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A review: Herbal antidiabetic drugs

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Abstract
Diabetes mellitus is a systematic metabolic disease characterized by hyper-glycemia, hyper-aminoacidemia and hypoinsulinemia. It occurs when there are elevated levels of glucose in a person's blood because their body is unable to produce part or sufficient amount of the insulin hormone. Herbal medications are effective at preventing diabetes and its associated complications. Consequently, the research progresses for a maximum of explorations of the hypoglycemic potential of herbs. The anti-diabetic activity of herbal remedies is mainly due to increased pancreatic secretion of insulin, inhibition of glucose production in the liver. In this study, many authors have collected more information on the plant-based plant compounds that have been studied for diabetes. A few medicinal plants traditionally used for diabetic treatment containing chemical constituents like polyphenols, alkaloids, glycosides, flavonoids, polysaccharides and terpenoids.

Keywords: Diabetes mellitus, medicinal plants, anti-diabetic, hypoglycemic

Introduction
Diabetes mellitus (DM) is a severe, chronic and complex metabolic disorder with multiple causes that has profound consequences, both acute and chronic. Also known only as diabetes, DM and its complications affect the populations of developing and developed countries, which presents a major socio-economic challenge [1]. An estimated 25% of the world's population is affected by this disease [2]. Genetic and environmental factors contribute significantly to the development of diabetes [3]. Diabetes mellitus is caused by abnormal carbohydrate metabolism, which is associated with low blood insulin [4]. During the development of diabetes, the cells of the body are not able to metabolize sugar properly due to the deficient action of insulin on target tissues resulting from insensibility or lack of insulin. (A peptide hormone that regulates blood glucose). The inability of insulin to metabolize sugar occurs when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. This triggers the body to break down its own fat, protein, and glycogen to produce sugar, leading to the presence of high sugar levels in the blood with excess by-products called ketenes being produced by the liver [1]. Uncontrolled diabetes result in a plethora of complications affecting the vascular system, eyes, nerves, and kidneys leading to peripheral vascular disease, nephropathy, neuropathy, retinopathy [5].

Types of Diabetes mellitus
Type 1 Diabetes: It is a chronic autoimmune disease associated with selective destruction of insulin producing pancreatic β-cells. Type 1 diabetes is often referred to as insulin-dependent (IDDM) or juvenile-onset diabetes [7].
Type 2 Diabetes: Type 2 diabetes mellitus is also known as adult-onset diabetes Interplay of genetics and lifestyle factors plays a vital role. Being obese or overweight increases the associated risks [6].

Mechanism of oral antidiabetic agents [8]
- Stimulation of beta cells in the pancreas to produce more insulin (sulfonylureas and meglitinides).
- Increasing the sensitivity of muscles and other tissues to insulin (thiazolidinediones).
- Decreasing gluconeogenesis by the liver (biguanides).

- Delaying the absorption of carbohydrates from the gastrointestinal tract (alpha-glucosidase inhibitors).

According to the World Health Organization (WHO), up to 90% of the population in developing countries uses plants and its products as traditional medicine for primary health care. The WHO has listed 21,000 plants, which are used for medicinal purposes around the world. Among these, 2500 species are in India [9]. There are about 800 plants which have been reported to show antidiabetic potential. A wide collection of plant-derived active principles representing numerous bioactive compounds have established their role for possible use in the treatment of diabetes [10].

Antidiabetic phytoconstituents and their mode of activity

Alkaloids: The role of alkaloids in the management of diabetes and numerous alkaloids isolated from different medicinal plants were found active against diabetes. Like other natural products, alkaloids regulate glucose metabolism either byinhibiting or inducing multiple candidate proteins including AMP-activated protein kinase, glucose transporters, glycogen synthase kinase-3, sterol regulatory element-binding proteins 1, glucokinase, -6-phosphatase, Acetyl-CoA carboxylase among the others [11].

Flavonoids: Suppressed the glucose level, reduced plasma cholesterol and triglycerides significantly and increased their hepatic glucokinase activity probably by enhancing the insulin release from pancreatic islets [12].

