



## Iraqi medicinal plants with hypoglycemic effects

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### Abstract

Diabetes mellitus is one of the most common endocrine metabolic disorders. It caused significant mortality due to its complications. Medicinal plants possessed hypoglycemic effects by many mechanisms. The current review discussed the medicinal plants with antidiabetic effect with special focus on their mechanism of action

**Keywords:** Diabetes; Insulin; Phytoconstituents; Pancrease; Blood glucose; Beta cell; Antidiabetic; Hypoglycaemic; Medicinal plant

### 1. Introduction

Diabetes mellitus is one of the most common endocrine metabolic disorders. It affected around 2.8% of the world's population. It caused significant mortality due to its nephropathy, retinopathy, neuropathy and cardiovascular complications. Many previous reviews showed that medicinal plants possessed antidiabetic effects. The search for more effective and safer hypoglycemic agents is one of the important areas of investigation. The medicinal plants possessed hypoglycemic effects by many mechanisms, included: enhancing regeneration or revitalization of damaged pancreatic beta cells, and protecting against further damage, enhancing insulin synthesis and secretion from the beta-cells, decreasing glucose absorption from gastro-intestinal system, increasing insulin sensitivity of the tissues, possessing of insulin mimicking effects, and changing the activity of some enzymes involved in glucose metabolism<sup>(1-3)</sup>. The current review discussed the medicinal plants with antidiabetic effect with special focus on their mechanism of action.

**Table 1** Medicinal plants possessed *in vitro* antidiabetic activity

Plants	Active extract or component	Model	Experimental animal	Ref.
<i>Canna indica</i>	polyphenolic of root	<i>In vitro</i>	glucose transport in cultured muscle cells	90-91
<i>Carthamus tinctorius</i>	N-p-coumaroyl serotonin and N-feruloyl serotonin	<i>In vitro</i>	$\alpha$ -glucosidase inhibition	104
<i>Citrullus colocynthis</i>	seed extracts	glucose-stimulated insulin release from pancreatic islets	<i>in vitro</i> rat pancreatic	124
<i>Daucus carota</i>	dichloromethane extract of carrot roots	Stimulated insulin- dependent glucose uptake assay	<i>in vitro</i> adipocytes	179-180

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	ethanol extract and ethylacetate fractions	$\alpha$ -glucosidase inhibition activity	<i>in vitro</i>	213
<i>Gossypium species</i>	aqueous extract of different parts (bark, leaf, and flower)	$\alpha$ -amylase and $\alpha$ -glucosidase inhibition	<i>in vitro</i>	225-226
<i>Hibiscus sabdariffa</i>	aqueous extracts	$\alpha$ -amylase and $\alpha$ -glucosidase inhibition	<i>in vitro</i>	245-246
<i>Leontice leontopetalum</i>	crude extract	<i>in vitro</i>	human pancreatic beta cell-treated with streptozotocin	290-292
<i>Ocimum basilicum</i>	crude extracts of the aerial parts	<i>in vitro</i> , and in alloxan induced diabetes	<i>in vitro</i> $\alpha$ -amylase and $\alpha$ -glucosidase inhibition and oral glucose tolerance in diabetic rats	345
<i>Phoenix dactylifera</i>	hydroalcoholic leaves extract, and aqueous ethanolic extract	$\alpha$ -amylase and $\alpha$ -glucosidase inhibition	<i>in vitro</i>	19-20
<i>Punica granatum</i>	The methanol extract, n-hexane extract, chloroform extract and the water fraction of flowers; extracts of pomegranate juice, peels, seeds	$\alpha$ -amylase and $\alpha$ -glucosidase inhibition	<i>in vitro</i>	21-24
<i>Rhus coriaria</i>	crude extracts	$\alpha$ -amylase inhibition	<i>in vitro</i>	25-26
<i>Saccharum officinarum</i>	polyphenol-rich sugarcane extract	on cellular pathways related to carbohydrate metabolism and the protective effect against metabolic disorders such as type 2 diabetes	<i>in vitro</i>	27
	molasses extracts	$\alpha$ -amylase and $\alpha$ -glucosidase inhibition	<i>in vitro</i>	28
<i>Sambucus nigra</i>	flower extracts	stimulate glucose uptake in primary porcine myotubes and reduce fat accumulation in <i>Caenorhabditis elegans</i>	<i>in vitro</i>	29
<i>Schinus molle</i>	fruits extracts	inhibitory effects against $\alpha$ -amylase and $\alpha$ -glycosidase	<i>in vitro</i>	30
<i>Stellaria media</i>	ethanolic leaves extract	inhibitory effects against $\alpha$ -amylase and $\alpha$ -glycosidase	<i>in vitro</i>	31
<i>Taraxacum officinale</i>	aqueous extract of shade-dried leaves	inhibitory effects against $\alpha$ -amylase and $\alpha$ -glycosidase	<i>in vitro</i>	32-33
<i>Tribulus terrestris</i>	Hexane, acetone, ethanol and aqueous extracts of fruits	$\alpha$ -amylase and $\alpha$ -glucosidase inhibitory activities	<i>in vitro</i>	34
<i>Trifolium pratense</i>	polysaccharides and formononetin	$\alpha$ -glucosidase inhibition ability	<i>in vitro</i>	35-36
	hydroalcoholic extract	pancreatic $\beta$ cell viability against against streptozotocin cytotoxicity	<i>in vitro</i>	37

