glucosidase inhibition
73	<i>Cynodon dactylon</i>	Poaceae	Leaves	Antidiabetic, antioxidant, hypolipidemic and improve diabetes associated neurological disorder
74	<i>Davana</i> <i>Artemisia pallens</i>	Asteraceae	aerial parts	Hypoglycemic
75	<i>Derris scandens</i>	Fabaceae	Whole plant	α -Glucosidase inhibition
76	<i>Dichrostachys glomerata</i>	Fabaceae	Whole plant	Antioxidant and hypoglycemic
77	<i>Dillenia indica</i>	Dilleniaceae	Leaves	Antidiabetic and hypolipidemic
78	<i>Dioecrescis erythroclada</i>	Rubiaceae	Whole plant	Antioxidant and antihyperglycemic
79	<i>Dioscorea opposita</i>	Dioscoreaceae	Leaves	α -Glucosidase inhibition
80	<i>Elephantopus scaber</i> , <i>Elephantopus mollis</i>	Asteraceae	Whole plant	Antidiabetic, α -glucosidase inhibition and apoptotic
81	<i>Eleutherine americana</i>	Iridaceae	Bud	α -Glucosidase inhibition
82	<i>Embelia ribes</i> , <i>Embelia officinalis</i>	Myrsinaceae	Leaves/aerial part	Antihyperglycemic
83	<i>Eriobotrya japonica</i>	Rosaceae	Leaves	Antihyperglycemic
84	<i>Euclea undulata</i>	Ebenaceae	Root/bark	α -Glucosidase inhibition and hypoglycemic
85	<i>Eucommia ulmoides</i>	Eucommiaceae	Whole plant	Inhibits action of α -Glucosidase, antidiabetic and antioxidant
86	<i>Fenugreek</i>	<i>Trigonella foenum-gracecum</i>	seed	Seed powder solution on the lipid profile of type II diabetic patients.
87	<i>Ficus bengalensis Linn</i>	Moraceae	Bark	Antidiabetic, antihyperglycemic and ameliorative
88	<i>Ficus golmerata</i>	Moraceae	Bark/fruit	Antioxidant, anti-cataract activity
89	<i>Ficus religiosa</i>	Moraceae	Bark	Antihyperglycemic, antioxidant and antidiabetic
90	<i>Fishbone fern</i> , <i>tuberous sword fern</i>	<i>Nephelepis tuberosa</i>	bulb	in recovers lipid metabolism in type II diabetic patients
91	<i>Flos ionicerae</i>	Caprifoliaceae	Whole plant	α -Glucosidase inhibition

92	<i>Foenum graecum</i>	Fabaceae	Whole plant	Antihyperglycemic
93	<i>Garlic</i>	<i>Allium sativum</i>	bulb	decrease of glucose levels in plasma
94	<i>Glycine max</i>	Fabaceae	Seed	α -Amylase inhibition
95	<i>Goat's rue</i>	<i>Galega officinalis</i>	seed	to stimulate the adrenal gland and pancreas
96	<i>Gowar plant</i>	<i>Cyamospsis tetragonolobus</i>	Fruit	lowers antihyperglycemic effect on blood glucose level
97	<i>Grateloupia elliptica</i>	Algae	-	Inhibites action of α -Glucosidase
98	<i>Green tea</i>	<i>Camellia sinensis</i>	leaf	
99	<i>Guduchi</i>	<i>Tinospora cardifolia</i>	Plant	anti-hyperglycemic effect
100	<i>Gyanandropsis gynandra</i>	Capparidaceae	Root	Antidiabetic
101	<i>Gymnema sylvestre, Gymnema montanum</i>	Asclepiadaceae	Leaves/callus/stem	Renewal of β cell, reduce blood glucose level, increase plasma insulin level and hypolipidemic
102	<i>Gynura divaricata</i>	Asteraceae	Aerial part	Hypoglycemic, α -glucosidase, α -amylase inhibition
103	<i>Hadga</i>	<i>Sesbania granflora</i>	Flowers ,bark	stimulating insulin secretion from the β -cells of the pancreas
104	<i>Hedychium spicatum</i>	Zingiberaceae	Rhizome	α -Glucosidase inhibition and antihyperglycemic
105	<i>Helicteres igora</i>	Sterculiaceae	Bark	Antihyperglycemiv and antiperoxidative
106	<i>Helleborus purpurascens</i>	Ranunculaceae	Leaves, bark	Antidiabetic
107	<i>Hypericum perforatum</i>	Hypericaceae	Leaves	Antidiabetic and antinociceptive
108	<i>Indian Gum Arabic</i>	<i>Acacia Arabica</i>	seeds	hypoglycemic, hypolipidemic, and antioxidant properties
109	<i>Indian Kino Tree</i>	<i>Pterocarpus marsupium</i>	bark	to repair pancreatic tissues function
110	<i>Ispaghula</i>	<i>Plantago ovata</i>	husk	to decrease postprandial glucose concentrations
111	<i>Jatropha curcus</i>	Euphorbiaceae	Leaves	Improve the disorder in lipid metabolism in diabetes
112	<i>Juniiperus oxycedrus</i>	Cupressaceae	Fruit/leaves	Hypoglycemic and antidiabetic
113	<i>Kielmeyera coriacea</i>	Calophyllaceae	Stem/bark	α -Amylase inhibition
114	<i>King of Bitter</i>	<i>Andrographis paniculata</i>	plant	to reduce hyperglycemia by inhibiting β -cell dysfunction
115	<i>Lagenaria siceraria</i>	Cucurbitaceae	Fruit	Antioxidant and antihyperglycemic