Polysacharides: Inccrease the level of serum isuline, reduce the blood glucose level and improve tolerance of glucose [13].

Saponin: Stimulate the release of insulin and blocks the formation of glucose in bloodstream [14].

Terpenoids: The glucose homoestasis by regulating glucose production and storage in the formation of glycogen. And targeting these PPAR γ by receptor agonists is an attractive pharmacological target both for prevention and treatment of metabolic disorders that includes DM [15].

Dietary fibers: effectively absorbed glucose, retard glucose diffusion and inhibit the activity of alpha amylase and may be responsible for decreasing the rate of glucose absorption [16].

In this journal article, an attempt has been made to compile the reported hypoglycemic plants available in various scientific journals and can be useful to health professionals, scientists and academics working in the pharmacology and therapeutic field to produce evidence alternative medicine based on curing various types of diabetes in humans and animals. This journal highlights the importance and interest in medicinal plants in the drive to demonstrate their antidiabetic effects and the responsible bioactive agents. This review also covers the common name of a plant, botanical name of plants, parts plants that are used, chemical constituent, and activity.

Table 1: Medicinal Plants Used in Diabetes Mellitus

Sr. No.	Botanical Name	Common Name	Family	Parts Used	Extract	Chemical Constituents	Activity	References
1	*Abrus Precatorious*	Gunja	Fabaceae	Seed	Ethanol	Phenol, Flavonoid	Antidiabetic	17
2	*Acacia Nilotica*	Babool	Fabaceae	Stem Bark	Aqueous	Flavonoids, Alkaloids,Tannins, Phenolic Compounds, Saponin	Antidiabetic	18,19
3	*Acacia Catechu*	Cutch Tree	Leguminosae	Bark	Petroleum Ether, Chloroform, Acetone, Ethanol, Aqueous	Carbohydrates, Alkaloids, Tannins, Flavonoids And Saponins	Hypoglycemic Effect	20,21
4	*Adansonia Digitata*	Baobab	Malvaceae	Fruit Pulp	Methanol	Glycosides, Flavonoids, Tannins, Saponins, Terpenoids	Antidiabetic	22
5	*Adhatoda Vasica*	Adulsa	Acanthaceae	Leaves	Methanol	Vasicine And Vasicinol	Antidiabetic	23
6	*Aegle Marmelose*	Bael	Rutaceae	Seeds	Aqueous	Alkaloid, Terpenoid	Antidiabetic	24,25
7	*Agrimonia Eupatoria*	Agrimony	Rosaceae	Leaves	Aqueous	Glucoside Alkaloid, Terpenoid	Antidiabetic	26
8	*Allium Cepa*	Onion	Amaryllidaceae	Onion Bulbs	Ether	Phenol, Flavonoid,Glycosides	Antidiabetic	27,28
9	*Allium Sativum*	Garlic	Amaryllidaceae	Garlic Bulb	Aqueous	Allyl Propyl Disulfide, Allicin, Cysteine Sulfoxide, And S-Allyl Cysteine Sulfoxide	Hypoglycemic	28,29,30
10	*Aloe Barbadensis*	Aloe Vera	Asphodelaceae	Leaf Pulp	-	Lopphenol, 24-Methylophenol, 24-Ethylophenol	Antidiabetic	31
11	*Andrographis Paniculata*	Green Chiretta	Acanthaceae	Leaves	Methanol, Petrolium Ether, Aqueous	Steroids, Phenols, Terpenoids, Alkaloids, Saponins, Flavonoids	Hypoglycemic And Hypolipidemic	32,33
12	*Cassia Angustifolia*	*Senna*	Fabaceae	Leaves	Aqueous	Anthracine Glycoside, Flavonoid, Saponin	Antihyerglycemic, Antihyperlipidemic	34
13	*Anthocephalus Indicus*	Kadamba	Rubiaceae	Root	Ethanol	Alkaloids, Secoiridoids, Triterpenes And Saponins	Antidiabetic, Hypoglycemic	35
14	*Azadirachta Indica*	Neem	Meliaceae	Leaves	Hydroalcoholic	Nimbidine	Anti-Hyperglycemic, Hypoglycemic	36
15	*Benincasa Hispida*	White Gourd	Cucurbitaceae	Stem	Aqueous	Steroids, Tannins, Alkaloids, Carbohydrates, Flavonoids And Glycosides	Hypoglycemic	37
16	*Berginia Ligulata*	Prashanbheda	Saxifragaceae	Roots And Leaves	Ethanol, Hexane, Ethyl Acetate, Chloroform, Butanol And Aqueous	B-Sitosterol, Tannic Acid, Stigmesterol, Gallic Acid, Bergenin	Alpha Glycosidase Inhibitor And Antidiabetic	38
17	*Beta Vulgaris*	Beet	Amaranthaceae	Root	Juice	Polyphenols, Flavonoids, Betalains,Ascorbic Acid, And Dehydroascorbic Acid	Antidibetic	39,40
18	*Boehavia Diffusa*	Punarnava	Nyctaginaceae	Root	Methanol	Phenolic, Flavonoid	Antidibetic	41
19	*Bombax Ceiba*	Silk Cotton	Malvaceae	Bark	Petrolium Ether, Ethyl Acetate, Ethanol	Triterpenoids	Anti-Hyperglycemic, Antidibetic	42
20	*Bougainvillea Spectabilis Willd*	Bougainvillea	Nyctaginaceae	Stem Bark	Methanol	Pinitol, B-Sitosterol, Quercetin	Antidiabetic, Antihyperglycemic	43