<i>Tropaeolum majus</i>	Benzyl isothiocyanate	insulin-signaling pathway, the intracellular localization of the transcription factor Forkhead box O 1 (FOXO1) and, the expression of proteins involved in gluconeogenesis	<i>in vitro</i>	38
<i>Urtica dioica</i>	aqueous extract of the leaves	Its ability to stimulate insulin release from $\beta$ cells	<i>in vitro</i>	39
	aqueous extract of the leaves	inhibition of $\alpha$ -amylase	<i>in vitro</i>	40
<i>Vitex agnus-castus</i>	different extracts	$\alpha$ -amylase and $\alpha$ -glucosidase inhibitory activities	<i>in vitro</i>	41
<i>Withania somnifera</i>	Leaves and roots extracts and purified withanolides	Stimulation of insulin secretion of pancreatic beta cells	<i>in vitro</i>	42
<i>Zizyphus spina-christi</i>	aqueous and 80% ethanol extract of the fruits	$\alpha$ -amylase and $\alpha$ -glucosidase inhibitory activities	<i>in vitro</i>	43

**Table 2** Medicinal plants possessed *in vivo* antidiabetic activity

Plants	Active extract or component	Model	Experimental animal	Ref.
<i>Achillea santolina</i>	aqueous extract	streptozotocin -induced diabetes	rats	44-45
<i>Adiantum capillus-veneris</i>	alcoholic extract	oral glucose tolerance test	rabbits	46-48
<i>Agrimony eupatoria</i>	aqueous extract	streptozotocin -induced diabetes	mice	49-50
<i>Agropyron repens</i>	aqueous extract	streptozotocin -induced diabetes	mice	51-52
<i>Allium cepa</i>	ethanol, chloroform and petroleum ether extracts	alloxan, glucose and epinephrine induced diabetes	several experimental animals	53-61
	aqueous extract	alloxan induced diabetes	rabbits	62
<i>Allium sativum</i>	aqueous, ethanol, petroleum ether, or chloroform extract, or the essential oil	Normal, alloxan and streptozotocin -induced diabetes	rabbits, rats and mice	63-64
	aqueous extract and S-allyl cysteine sulphoxide, (allicin)	alloxan induced diabetes	rats	65-66
	garlic oil and diallyl trisulphide	streptozotocin -induced diabetes	rats	67
	Garlic juice	alloxan induced diabetes	rabbits	68
<i>Aloe vera</i>	Aloe gel	diabetic and normal	mice	69-73
<i>Alpinia galanga</i>	powdered rhizome	normoglycemic rabbits	rabbits	74-75
	Ethanol extract	glucose uptake model in diabetic rats	rats	76
<i>Althaea officinalis</i>	polysaccharide from the root	Normoglycemic	mice	77-78