116	<i>Lantana camara</i>	Verbenaceae	Leaves	Antidiabetic
117	<i>Levisticum officinale</i>	Apiaceae	Root	α -Glucosidase inhibition
118	<i>Life Plant</i>	Biophytum sensitivum	plant leaf	Pancreatic beta-cell stimulating action
119	<i>Ligusticum chuanxiong</i>	Apiaceae	Aerial part	Decrease kidney damage caused by diabetes
120	<i>Lingzhi mushroom</i>	Gandoderma lucidium	Fruit	prolongs the lifespan of beta-cells
121	<i>Liriope spicata</i>	Liliaceae	Root	Antidiabetic
122	<i>Lithocarpus polystachyus</i>	Fagaceae	Leaves	α -Amylase, α -Glucosidase inhibition and Hypoglycemic
123	<i>Lpomoea batatas</i>	Convolvulaceae	Whole plant	Antihyperglycemic
124	<i>Luffa acutangula</i>	Cucurbitaceae	Fruit	Antioxidant and antihyperglycemic
125	<i>Madagascar periwinkle Catharanthus roseus</i>	Apocynaceae	leaf	Antioxidant ,Antihyperglycemic
126	<i>Malmea depressa</i>	Annonaceae	Root	Inhibits hepatic glucose production (gluconeogenesis)
127	<i>Mangifera indica</i>	Anacardiaceae	Stem bark/leaves	Antihyperglycemic
128	<i>Marrubium vulgare</i>	Lamiaceae	Leaves	Antihyperglycemic and dyslipidemia effect
129	<i>Mimosa pudica</i>	Fabaceae	Whole pant	Antihyperglycemic
130	<i>Momordica charantia</i>	Cucurbitaceae	Fruit	Hypoglycemic effect, Antidiabetic effect
131	<i>Morinda cetrifolia</i>	Rubiaceae	Leaves	Antioxidant and anticancerous activity
132	<i>Morus alba Morus nigra</i>	Moraceae	Whole plant	Antioxidant
133	<i>Mucuna pruriens</i>	Fabaceae	Seed	Hypoglycemic
134	<i>Murraya koenigii</i>	Rutaceae	Leaves	
135	<i>Nephelium lappaceumrin</i>	Magnoliopsida	Peel	
136	<i>Nervilia plicata</i>	Orchiaceae	Stem	Antidiabetic
137	<i>Nymphaea stellata</i>	Nymphaeaceae	Flower	α -Glucosidase inhibition
138	<i>Ocimum sanctum</i>	Labiatae	Whole plant	

