International Journal of Biological and Pharmaceutical Sciences Archive

ISSN: 0799-6616 (Online)

Journal homepage: https://ijbpsa.com/

(REVIEW ARTICLE)

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Iraqi medicinal plants with hypoglycemic effects

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International Journal of Biological and Pharmaceutical Sciences Archive, 2024, 08(02), 096-133

Publication history: Received on 09 November 2024; revised on 21 December 2024; accepted on 23 December 2024

Article DOI: https://doi.org/10.53771/ijbpsa.2024.8.2.0089

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 [1-3]. 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.
Canna indica	polyphenolic of root	*In vitro*	glucose transport in cultured muscle cells	90-91
Carthamus tinctorius	N-p-coumaroyl serotonin and N-feruloyl serotonin	*In vitro*	α-glucosidase inhibition	104
Citrullus colocynthis	seed extracts	glucose-stimulated insulin release from pancreatic islets	in vitro rat pancreatic	124
Daucus carota	dichloromethane extract of carrot roots	Stimulated insulin- dependent glucose uptake assay	*in vitro* adipocytes	179-180

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

Tropaeolum majus	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	*in vitro*	38
Urtica dioica	aqueous extract of the leaves	Its ability to stimulate insulin release from β cells	*in vitro*	39
	aqueous extract of the leaves	inhibition of α-amylase	*in vitro*	40
Vitex agnus-castus	different extracts	α-amylase and α-glucosidase inhibitory activities	*in vitro*	41
Withania somnifera	Leaves and roots extracts and purified withanolides	Stimulation of insulin secretion of pancreatic beta cells	*in vitro*	42
Zizyphus spina-christi	aqueous and 80% ethanol extract of the fruits	α-amylase and α-glucosidase inhibitory activities	*in vitro*	43

Table 2 Medicinal plants possessed *in vivo* antidiabetic activity

Plants	**Active extract or component**	**Model**	**Experimental animal**	**Ref.**
Achillea santolina	aqueous extract	streptozotocin -induced diabetes	rats	44-45
Adiantum capillus-veneris	alcoholic extract	oral glucose tolerance test	rabbits	46-48
Agrimony eupatoria	aqueous extract	streptozotocin -induced diabetes	mice	49-50
Agropyron repens	aqueous extract	streptozotocin -induced diabetes	mice	51-52
Allium cepa	ethanol, chloroform and petroleum ether extracts	alloxan, glucose and epinephrine induced diabetes	several experimental animals	53-61
	aqueous extract	alloxan induced diabetes	rabbits	62
Allium sativum	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
Aloe vera	Aloe gel	diabetic and normal	mice	69-73
Alpinia galanga	powdered rhizome	normoglycemic rabbits	rabbits	74-75
	Ethanol extract	glucose uptake model in diabetic rats	rats	76
Althaea officinalis	polysaccharide from the root	Normoglycemic	mice	77-78

	scopoletin	hyperglycemia in levo-thyroxine-induced hyperthyroid rats	rats	79
Anchusa strigosa	aqueous extract	streptozotocin -induced diabetes	rats	80-81
Anthemis nobelis	aqueous extract and flavonoid extract	streptozotocin -induced diabetes	rats	82-84
Arctium lappa	ethanolic extract	streptozotocin -induced diabetes	rats	85-86
Artemisia campestris	aqueous leaf extracts	alloxan-induced diabetes	rats	87-89
Asparagus officinalis	methanolic seed extract and aqueous extract of asparagus by-product	streptozotocin -induced diabetes	rats	90-92
Avena sativa	ethanolic extract	induced diabetes (not specified)	mice	93-94
Ballota nigra	aqueous extract	alloxan-induced diabetes	rats	95-96
Benincasa hispida	stem chloroform extract	Normoglycemic	rats	97-98
	crude extract	normoglycemic	mice	99
Brassica nigra	extracts of the seeds	streptozotocin -induced diabetes	rats	100-102
Brassica rapa	roots ethanol extract	Type 2 induced diabetes	mice	103
Bryophyllum calycinum	aqueous extract	streptozotocin -induced diabetes	rats	104-107
Caesalpinia crista	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
Calotropis procera	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
Capparis spinosa	fruit extract	streptozotocin -induced diabetes	rats	120-123
Capsicum annuum and Capsicum frutescens	capsaicin	Normoglycemic	dogs	124
Carum carvi	aqueous and ethanolic extract	streptozotocin -induced diabetes	rats	125-129
Carthamus tinctorius	crude extract	alloxan induced diabetes	rabbits	130-131
Casuarina equisetifolia	crude squeous and methanolic leaf extracts	alloxan induced diabetes	rats and mice	132-136