	scopoletin	hyperglycemia in levo-thyroxine-induced hyperthyroid rats	rats	79
<i>Anchusa strigosa</i>	aqueous extract	streptozotocin -induced diabetes	rats	80-81
<i>Anthemis nobelis</i>	aqueous extract and flavonoid extract	streptozotocin -induced diabetes	rats	82-84
<i>Arctium lappa</i>	ethanolic extract	streptozotocin -induced diabetes	rats	85-86
<i>Artemisia campestris</i>	aqueous leaf extracts	alloxan-induced diabetes	rats	87-89
<i>Asparagus officinalis</i>	methanolic seed extract and aqueous extract of asparagus by-product	streptozotocin -induced diabetes	rats	90-92
<i>Avena sativa</i>	ethanolic extract	induced diabetes (not specified)	mice	93-94
<i>Ballota nigra</i>	aqueous extract	alloxan-induced diabetes	rats	95-96
<i>Benincasa hispida</i>	stem chloroform extract	Normoglycemic	rats	97-98
	crude extract	normoglycemic	mice	99
<i>Brassica nigra</i>	extracts of the seeds	streptozotocin -induced diabetes	rats	100-102
<i>Brassica rapa</i>	roots ethanol extract	Type 2 induced diabetes	mice	103
<i>Bryophyllum calycinum</i>	aqueous extract	streptozotocin -induced diabetes	rats	104-107
<i>Caesalpinia crista</i>	seed powder	alloxan-induced diabetes	rabbits	108-109
	seed extract	alloxan-induced diabetes	rats	110-111
	ethanolic and aqueous seed extracts	streptozotocin -induced diabetes	pup's models	112
	aqueous and 50% ethanolic seed extracts	normal and streptozotocin -induced diabetes	rats	113
	hydromethanolic extract	streptozotocin -induced diabetes	rats	114
<i>Calotropis procera</i>	root extracts	streptozotocin -induced diabetes	rats	115-116
	dried latex	alloxan-induced diabetes	Rats	117-118
	root methanol, stem methanol and leaf ethyl-acetate extracts	streptozotocin -induced diabetes	rats	119
<i>Capparis spinosa</i>	fruit extract	streptozotocin -induced diabetes	rats	120-123
<i>Capsicum annum and Capsicum frutescens</i>	capsaicin	Normoglycemic	dogs	124
<i>Carum carvi</i>	aqueous and ethanolic extract	streptozotocin -induced diabetes	rats	125-129
<i>Carthamus tinctorius</i>	crude extract	alloxan induced diabetes	rabbits	130-131
<i>Casuarina equisetifolia</i>	crude squeeous and methanolic leaf extracts	alloxan induced diabetes	rats and mice	132-136

<i>Casuarina equisetifolia</i>	leaves ethanolic extract	streptozotocin -induced diabetes	rats	137-138
<i>Cicer arietinum</i>	petroleum ether extract	alloxan induced diabetes	mice	139
<i>Cichorium intybus</i>	crude extract	alloxan induced diabetes	rats	140-141
	ethanolic extract	streptozotocin induced diabetes	rats	142
	crude extracts	hyperglycemic model	mice	143
<i>Cistanche tubulosa</i>	crude extract (equivalent to 120.9, 72.6 or 24.2 mg verbascoside/kg)	type 2 diabetes model	mice	144-145
	acylated phenylethanoid glycosides (echinacoside and acteoside)	starch-loaded model	mice	146
<i>Citrus species</i>	hexane extract of <i>Citrus limon</i> peel	alloxan induced diabetes	rats	147-148
	petroleum ether extract of <i>Citrus medica</i> seeds	streptozotocin induced diabetes	rats	149
	methanol extract of <i>Citrus limetta</i> fruit peel	streptozotocin induced diabetes	rats	150
	four different concentrations of peel extract	alloxan induced diabetes	mice	151
<i>Clerodendrum inerme</i>	crude extract	streptozotocin-induced diabetes	mice	152-153
<i>Clitoria ternatea</i>	methanol and ethanol leaves extract	streptozotocin induced diabetes	rats	154-155
	methanol extract of leaves	alloxan-induced diabetes	rats	156
	aqueous extract of leaves and flowers	alloxan-induced diabetes	rats	157-158
	crude leaf extracts	streptozotocin induced diabetes	rats	159-161
<i>Coriandrum sativum</i>	aqueous extract	streptozotocin-induced diabetes	mice	162
	ethanol extract	streptozotocin-induced diabetes	rats	163
<i>Cressa cretica</i>	ethanolic extract	alloxan-induced diabetes	rats	164-165
	methanolic extract	streptozotocin-induced diabetes	rats	166
<i>Crocus sativus</i>	<b>aqueous extract</b>	streptozotocin-induced diabetes	rats	167-170
<i>Cuminum cyminum</i>	Seeds	streptozotocin induced diabetes	rats	171-172
	methanolic extract of seeds	streptozotocin induced diabetes	rats	173
	Diet supplemented with <i>Cuminum cyminum</i>	alloxan induced diabetes	rats	174-175
<i>Cydonia oblonga</i>	hydro-ethanolic extract	streptozotocin induced diabetes	rats	176-177