21	Butea Monosperma	Flame-Of-The-Forest	Fabaceae	Flower	Methanol	Flavonoids, Steroids, Phenolic Contents, Glycosides.	Antidiabetic	44
22	*Caesalpinia Bonducella*	Grey Nicker	Fabaceae	Whole Plant	Hydro-Ethanolic	Alkaloids, Carbohydrates, Glycosides, Phenol, Tannins, Saponins, Phytosterols,	Antidiabetic, Antihyperglycemic	45
23	*Carica Papaya*	Papaya	Caricaceae	Seed	Aqueous	Flavonoids, Alkaloids And Tannins	Antihyperglycemic, Hypolipidemic	46
24	*Cassica Auriculata*	Avartaki	Caesalpiniaceae	Flowers	Hydromethanolic	Phenolic Compounds, Carbohydrates, Tannins, Steroids	Antidiabetic	47
25	*Catharanthus Roseum*	Periwinkle	Apocynaceae	Whole Plant	Methanolic	Vindoline,Quercetin,Coumaric	Antidiabetic	48
26	*Centratherum Anthelminticum*	Kalijiri	Asteraceae	Seed	Aqueous	Flavonoids, Steroids, Glycosides	Antidiabetic, Hypoglycemic	49
27	*Cinnamon Zeylanicum*	Dalchini	Lauraceae	Quills	Aqueous	Cinnamon. Benzoic Acid, Cinnamyl Alcohol, Benzyl Alcohol, And 4-Allyl-2,6-Dimethoxyphenol	Antidiabetic	50
28	*Citrullus Colocynthis* Schrad	Bitter Cucumber	Cucurbitaceae	Seed	Aqueous	Phenolic Compounds,Flavonoid	Antidiabetic,Anti-Hyperlipidemic	51
29	*Costus Speciosus*	Crepe Ginger	Costaceae	Rhizome	Ethanolic	Coumarin, Quinones And Sulphur	Antidiabetic	52
30	*Curcuma Longa*	Turmeric	Zingiberaceae	Rhizome	Hexane, Ethyl Acetate, Methanol, 70% Methanol And Water	Phenolics Curcuminoids	Antidiabetic	53
31	*Cyamposis Tetraagonoloba*	Cluster Bean	Leguminosae	Beans	Ethanol	Tannins, Coumarins, Or Flavonoids,	Antihyperglycemic	54
32	*Decalepia Hamiltonii*	Swallow-Root	Apocynaceae	Root	Methanol	Flavonoids, Tannins, Alkaloids	Antidiabetic	55
33	*Dioscorea Bulbifera*	Air Yam	Dioscoreaceae	Fresh Tubers	Methanol	Alkaloids, Flavonoids, Tannins, Saponins, Steroids, Terpenoids	Antidiabetic	56
34	*Emblica Officinalis*	Amla	Phyllanthaceae	Leaves	Hydro-Methanolic	Tannins, Polyphenolic Compound And Flavonoids	Hypoglycemic,Antidiabetic	57
35	*Embelia Ribes*	Black Pepper	Myrisinaceae	Berries	Ethanol	Embelin, Alkaloid,Resinoid, Tannins	Antidiabetic, Hypoglycemic	58
36	*Ficus Bengalenesis*	Banyan	Moraceae	Fruit, Aerial Root And Bark	Ethanol, And Aqueous	Pentacyclic Triterpenes And Triterpenoids, Coumarin, Sterols	Hypoglycemic & Hypoli[Pidemic	59
37	*Gymne Sylvestre*	Gurmar	Asclepiadaceae	Leaves	Ethanol	Anthraquinones, Flavones,Tritepenoid	Anti-Diabetic	60
38	*Hibiscus Rosasinesis*	Shoe Flower	Malvaceae	Flower	Methanol, Ehanol, Aqueous	Tannins, Anthraquinones, Quinines	Hypoglycemic, Antihyperglycaemic	61,62