139	<i>Olea europaea</i>	Oleaceae	Whole plant	Antidiabetic
140	<i>Onion Allium cepa</i>	Amaryllidaceae	bulb	to increase insulin secretion
141	<i>Ophiopogon japonicas</i>	Asparagaceae	Whole plant	
142	<i>Opuntia humifusa</i> <i>Opuntia dillenii</i>	Cactaceae	Stem, aerial part	Hypoglycemic and hypolipidemic
143	<i>Opuntia streptacantha</i>	Cactaceae	Leaves	Antihyperglycemic
144	<i>Palo fierro</i>	Fabaceae	Seed	α -Amylase inhibition
145	<i>Panax ginseng</i>	Araliaceae	Root	Increase plasma insulin level
146	<i>Panax quinquefolius</i>	Araliaceae	Bark	Hypoglycemic
147	<i>Parinari excelsa</i>	Chrysobalanaceae	Bark	Antidiabetic
148	<i>Peltophorum pterocarpum</i>	Fabaceae	Leaves/bark	
149	<i>Phalsa</i>	Grewia asiatica	Fruit	increases liver glycogen and pancreatic GSH contents
150	<i>Phyllanthus amarus</i>	Phyllanthaceae	Whole plant	Antidiabetic
151	<i>Pilea microphylla</i>	Urticaceae	Leaves	Antihyperlipidemic and antioxidant
152	<i>Pimpinella tirupatiensis</i>	Apiaceae	Tuberous root	
153	<i>Pine</i>	Pinaceae	Pine bark	A-Amylase and α -Glucosidase inhibition
154	<i>Pinyn Acontium carmichaelii</i>	Ranunculaceae	Root	Improved the glucose take rate
155	<i>Pistacia vera</i>	Anacardiaceae	Fruits hull	A-Glucosidase inhibition
156	<i>Pongamia pinnata</i>	Fabaceae	Seed/flower	α -Amylase and α -Glucosidase inhibition
157	<i>Prosopis glandulosa</i>	Fabaceae	Leaves	Hypoglycemic, hypolipidaemic and reduce insulin resistance
158	<i>Prunus amygdalus</i>	Rosaceae	Seed	Antidiabetic
159	<i>Psidium guajava</i>	Myrtaceae	Leaves	α -Amylase inhibition
160	<i>Psoralea corlifolia</i>	Fabaceae	Leaves	Antioxidant

161	<i>Pterocarpus santalinus</i> , <i>Pterocarpus marsupium</i>	Fabaceae	Bark/wood bark/leaves	Hypoglycemic, improve hyperlipidemia, antihyperglycemic mucosal ulceration
162	<i>Pueraria lobata</i>	Fabaceae	Root	Antidiabetic, α -Amylase and α -Glucosidase inhibition
163	<i>Pumpkin</i>	Cucurbitaceae	Fruit/seed	Hypoglycemic
164	<i>Punica granatum</i>	Lythraceae	Fruit	Antidiabetic
165	<i>Ramulus cinnamomi</i>	lauraceae	Aerial part	α -Glucosidase inhibition
166	<i>Rauwolfia serpentine</i>	Apocyanaceae	Leaves	Hypoglycemic
167	<i>Rheum emodi wall ex.</i>	Polygonaceae	Rhizome	α -Glucosidase inhibition
168	<i>Rhus verniciflua</i>	Anacardiaceae	Stem	α -Glucosidase inhibition
169	<i>Ricinus communis</i>	Euphorbiaceae	Root	Antidiabetic
170	<i>Rosa damascene</i>	Rosaceae	floret	α -Glucosidase inhibition
171	<i>Rosmarinus officinalis</i>	Lamiaceae	Aerial part	Antidiabetic and α -Glucosidase inhibition
172	<i>Rumex patientia</i>	Polygonaceae	Seed	Antihyperglycemic and antihyperlipidemia
173	<i>Salacia reticulate</i> , <i>Salacia oblonga wall</i>	Celastraceae	Leaves/root bark	α -Glucosidase inhibition, Antidiabetic
174	<i>Salvadora persica</i>	Salvadoraceae	wood	α -Glucosidase inhibition
175	<i>Sanguisorba minor</i>	Rosaceae	Aerial part	α -Glucosidase inhibition
176	<i>Sarcopoterium spinosum</i>	Rosaceae	Root	Antidiabetic
177	<i>Sea pea</i> <i>Lathyrus japonica</i>		Seed	increase insulin sensitivity, improve lipid metabolism
178	<i>Sechium edule</i>	Cucurbitaceae	Fruit	Antioxidant and hyperglycemic
179	<i>Selaginella tamariscina</i>	Selaginellaceae	Aerial part	Antihyperglycemic and antihyperlipidemia
180	<i>Silybum marianum</i>	Asteraceae	Whole plant	Antihyperglycemic
181	<i>Smallanthus sonchifolius</i>	Asteraceae	Root/leaves	Hypolipidemic, antidiabetic
182	<i>Solanum melongena</i>	Solanaceae	Fruit	Antioxidant and hyperglycemic