<i>Cynodon dactylon</i>	ethyl acetate (70%) extract of root and stem	hyperglycemia induced by a combination of ketamine and xylazine	mice	178-179
	aqueous extract	normoglycemic rats	rats	180-181
	ethanolic extract of root stalks	streptozotocin induced diabetes	rats	182
	crude extract	alloxan- induced diabetes	rats	183
<i>Cyperus rotundus</i>	crude extract	alloxan induced hyperglycemia	rats	184-185
	aqueous decoction of tuber parts	alloxan induced diabetic and normoglycemic rabbits	rabbits	186
<i>Dactyloctenium aegyptium</i>	different solvent extracts	streptozotocin induced diabetes	rats	187-188
	<i>n</i> -hexane, chloroform, ethyl acetate and methanolic fractions from ethanolic extract	streptozotocin induced diabetes	rats	189
<i>Dalbergia sissoo</i>	pet.ether and ethanolic extracts	alloxan induced diabetes	Rats	190-192
	aqueous stem bark extract	streptozotocin-nicotinamide induced type 2 diabetes	rats	193
	ethanolic extract of bark	alloxan induced diabetes	rats	194
<i>Datura fastuosa</i>	seed powder	alloxan-induced diabetes	rats	195-196
<i>Daucus carota</i>	methanol extract of seeds	streptozocin-induced diabetes	rats	197
<i>Desmostachia bipinnata</i>	hydroalcoholic extract	non- diabetic	rats	198-199
	ethanolic extract alloxan induced diabetes	alloxan induced diabetes	rats	200
<i>Digitalis species</i>	Digitonin, a saponin from the seeds	glucose tolerance test	rats	201-202
<i>Dodonaea viscosa</i>	methanolic leaves extracts	alloxan-induced diabetes	rabbits	203-204
	ethyl acetate and methanolic extracts	streptozocin-induced diabetes and normoglycemic	rats	205
	methanol and chloroform	alloxan-induced diabetes	rats	206
<i>Dolichos lablab</i>	methanolic extract	streptozotocin-nicotinamide induced diabetes	rats	207-209
	ethanolic extract of leaves	alloxan induced diabetes	rats	210
<i>Echinochloa crusgalli</i>	70% hydroalcoholic Extract	alloxan induced diabetes	rats	211-212
<i>Ephedra species</i>	alcoholic extract	alloxan induced diabetes	rats	213-214
<i>Equisetum arvense</i>	methanolic extract	streptozotocin-nicotinamide induced diabetes	rats	215-218
<i>Eryngium creticum</i>	aqueous decoction of arial parts	normoglycemic streptozocin- hyperglycemic	rats	219-220
	aqueous extracts	alloxan induced diabetes	rats	221-223