Casuarina equisetifolia	leaves ethanolic extract	streptozotocin -induced diabetes	rats	137-138
Cicer arietinum	petroleum ether extract	alloxan induced diabetes	mice	139
Cichorium intybus	crude extract	alloxan induced diabetes	rats	140-141
	ethanolic extract	streptozotocin induced diabetes	rats	142
	crude extracts	hyperglycemic model	mice	143
Cistanche tubulosa	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
Citrus species	hexane extract of *Citrus limon* peel	alloxan induced diabetes	rats	147-148
	petroleum ether extract of *Citrus medica* seeds	streptozotocin induced diabetes	rats	149
	methanol extract of *Citrus limetta* fruit peel	streptozotocin induced diabetes	rats	150
	four different concentrations of peel extract	alloxan induced diabetes	mice	151
Clerodendrum inerme	crude extract	streptozotocin-induced diabetes	mice	152-153
Clitoria ternatea	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
Coriandrum sativum	aqueous extract	streptozotocin-induced diabeties	mice	162
	ethanol extract	streptozotocin-induced diabeties	rats	163
Cressa cretica	ethanolic extract	alloxan-induced diabeties	rats	164-165
	methanolic extract	streptozotocin-induced diabeties	rats	166
Crocus sativus	**aqueous extract**	streptozotocin-induced diabeties	rats	167-170
Cuminum cyminum	Seeds	streptozotocin induced diabetes	rats	171-172
	methanolic extract of seeds	streptozotocin induced diabetes	rats	173
	Diet supplemented with *Cuminum cyminum*	alloxan induced diabetes	rats	174-175
Cydonia oblonga	hydro-ethanolic extract	streptozotocin induced diabetes	rats	176-177

Cynodon dactylon	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
Cyperus rotuntdus	crude extract	alloxan induced hyperglycemia	rats	184-185
	aqueous decoction of tuber parts	alloxan induced diabetic and normoglycemic rabbits	rabitts	186
Dactyloctenium aegyptium	different solvent extracts	streptozotocin induced diabetes	rats	187-188
	n-hexane, chloroform, ethyl acetate and methanolic fractions from ethanolic extract	streptozotocin induced diabetes	rats	189
Dalbergia sissoo	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
Datura fastuosa	seed powder	alloxan-induced diabetes	rats	195-196
Daucus carota	methanol extract of seeds	streptozocin-induced diabetes	rats	197
Desmostachia bipinnata	hydroalcoholic extract	non- diabetic	rats	198-199
	ethanolic extract alloxan induced diabetes	alloxan induced diabetes	rats	200
Digitalis species	Digitonin, a saponin from the seeds	glucose tolerance test	rats	201-202
Dodonaea viscose	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
Dolichos lablab	methanolic extract	streptozotocin-nicotinamide induced diabetes	rats	207-209
	ethanolic extract of leaves	alloxan induced diabetes	rats	210
Echinochloa crusgalli	70% hydroalcoholic Extract	alloxan induced diabetes	rats	211-212
Ephedra species	alcoholic extract	alloxan induced diabetes	rats	213-214
Equisetum arvense	methanolic extract	streptozotocin-nicotinamide induced diabetes	rats	215-218
Eryngium creticum	aqueous decoction of arial parts	normoglycemic streptozocin-hyperglycemic	rats	219-220
	aqueous extracts	alloxan induced diabetes	rats	221-223