183	<i>Solanum torvum</i>	Solanaceae	Fruit	Antihyperglycemic and regeneration of β -cell
184	<i>Sorghum</i>	Cereal crop	Grain	α -Amylase and α -Glucosidase inhibition
185	<i>Stevia rebaudiana</i>	Asteraceae	Leaves	Hypoglycemic
186	<i>Sugar apple</i> <i>Annona squamosa</i>	Annonaceae	leaf	increased the activities of insulin, C-peptide
187	<i>Symplocos cochinchinensis</i>	Symplocaceae	Leaves	Antidiabetic
188	<i>Syzygium cumini</i>	Myrtaceae	Leaves/fruit/seed/bark	α -Amylase inhibition, β -cell regeneration
189	<i>Tanner's Cassia</i>	Cassia auriculata	flower extract	Antidiabetic
190	<i>Tectona grandis</i>	Lamiaceae	Flower	Antidiabetic, antihyperlipidemic and antioxidant
191	<i>Terminalia bellerica</i>	Cobretaceae	Fruit	Antioxidant, α -Amylase, α -Glucosidase inhibition, promote insulin secretion, regenerate β -cells and antiglycation
192	<i>Tetracera scandens</i>	Dilleniaceae	Leaves	Antihyperglycemic
193	<i>Teucrium capitatum</i>	Lamiaceae	Whole plant	Antidiabetes
194	<i>Thymus serpyllum</i>	Lamiaceae	Aerial part	α -Glucosidase inhibition
195	<i>Tinospora cordifolia</i>	Menispermaceae	Stem	Antioxidant, anti-cataract activity, improves the imbalance in lipid metabolism in diabetes
196	<i>Tribulus terrestris</i>	Zygophyllaceae	Whole plant	Antioxidant, Antidiabetic
197	<i>Trichosanthes cucumerina</i>	Cucurbitaceae	Fruit	Antioxidant and Hypoglycemic
198	<i>Trigonella berythea</i>	Fabaceae	Whole plant	Antidiabetic
199	<i>Uncaria tomentosa</i>	Rubiaceae	Leaves/bark	Antidiabetes
200	<i>Vaccinium arctostaphylos</i>	Ericaceae	fruits	α -Glucosidase inhibition
201	<i>Vaccinium bracteatum tumb</i>	Ericaceae	Leaves	Hypoglycemic
202	<i>Verbascum kermanensis</i>	Scrophulariaceae	Leaves	α -Glucosidase inhibition
203	<i>Vitis vinifera L.</i>	Vitaceae	Seed/skin	Antidiabetic
204	<i>Zataria multiflora</i>	Lamiaceae	Aerial part	α -Glucosidase inhibition
205	<i>Zhumeria majdae</i>	Lamiaceae	leaves	α -Glucosidase inhibition

206	<i>Zingiber officinale</i>	Zingiberaceae	Root	Hypoglycemic and antioxidant
207	<i>Zizyphus spinachristi</i>	Rhamnaceae	Leaves	Antidiabetic
208	<i>Zygophyllum album</i>	Zygophyllaceae	Leaves/root	Recovery β -cell damage and antioxidant

Conclusion

This review concluded list of medicinal plants and traditional medicines in the management of diabetes. Most of people used medicinal plants and traditional medicines in the management of their diabetes, either alone or in combination with conventional medicines. Most of the traditional medicines were plant products that were cheap and widely available locally. Although traditional medicines have potential benefits, they also have potential adverse effects. Presently there is limited understanding of the physiological effects of most of the traditional medicines that were widely used, so it is not likely to assess whether these medicines were beneficial, harmful, or both. In view of this, the findings reveal a need for further research to identify the bioactive compounds present in these medicinal plants and to determine their efficacy at a physiological level.