<i>Eucalyptus species</i>	ethanolic extract	oral glucose tolerance test	rats	224-225
<i>Euphorbia hirta</i>	ethanol extract	alloxan induced diabetes	rats	226-227
	ethanolic extract of leaf, flower and stem	streptozotocin induced diabetes	mice	228
<i>Foeniculum vulgare</i>	methanolic extracts	anti-glycative activity assay	<i>in vitro</i>	229-230
<i>Fumaria officinalis</i>	crude aqueous extracts	diabetes induced by feeding 21% fructose in drinking water	rats	231-232
<i>Fumaria parviflora</i>	methanolic extract	streptozotocin-induced diabetes	rats	233
	consumption of the plant	streptozocin induced diabetes	rats	234
	powdered plant	normal and alloxan- induced diabetes	rabbits	235-236
<i>Glossostemon bruguieri</i>	root mucilages	streptozotocin-induced diabetes diabetic	rats	237
<i>Glycyrrhiza glabra</i>	glycyrrhizin	in genetically diabetic model	mice	238
	glycyrrhizin	streptozotocin-induced diabetes	rats	239
<i>Gossypium species</i>	seed	alloxan-induced diabetic	rabbits	240
	ethyl ether and ethanol extracts	alloxan induced diabetes	rats	241
<i>Helianthus annuus</i>	ethanol seed extract	streptozotocin induced type 2 diabetes	rats	242-243
	crude methanol extract	alloxan-induced diabetes	rats	244
	methanol extract	alloxan-induced diabetes	rats	245
<i>Helianthus tuberosus</i>	ethanol extracts	streptozotocin induced diabetes	rats	246-247
<i>Hibiscus cannabinus</i>	methanolic extract	streptozotocin induced diabetes	rats	248-249
<i>Hibiscus rosa-sinensis</i>	aqueous ethanolic and ethanol extracts	streptozotocin-induced diabetes	rats	250-252
	flowers extract	alloxan induced diabetes	rats	253-254
	ethanolic extract	alloxan-induced diabetes	rats	255-257
<i>Hibiscus sabdariffa</i>	crude extract, ethanolic extract and polyphenol extract	streptozotocin- induced diabetes	rats	258-262
	calyxes aqueous extract	streptozotocin-induced diabetes	rats	263
	hydroalcoholic extract of flower	alloxan induced diabetes	rats	264
<i>Hyoscyamus Species</i>	methanolic leaves extract of	streptozotocin-induced diabetes	rats	265-266
	calystegines, polyhydroxylated alkaloids extracted from seeds	streptozotocine induced diabetes	mice	267
<i>Jasminum sambac</i>	flower extract	streptozotocin induced diabetes	rats	268

	ethyl acetate and water extracts of leaves	alloxan induced diabetes	rats	269-270
<i>Juglans regia</i>	crude extracts	streptozotocin induced diabetes	rats	271-272
	aqueous extract of leaf	normal and diabetic rats	rats	273
	ethanolic leaf extract	alloxan-induced diabetes	rats	274
	methanolic extracts of leaf and fruit peel	alloxan induced diabetes	rats	275
	crude leaf extract	streptozotocin-nicotinamide induced diabetes	rats	276
<i>Juniperus communis</i>	decoction	streptozotocin-induced diabetes	rats	277-278
<i>Juniperus oxycedrus</i>	water leaves extracts	streptozotocin-induced diabetes	rats	279-280
	oils	inhibition of $\alpha$ -amylase	<i>in vitro</i>	281
	ethanol and water leaves extracts	streptozotocin-induced diabetes	rats	282
<i>Jussiaea repens</i>	ethyl acetate extract	alloxan-induced diabetes	rats	283-284
<i>Kochia scoparia</i> ( <i>Bassia scoparia</i> )	methanolic extract	glucose-loaded test	rats	285-287
<i>Lagerstroemia speciosa</i>	aqueous leaf extract	streptozotocin-induced diabetes	mice	288
	crude leaves extract	streptozotocin-induced diabetes	Rats	289
	dried powder and decoction	alloxan induced diabetes	mice	290
	diet containing 5% of the hot-water leaves extract	type 2 diabetes	mice	291-292
<i>Lathyrus sativus</i>	methanolic extract of non-boiled and boiled seeds extract	glucose-loaded test	mice	293-294
<i>Lawsonia inermis</i>	Hydroalcoholic and ethanol leaf extract	alloxan induced diabetes	Rats	295-296
	70% ethanolic leaf extract	alloxan induced diabetes	mice	297-298
<i>Lippia nodiflora</i>	methanol extract	streptozotocin induced diabetes	rats	299
	$\gamma$ -sitosterol isolated from <i>Lippia nodiflora</i>	streptozotocin induced diabetes	rats	300-302
<i>Luffa acutangula</i>	seeds ethanolic extract	streptozotocin induced diabetes	rats	303
	methanolic leaves extract	oral glucose tolerance test	mice	304
	petroleum ether, chloroform and ethanol extracts of fruits	alloxan induced diabetes	rats	305
	methanolic and aqueous extracts of fruits	streptozotocin and nicotinamide induce type 2 diabetes	rats	306-307
<i>Mangifera indica</i>	crude leaf extracts	normal and alloxan- induced diabetes	rats	308