Eucalyptus species	ethanolic extract	oral glucose tolerance test	rats	224-225
Euphorbia hirta	ethanol extract	alloxan induced diabetes	rats	226-227
	ethanolic extract of leaf, flower and stem	streptozotocin induced diabetes	mice	228
Foeniculum vulgare	methanolic extracts	anti-glycative activity assay	*in vitro*	229-230
Fumaria officinalis	crude aqueous extracts	diabetes induced by feeding 21% fructose in drinking water	rats	231-232
Fumaria parviflora	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
Glossostemon bruguieri	root mucilages	streptozotocin-induced diabetes diabetic	rats	237
Glycyrrhiza glabra	glycyrrhizin	in genetically diabetic model	mice	238
	glycyrrhizin	streptozotocin-induced diabetes	rats	239
Gossypium species	seed	alloxan-induced diabetic	rabbits	240
	ethyl ether and ethanol extracts	alloxan induced diabetes	rats	241
Helianthus annuus	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
Helianthus tuberosus	ethanol extracts	streptozotocin induced diabetes	rats	246-247
Hibiscus cannabinus	methanolic extract	streptozotocin induced diabetes	rats	248-249
Hibiscus rosa-sinensis	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
Hibiscus sabdariffa	crude extract, ethanolic extract and polyphenol extract	streptozotocin- induced diabetes	rats	258-262
	calyxes aqueous extract	streptozotocin-induced diabeties	rats	263
	hydroalcoholic extract of flower	alloxan induced diabetes	rats	264
Hyoscyamus Species	methanolic leaves extract of	streptozotocin-induced diabetes	rats	265-266
	calystegines, polyhydroxylated alkaloids extracted from seeds	streptozotocine induced diabetes	mice	267
Jasminum sambac	flower extract	streptozotocin induced diabetes	rats	268

	ethyl acetate and water extracts of leaves	alloxan induced diabetes	rats	269-270
Juglans regia	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
Juniperus communis	decoction	streptozotocin-induced diabetes	rats	277-278
Juniperus oxycedrus	water leaves extracts	streptozotocin-induced diabetes	rats	279-280
	oils	inhibition of α-amylase	*in vitro*	281
	ethanol and water leaves extracts	streptozotocin-induced diabetes	rats	282
Jussiaea repens	ethyl acetate extract	alloxan-induced diabetes	rats	283-284
Kochia scoparia (Bassia scoparia)	methanolic extract	glucose-loaded test	rats	285-287
Lagerstroemia speciosa	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
Lathyrus sativus	methanolic extract of non-boiled and boiled seeds extract	glucose-loaded test	mice	293-294
Lawsonia inermis	Hydroalcoholic and ethanol leaf extract	alloxan induced diabetes	Rats	295-296
	70% ethanolic leaf extract	alloxan induced diabetes	mice	297-298
Lippia nodiflora	methanol extract	streptozotocin induced diabetes	rats	299
	γ-sitosterol isolated from *Lippia nodiflora*	streptozotocin induced diabetes	rats	300-302
Luffa acutangula	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
Mangifera indica	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
Marrubium vulgare	ethanolic extracts (root, leaf and stem)	normoglycemic	rats	313
	infusion	alloxan induced diabetes	rats	314
Matricaria chamomilla	leave extract	streptozotocin-induced diabetes	rats	315
	Matricaria chamomilla and *Origanum vulgare* extracts combination	alloxan-induced diabetes	rats	316
	aerial part ethanolic extract	streptozotocin- induced diabetes	rats	317
Medicago sativa	aqueous and aqueous ethanolic extracts	streptozotocin induced diabetes	rats	318-319
	aqueous extract	alloxan-induced diabetes	rats	320-321
Melilotus officinalis	extract formulated under the by trade name of Semilil (Angipars)	streptozotocin induced diabetes	rats	322-323
Mirabilis jalapa	ethanolic extract of root	streptozotocin induced diabetes	mice	324
	hydroethanolic leaf extract	streptozotocin induced diabetes	rats	325-326
Morus alba	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
Nasturtium officinale	ethyl acetate, methanol and aqueous extracts	streptozotocin induced- diabetes	rats	334
	aqueous, acetonic, and alcoholic extracts	alloxan and streptozotocin induced diabetes	rats	335-338
Nerium oleander	standardized hydromethanolic leaf extract	alloxan induced diabetes	mice	3339
	crude extract	streptozotocin- induced diabetes	rats	340-341
Nicotiana tabacum	hydroethanolic leaf extract	oral glucose tolerance test in normoglycemic model	rats	342-343
Ocimum basilicum	methanol-dichloromethane,	alloxan induced diabetes	rats	344-345