References

1. World Health Organization Diabetes Fact Sheet. [Accessed June 16, 2023]. <http://www.who.int/mediacentre/factsheets/fs312/en/>
2. Diabetes UK know Diabetes fight Diabetes. [Accessed May 20, 2023] <https://www.diabetes.org.uk/guide-to-diabetes/complications>
3. Akbar, S. (2020). Handbook of 200 medicinal plants: a comprehensive review of their traditional medical uses and scientific justifications.
4. Pandeya, K.B. & Tripathi, Indra & Mishra, Mahendra & Dwivedi, N. & Pardhi, Yogesh & Kamal, A. & Gupta, Pragati & Mishra, Chinmayi. (2013). *A critical review on traditional herbal drugs: An emerging alternative drug for diabetes*. Int J Org Chem. 3. 1-22.
5. American Diabetes Association. [Accessed May 20, 2023] <https://diabetes.org/diabetes>
6. Hemler, E. C., & Hu, F. B. (2019). Plant-Based Diets for Personal, Population, and Planetary Health. *Advances in Nutrition*, 10(Supplement_4), S275–S283.
7. Modak, M., Dixit, P., Londhe, J., Ghaskadbi, S., & Devasagayam, T. P. (2007). Indian herbs and herbal drugs used for the treatment of diabetes. *Journal of clinical biochemistry and nutrition*, 40(3), 163–173.
8. Cefalu WT, Stephens JM, Ribnicky DM. Diabetes and Herbal (Botanical) Medicine. In: Benzie IFF, Wachtel-Galor S, editors. *Herbal Medicine: Biomolecular and Clinical Aspects*. 2nd edition. Boca Raton (FL): CRC Press/Taylor & Francis; 2011. Chapter 19.
9. Deshpande, A. D., Harris-Hayes, M., & Schootman, M. (2008). Epidemiology of diabetes and diabetes-related complications. *Physical therapy*, 88(11), 1254–1264.
10. Kasole, R., Martin, H. D., & Kimiywe, J. (2019). *Traditional Medicine and Its Role in the Management of Diabetes Mellitus: "Patients' and Herbalists' Perspectives."* *Evidence-Based Complementary and Alternative Medicine*, 2019, 1–12.
11. Kooti, Wesam; Farokhipour, Maryam; Asadzadeh, Zahra; Ashtary-Larky, Damoon; Asadi-Samani, Majid (2016). *The role of medicinal plants in the treatment of diabetes: a systematic review*. *Electronic physician*, 8(1), 1832–1842.
12. Kumar, S., Mittal, A., Babu, D., & Mittal, A. (2021). Herbal medicines for diabetes management and its secondary complications. *Current diabetes reviews*, 17(4), 437–456.
13. McMacken, M., & Shah, S. (2017). A plant-based diet for the prevention and treatment of type 2 diabetes. *Journal of geriatric cardiology : JGC*, 14(5), 342–354.
14. Rutebemberwa, E., Lubega, M., Katureebe, S.K. *et al.* Use of traditional medicine for the treatment of diabetes in Eastern Uganda: a qualitative exploration of reasons for choice. *BMC Int Health Hum Rights* 13, 1 (2013).
15. Choudhury, H., Pandey, M., Hua, C. K., Mun, C. S., Jing, J. K., Kong, L., ... Kesharwani, P. (2018). An update on natural compounds in the remedy of diabetes mellitus: A systematic review. *Journal of Traditional and Complementary Medicine*, 8(3), 361–376.
16. Tran, N., Pham, B., & Le, L. (2020). Bioactive Compounds in Anti-Diabetic Plants: From Herbal Medicine to Modern Drug Discovery. *Biology*, 9(9), 252. doi:10.3390/biology9090252
17. Rao, M. U., Sreenivasulu, M., Chengaiah, B., Reddy, K. J., & Chetty, C. M. (2010). Herbal medicines for diabetes mellitus: a review. *Int J PharmTech Res*, 2(3), 1883-1892.
18. Andrade, C., Gomes, N. G., Duangsrisai, S., Andrade, P. B., Pereira, D. M., & Valentao, P. (2020). Medicinal plants utilized in Thai Traditional Medicine for diabetes treatment: ethnobotanical surveys, scientific evidence and phytochemicals. *Journal of ethnopharmacology*, 263, 113177.
19. Nagaraju, N., & Rao, K. N. (1989). Folk-medicine for diabetes from rayalaseema of andhra pradesh. *Ancient science of life*, 9(1), 31.

20. Batiha, G. E. S., Shaheen, H. M., Elhawary, E. A., Mostafa, N. M., Eldahshan, O. A., & Sabatier, J. M. (2023). Phytochemical Constituents, Folk Medicinal Uses, and Biological Activities of Genus *Angelica*: A Review. *Molecules*, 28(1), 267.
21. Khan, M. S. A., & Ahmad, I. (2019). Herbal medicine: current trends and future prospects. In *New look to phytomedicine* (pp. 3-13). Academic Press.
22. Moradi, B., Abbaszadeh, S., Shahsavari, S., Alizadeh, M., & Beyranvand, F. (2018). The most useful medicinal herbs to treat diabetes. *Biomedical Research and Therapy*, 5(8), 2538-2551
23. Jarald, E., Joshi, S. B., & Jain, D. (2008). Diabetes and herbal medicines.
24. Rayate, A. S., Nagoba, B. S., Mumbre, S. S., Mavani, H. B., Gavkare, A. M., & Deshpande, A. S. (2023). Current scenario of traditional medicines in management of diabetic foot ulcers: A review. *World Journal of Diabetes*, 14(1), 1.