	seed kernels ethanol extract	streptozotocin induced diabetes	rats	309
	50% ethanol extract of leaves	streptozotocin induced diabetes	rats	310-311
	ethanol and water extracts of leaves and stem-barks	nondiabetic and tyoe 2 induced diabetes	rats	312
<i>Marrubium vulgare</i>	ethanolic extracts (root, leaf and stem)	normoglycemic	rats	313
	infusion	alloxan induced diabetes	rats	314
<i>Matricaria chamomilla</i>	leave extract	streptozotocin-induced diabetes	rats	315
	<i>Matricaria chamomilla</i> and <i>Origanum vulgare</i> extracts combination	alloxan-induced diabetes	rats	316
	aerial part ethanolic extract	streptozotocin-induced diabetes	rats	317
<i>Medicago sativa</i>	aqueous and aqueous ethanolic extracts	streptozotocin induced diabetes	rats	318-319
	aqueous extract	alloxan-induced diabetes	rats	320-321
<i>Melilotus officinalis</i>	extract formulated under the by trade name of Semilil (Angipars)	streptozotocin induced diabetes	rats	322-323
<i>Mirabilis jalapa</i>	ethanolic extract of root	streptozotocin induced diabetes	mice	324
	hydroethanolic leaf extract	streptozotocin induced diabetes	rats	325-326
<i>Morus alba</i>	leaf crude extracts	type II diabetic model	rats	327
	flavonoids rich fraction of 70% alcohol extract of root bark	streptozotocin-induced diabetes	rats	328
	aqueous and alcoholic extract of leaves	streptozotocin induced diabetes	rats	329-330
	fruit extract	type 2 diabetes model	mice	331
	stem bark extract	streptozotocin-induced diabetes	rats	332-333
<i>Nasturtium officinale</i>	ethyl acetate, methanol and aqueous extracts	streptozotocin induced-diabetes	rats	334
	aqueous, acetonc, and alcoholic extracts	alloxan and streptozotocin induced diabetes	rats	335-338
<i>Nerium oleander</i>	standardized hydromethanolic leaf extract	alloxan induced diabetes	mice	3339
	crude extract	streptozotocin-induced diabetes	rats	340-341
<i>Nicotiana tabacum</i>	hydroethanolic leaf extract	oral glucose tolerance test in normoglycemic model	rats	342-343
<i>Ocimum basilicum</i>	methanol-dichloromethane,	alloxan induced diabetes	rats	344-345

	methanol and n-hexane leaf extracts			
	aqueous extract	streptozotocin induced diabetes	rats	346-347
<i>Passiflora incarnata</i>	methanolic leaves extract	streptozotocin-induced diabetes	mice	348
<i>Peganum harmala</i>	Hydroalcoholic extract	streptozotocin-induced diabetes	rats	349
	ethanolic extract	normal and streptozotocin-induced diabetes	rats	350
	methanolic extract	Obese diabetic	Rats	351
<i>Petroselinum crispum</i>	crude extracts	streptozotocin-induced diabetes	rats	352-354
<i>Phoenix dactylifera</i>	aqueous seed extract	streptozotocin-induced diabetes	rats	355-356
	Fruits	alloxan induced diabetes	rats	357
<i>Pimpinella anisum</i>	aqueous seed extract	streptozotocin-induced diabetes	rats	358
<i>Plantago ovata</i>		normal, type 1 and type 2 diabetic models	rats	359
	seed husk	diabetic mice	mice	360
<i>Portulaca oleracea</i>	fresh and dried <i>Portulaca oleracea</i>	streptozotocin-induced diabetes	mice	361-362
	hydroethanolic extract	alloxan- induced diabetes	rats	363
<i>Prosopis fratta</i>	aqueous solution of the lyophilized root extract	normoglycemic and streptozocin-induced hyperglycemia	rats	364
	fruit extract	streptozotocin-induced diabetes	rats	365-369
<i>Prunus cerasus</i>	pulps and seeds extracts	alloxan induced diabetes	mice	<b>370</b>
<i>Prunus persica</i>	Quercetin rich ethyl acetate fraction of leaves	streptozotocin-induced diabetes	rats	371-372
<i>Punica granatum</i>	fruit peel extract	streptozotocin-induced diabetes	rats	373
	juice and seed powder	streptozotocin- nicotinamide induced type 2 diabetes	rats	374
<i>Quercus infectoria</i>	aqueous and methanolic extracts of the galls	glucose tolerance test and sucrose tolerance test models	rats	375
<i>Rheum ribes</i>	decoction extract of the roots, aqueous and ethanolic roots extracts	alloxan-induced diabetes	rats	376-377
	root aqueous extract	streptozotocin-induced diabetes	rats	378-379
<i>Rhus coriaria</i>	lyophilized extract, methanolic and aqueous extracts	streptozotocin, and alloxan - induced diabetes	Rats	380-382
<i>Ricinus communis</i>	ethanolic extract of roots	normal as well as in type 1 diabetes	rats	383