39	*Holarrhena Antidysenterica*	Kutaja	Apocynaceae	Stem Bark	Methanol	Flavonoides, Phenolic Compounds	Antihyperglycemic, Hypoglycemic	63
40	*Hordeum vulgare*	Barley	Poaceae	Leaves	Hydroalcoholic	Phenolics Componds: Ferulic Acid, Naringin, And Catechin	Hypoglycemic	64,65
41	*Ichnocarpus Racemose*	Black Creeper.	Apocynaceae	Leaves	Hydroalcoholic	Flavonoids, Polyphenolic Compounds	Anti-Diabetic And Antihyperlipidemic	66
42	*Ipomoea Batatas*	Sweet Potato	Convolvulaceae	Root	Methanol	Glycoprotein, Anthocyanins, Alkaloids, And Flavonoids	Antidiabetic	67
43	*Senna Tora*	Sicklepod	Caesalpiniaceae	Seed	Ethanol	Alkaloids, Berberine. Palmatine, Tembetarin, Magnoflorine Choline, Tinosporin Isocolubin	Antidiabetic	68
44	*Jatropha Curcus*	Purging Nut	Euphorbiaceae	Root	Aqueous	Flavonoids, Tannins, Saponin And Phlobatannin	Hypoglycaemic	69
45	*Lepidium Sativum*	Garden Cress	Brassicaceae	Seed	Methanol	Polyphenols, Flavonoids	Hypoglycemic	70
46	*Lowsonia Inermis*	Henna Tree	Lythraceae	Whole Plant	Ethanol	Mannite, Tannic Acid, Gallic Acid And Naphtaquinone	Hypoglycemic, Antihyperglycemic	71
47	*Mangifera Indica*	Mango	Anacardiaceae	Leaves	Aqueous	Phenol And Flavonoid	Hypoglycemic	72
48	*Melia Azadarach*	Chinabery Tree	Meliaceae	Twigs	Ethanol	Polyphenolic, Flavonoids, Terpenoids, Anthraquinones And Saponins	Hypoglycaemic	73
49	*Momordica Charantia*	Bitter-Melon	Cucurbitaceae	Fruit	Ethanol	Saponins And Cucurbitane Triterpenoids	Stimulate Insuline Secretion (Antidiabetic)	74,75
50	*Moringa Oleifera*	Drumstick Tree	Moringaceae	Leaves	Aqueous/ Ethanol	Moringinine, Quercetin And Chlorogenic Acid	Hypoglycaemic	76
51	*Morus Alba*	Kalpa Vruksha	Moraceae	Leaves	Ethanol	Flavonoid,Polysaccharides, Glycopeptides And Ecdysteroid	Antidiabetic	77
52	*Mucuna Pruriens*	Velvet Bean	Leguminoseae	Seed	Ethanol	Glutathione, Gallic Acid, And Beta-Sitosterol Alkaloid	Antidiabetic	78,79
53	*Musa Paradisiacal*	Banana	Zingiberales	Leaves, Fruit Peels, Stems And Roots	Ethanol	Carbohydrates, Catecholamines, L Flavonoids And Glycoside	Antidiabetic	80
54	*Myristica Fragrance*	Nutmeg	Myristicaceae	Rhizome	Hydroalcoholic	Flavanoids, Alkaloids, Glycosides, Polysaccharides, And Peptidoglycans	Antihyperglycemia And Antihyperlipidemia	8186,
55	*Nigella Sativa*	Black Cumin	Ranunculaceae	Seed	Methanol	Flavanoids, Carotenoids	Antidiabetic	82
56	*Ocimum Sanctum*	Holy Basil	Lamiaceae	Whole Plant	Hydroalcohol	Rosmarinic Acid, Stigmasterol, Linalool, Bieugenol, And Aesculin	Antidiabetic	83
57	*P. Santalinus*	Red Sandalwood	Fabaceae	Heartwood	Methanol	Terpinoids	Antidiabetic	84