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

Rosa canina	fruits and purified oligosaccharide	streptozotocin - induced diabetes	rats	384-386
Rosa damascena	ethanolic and methanolic extracts of the flowers	normal as well as in type 1 diabetes	rats	387-388
Salvia aegyptiaca	ethanolic leaves extract	normoglycemic and diabetic animals	rats	389
Sambucus nigra	aqueous extracts	alloxan induced diabetes	mice	390
	polyphenolic extracts of the fruit of	streptozotocin - induced diabetes	rats	391
Sesamum indicum	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
Sesbania sesban	aqueous leaves extract	streptozotocin - induced diabetes	rats	394
	petroleum ether extract	streptozotocin - induced diabetes	mice	395
Silybum marianum	aqueous extracts of aerial part	normal and streptozotocin - induced diabetes	rats	396
	silymarin	alloxan induced diabetes	rats	397
Solanum nigrum	aqueous extract of berries	alloxan induced diabetes	rats	398
	methanolic fruit extract	streptozotocin - induced diabetes	rats	399
Sonchus oleraceus	hydroethanolic extracts	streptozotocin induced diabetes and streptozotocin + nicotinamide induced diabetes	mice and rats	400-403
Spinacia oleracea	ethanolic and aqueous extract	in the normal and the alloxan-induced diabetes	rats	404
Teucrium polium	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
Thuja occidentalis	methanolic residue and ethanolic fraction	alloxan induced diabetes model	rats	411
Tribulus terrestris	hydroalcoholic extract, crude fruit extract	streptozotocin induced diabetes	rats	413-415
Trifolium pratense	aqueous extract of flowering tops	streptozotocin induced type 2 diabetic model	rats	416-417
Trigonella foenum-graecum	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
Urtica dioica	hexane, chloroform, ethyl acetate, methanol, and	glucose tolerance test	rats	425-427

	aqueous extracts of the leaves			
	distillate and hydroalcholic extract	streptozotocin induced diabetic model	rats	428-430
Urtica pilulifera	seeds lectin and methanol, ethylacetate, chloroform and hexane extracts	streptozotocin and alloxan induced diabetes models	rats	431-437
Vinca rosea (Catharanthus roseus)	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
Viola odorata	aqueous and hydro-alcoholic extracts	streptozotocin induced diabetes model	rats	446-448
Vitex agnus-castus	methanolic extract of the fruits	alloxan and streptozotocin induced diabetes model	rats	449-450
Vitis vinifera	aqueous and ethanolic extracts of the leaves,	streptozotocin-induced diabetic models	rats	451-453
	grape skin	alloxan-induced diabetes	mice	454
Withania somnifera	roots and leaves extracts	streptozotocin and alloxan-induced diabetes	rats	455-459
Xanthium strumarium	aqueous extract	alloxan-induced diabetes	mice	460
	caffeic acid, a phenolic compounds contained in the fruit	streptozotocin -induced diabetes	rats	461
Ziziphus jujuba	methanolic and hydroalcoholic extracts of leaves	streptozotocin and alloxan-induced diabetes	rats	462-464
Zizyphus spina-christi	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.**
Allium cepa	ingestion of crude *Allium cepa*	Clinical	type1 and 2 diabetic patients	469
Allium sativum	garlic powder	Clinical	Diabetic patients	470
Aloe vera	Aloe gel	Clinical	type 2 diabetic patients	471-472

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