<i>Rosa canina</i>	fruits and purified oligosaccharide	streptozotocin - induced diabetes	rats	384-386
<i>Rosa damascena</i>	ethanolic and methanolic extracts of the flowers	normal as well as in type 1 diabetes	rats	387-388
<i>Salvia aegyptiaca</i>	ethanolic leaves extract	normoglycemic and diabetic animals	rats	389
<i>Sambucus nigra</i>	aqueous extracts	alloxan induced diabetes	mice	390
	polyphenolic extracts of the fruit of	streptozotocin - induced diabetes	rats	391
<i>Sesamum indicum</i>	alcoholic extract as well as its petroleum ether and butanol fractions	alloxan induced diabetes	rats	392
	hot-water extract from defatted sesame	genetically diabetic KK-Ay mice	mice	393
<i>Sesbania sesban</i>	aqueous leaves extract	streptozotocin - induced diabetes	rats	394
	petroleum ether extract	streptozotocin - induced diabetes	mice	395
<i>Silybum marianum</i>	aqueous extracts of aerial part	normal and streptozotocin - induced diabetes	rats	396
	silymarin	alloxan induced diabetes	rats	397
<i>Solanum nigrum</i>	aqueous extract of berries	alloxan induced diabetes	rats	398
	methanolic fruit extract	streptozotocin - induced diabetes	rats	399
<i>Sonchus oleraceus</i>	hydroethanolic extracts	streptozotocin induced diabetes and streptozotocin + nicotinamide induced diabetes	mice and rats	400-403
<i>Spinacia oleracea</i>	ethanolic and aqueous extract	in the normal and the alloxan-induced diabetes	rats	404
<i>Teucrium polium</i>	aqueous decoction of aerial parts	normoglycemic and streptozotocin-hyperglycemic model	rats	405-408
	aqueous and methanol aerial part extracts	alloxan induced diabetes model	mice	409-410
<i>Thuja occidentalis</i>	methanolic residue and ethanolic fraction	alloxan induced diabetes model	rats	411
<i>Tribulus terrestris</i>	hydroalcoholic extract, crude fruit extract	streptozotocin induced diabetes	rats	413-415
<i>Trifolium pratense</i>	aqueous extract of flowering tops	streptozotocin induced type 2 diabetic model	rats	416-417
<i>Trigonella foenum-graecum</i>	ethanol extract of seeds	normoglycemic and alloxan induced diabetes model	rats	418-421
	Seeds and water soluble compound purified from fenugreek	alloxan induced diabetes model	rabbits	422-424
<i>Urtica dioica</i>	hexane, chloroform, ethyl acetate, methanol, and	glucose tolerance test	rats	425-427