58	*Paspalum Scrobiculatum*	Kodo Millet	Poaceae	Seed	Ethanol	Phenolic Compounds	Antidiabetic	85
59	*Phyllanthus Amarus*	Gale Of The Wind	Phyllanthaceae	Leaves	Aqueous	Saponins, Flavonoids Lignans Alkaloid And Cardiac Glycosides	Antidiabetic	86,87
60	*Polyalthia Longifolia Var*	Ashoka	Annonaceae	Leaves	Aqueous	Terpenes, Non-Reducing Sugar	Hypoglycemic	88
61	*Psidium Guajave*	Guava	Myrtaceae	Leaves	Methanol	Alkaloids,Flavones, Tannins, Steroidal Glycosides,Coumarin	Antidiabetic	89
62	*Pterocarpus Marsupium*	Vijayasar	Fabaceae	Wood, Bark Combined Extract Of Wood And Bark	Ethanol	Alkaloids Coumarins, Flavonoids, Glycosides, Terpenoids, Tannins,	Antidiabetic, Antihyperlipidaemic	90
63	*Rauwolfia Serpentine*	Devil Pepper	Apocynaceae	Root	Methanol	Flavonoids, Saponins And Alkaloids	Antidiabetic	91
64	*Rheum Emodi*	Rhubarb	Polygonaceae	Rhizomes	Chloroform	Anthraquinons	Antidiabetic	92
65	*Syzygium Cumini.*	Jambul	Myrtaceae	Seeds, Fruit	Ethyl Acetate	Flavonoids, Triterpenoid	Hypoglycemic And Hypolipidemic	93,94
66	*Salacia Reticulate*	Kothala Himbutu	Hypocrataceae	Root Bark	Aqueous	Salacinol, Kotalanol, Ponkorinol, Salaprinol	Petroleum Ether, Chloroform And Methanol	95
67	*Saraca Indica*	Asoka Tree	Caesalpinaceae	Leaves	Petroleum Ether, Chloroform And Methanol	Glycoside, Flavanoids, Tannins, Saponins	Antihyperlipidaemic	96
68	*Scoparia Dulcis*	Goatweed	Plantaginaceae	Whole Plants	Ethanol	Scoparic Acid D (SAD), A Diterpenoid	Antihyperglycaemic	97
69	*Solanum Nigrum*	Black Nightshade	Solanaceae	Berries	Aqueous	Flavonoids, Alkaloids, Saponins, Tannins, Glycosides, Terpenoids, Proteins, Resin	Antidiabetic	98
70	*Stevia Rabudiana*	Stevia, Honey Leaf	Asteraceae	Leaves	Aqueous	Diterpene Glycosides Including Stevioside,	Antidiabetic	99
71	*Strychnos Potatorum*	Clearing-Nut Tree	Loganiaceae	Leaves & Seeds	Methanol	Steroids, Alkaloids, Tannins And Reducing Sugars	Antihyperglycaemic	100
72	*Annona squamosa*	Sugar Apple	Annonaceae	Leaves	Methanol	Phenolic Compounds, Gallic Acid, Ferullic Acid, Caffeic Acid,Cinnamic Acid And Quercetin	Antidiabetic	101
73	*Swertia Chirayita*	Chiretta	Gentinaceae	Whole Plants	Ethanol And Aqueous	Phenolic Compounds	Antidiabetic	102
74	*Syzygium Alternifolium*	Arcot	Myrtaceae	Seed	Petroleum Ether, Chloroform, Acetone,Methanol, And Water	Cuminoside, Sterols, Alkaloids, Carbohydrates, Tannins, Phenols	Hypolipidemic And Hypoglycemic	103
75	*Talinum Portulacifolium*	Surinum Purslane	Portulacaceae	Leaves	Methanol	Flavonoids, Alkaloids, Glycoside, And Phenolic	Hypoglycemic And Hypolipidaemic	104
76	*Tecoma Stansi*	Yellow Elder	Bignoniaceae	Leaves	Methanol	Flavonoids, Alkaloids	Anti-Hyperglycemic	105
77	*Tinospora Cordifolia*	Guduchi	Menispermaceae	Stem	Methanol	Alkaloids(Palmatine, Jatrorrhizine And Magnoflorine)	Hypoglycemic	106
78	*Tribulus Terestris*	Gokharu	Zygophyllaceae	Leaves, Stems And Flowers	Methanol	Flavonoids, Anthraquinone, And Phenolic Compounds And Saponin	Anti-Hyperglycaemic	107
79	*Trigonella Foenum*	Methi	Leguminosae	Seed	Methanol	Alkaloid Trigonelline With Mucilage, Tannic Acid,	Hypoglycemic	108
80	*Withania Somnifera*	Ashwagandha	Solanaceae	Root	Methanol	Catechin, Withenoid	Antidiabetic	109
81	*Swietenia Macrophylla*	Sky Fruit	Meliaceae	Seed	Petroleum Ether, Chloroform, And Methanol	Fucosterol And B-Sitosterol	Anti-Hyperglycaemic	110
82	*Withania Coagulans*	Panir Full	Solanaceae	Fruit	Aqueous	Alkaloids And Steroids	Hypoglycemic And Antidiabetic	111
83	*Achyranthes Aspera*	Chaff-Flower	Amaranthaceae	Leaves	Ethanol	F Alkaloids, Phenolics, Flavonoids, Saponins, Carbohydrates, Steroids And Terpenoids	Antidiabetic	112
84	*Quassia Amara*	Bitter-Wood	Simaroubaceae	Stem Wood	Methanol	Quassin And Neoquassin	Antidiabetic	113
85	*Picrorhiza Kurroa*	Kutki	Scrophulariaceae	Whole Plant	Aqueous	Phenolic Compounds (Kutkin, Kutkoside)	Antidiabetic	114

Conclusion

In this present review work, medicinal plant species showed that they have anti-diabetic activity. Many of these species have alkaloids, flavonoids, steroids, poly phenol, polysaccharides. Diabetes mellitus is a metablolic disease which is characterized by the presence of high concentration of glucose in the blood. So many therapies are available to treat the diabetes. However, the allopathic medicines producing several unwanted side effects. The herbal medicines having similar mechanism of action as allopathic medicines but it has negligible side effect with low cost. Plant drugs and herbal medicines are less toxic and they are free from side effects than synthetic drugs. Ant hyperglycemic effects of the plants due to their ability to restore the pancreatic tissues. Hence, treatment with herbal drugs has an effect to protect the pancreatic β- cells and smoothing out fluctuation in the glucose levels.

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