	aqueous extracts of the leaves			
	distillate and hydroalcoholic extract	streptozotocin induced diabetic model	rats	428-430
<i>Urtica pilulifera</i>	seeds lectin and methanol, ethylacetate, chloroform and hexane extracts	streptozotocin and alloxan induced diabetes models	rats	431-437
<i>Vinca rosea (Catharanthus roseus)</i>	methanolic whole plant extract, ethanol extract from the leaves, leaf dichloromethane: methanol (1:1) extracts and leaf juice	alloxan induced diabetes model	rats	438-442
	dichloromethane: methanol extract (1:1) of leaves and twigs, petroleum-ether, ethyl acetate and chloroform fractions from ethanolic extract of the leaves and leaf powder	streptozotocin induced diabetes model	rats	443-445
<i>Viola odorata</i>	aqueous and hydro-alcoholic extracts	streptozotocin induced diabetes model	rats	446-448
<i>Vitex agnus-castus</i>	methanolic extract of the fruits	alloxan and streptozotocin induced diabetes model	rats	449-450
<i>Vitis vinifera</i>	aqueous and ethanolic extracts of the leaves,	streptozotocin-induced diabetic models	rats	451-453
	grape skin	alloxan-induced diabetes	mice	454
<i>Withania somnifera</i>	roots and leaves extracts	streptozotocin and alloxan-induced diabetes	rats	455-459
<i>Xanthium strumarium</i>	aqueous extract	alloxan-induced diabetes	mice	460
	caffeic acid, a phenolic compounds contained in the fruit	streptozotocin -induced diabetes	rats	461
<i>Ziziphus jujuba</i>	methanolic and hydroalcoholic extracts of leaves	streptozotocin and alloxan-induced diabetes	rats	462-464
<i>Zizyphus spina-christi</i>	leaves extracts	streptozotocin and alloxan-induced diabetes	rats	465-468

**Table 3** Medicinal plants possessed clinical antidiabetic activity

Plants	Active extract or component	Model	Experimental animal	Ref.
<i>Allium cepa</i>	ingestion of crude <i>Allium cepa</i>	Clinical	type1 and 2 diabetic patients	469
<i>Allium sativum</i>	garlic powder	Clinical	Diabetic patients	470
<i>Aloe vera</i>	Aloe gel	Clinical	type 2 diabetic patients	471-472

<i>Arctium lappa</i>	Root extract	Clinical	normal and diabetic patients	473
<i>Avena sativa</i>	oat-buckwheat bread, buckwheat porridge and $\beta$ -glucan	glycaemic response clinically	Normoglycemic Subjects	474-475
<i>Benincasa hispida</i>	Salad contained 100gm of ash gourd	Clinical	hyperlipidemic diabetic patients	476-477
<i>Citrullus colocynthis</i>	fruits	Clinical	type II diabetic patients	478-479
<i>Coriandrum sativum</i>	seeds	Clinical	type 2 diabetic patients	480-481
	aqueous and alcoholic extracts	Clinical	type 2 diabetic patients	482-483
	flower powder	Clinical	type II diabetic patients	484
<i>Juglans regia</i>	leaf extract	Clinical	type II diabetic patients	485-486
	walnut hydrosol	Clinical	patients with type 1 diabetes	487
<i>Lagerstroemia speciosa</i>	leaves extract [standardized to 1% corosolic acid (Glucosol)]	Clinical	type 2 diabetic patients	488
<i>Marrubium vulgare</i>	aqueous extract	Clinical	type 2 non-controlled diabetic patients	489-490
<i>Matricaria chamomilla</i>	The effects of chamomile tea in hot water	Clinical	patients with type 2 diabetes	491-492
<i>Plantago ovata</i>	husk	Clinical	euglycemic, at-risk, and diabetic patients	493
<i>Plantago psyllium</i>	mucilage	Many clinical trials	diabetic patients	494-496
<i>Rheum ribes</i>	root powder, aqueous extract of the roots	Many clinical trials	diabetic patients	497
<i>Rhus coriaria</i>	powder	A double blind randomized controlled clinical trial	type 2 diabetic patients	498
<i>Rosa damascena</i>	methanolic extract of the flowers	A triple-blind, placebo and acarbose-controlled randomized trial	type II diabetic patients and healthy volunteers	499
<i>Teucrium polium</i> in	dried alcoholic extract	clinical trial	type II diabetic patients	500
<i>Trigonella foenum-graecum</i>	fenugreek seed	clinical trials	non-insulin dependent diabetic patients	501-503
<i>Urtica dioica</i>	leaves extracts	clinical trials	patients with type 2 diabetes mellitus	504-506
<i>Vitis vinifera</i>	grape seed extract	A double blind clinical trial	patients with type 2 diabetes mellitus	507
<i>Ziziphus jujuba</i>	dried fruits	A randomized controlled clinical trial	patients with type 2 diabetes mellitus	508

## 2. Conclusion

Diabetes mellitus is one of the most common endocrine metabolic disorders. It caused significant mortality due to its complications. Medicinal plants possessed hypoglycemic effects by many mechanisms. The current review discussed the medicinal plants with antidiabetic effect with special focus on their mechanism of action.

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