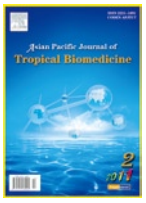
Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Biomedicine

journal homepage:www.elsevier.com/locate/apjtb



Document heading

Current status of Indian medicinal plants with antidiabetic potential: a review

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ARTICLE INFO

Article history:
Received 18 August 2011
Received in revised form 5 September 2011
Accepted 27 September 2011
Available online 15 October 2011

Keywords:
Indian medicinal plants
Antidiabetic potential
Indigenous remedy
Diabetes mellitus
Active principle
Chemical compound

ABSTRACT

In India, indigenous remedies have been used in the treatment of diabetes mellitus since the time of Charaka and Sushruta. Plants have always been an exemplary source of drugs and many of the currently available drugs have been derived directly or indirectly from them. The ethnobotanical information reports that about 800 plants may possess anti-diabetic potential. Out of several Indian medicinal plants 33 plants were reviewed. The most effective antidiabetic Indian medicinal plants are *Acacia arabica, Aegle marmelose, Agrimonia eupatoria, Allium cepa, Allium sativum, Aloe vera, Azadirachta indica, Benincasa hispida, Beta vulgaris, Caesalpinia bonducella, Citrullus colocynthis, Coccinia indica, Eucalyptus globules, Ficus bengalenesis, Gymnema sylvestre, Hibiscus rosasinesis, Ipomoea batatas, Jatropha curcus, Mangifera indica, Momordica charantia, Morus alba, Mucuna pruriens, Ocimum sanctum, Pterocarpus marsupium, Punica granatum, Syzigium cumini, Tinospora cordifolia, Trigonella foenum graecum.* A wide array of plant derived active principles representing numerous chemical compounds has demonstrated activity consistent with their possible use in the treatment of diabetes.

1. Introduction

Diabetes mellitus is a chronic endocrine disorder caused by an absolute or relative lack of insulin and/or reduced insulin activity that results in hyperglycemia and abnormalities in carbohydrate, fat and protein metabolism. Diabetes has emerged as a major healthcare problem in India. A national urban survey in 2005 observed that the prevalence of diabetes in urban India in adults was 15.1%. Recent data have illustrated the impact of socio-economic transition occurring in rural India. The transition has occurred in the last 15 years and the prevalence has risen from 2.4% to 6.4%[1].

In India, indigenous remedies have been used in the treatment of diabetes mellitus since the time of Charaka and Sushruta. Plants have always been an exemplary source of drugs and many of the currently available drugs have been derived directly or indirectly from them. The ethnobotanical information reports that about 800 plants may possess anti-diabetic potential[2]. Several such herbs have shown anti-diabetic activity when assessed using presently available experimental techniques. A wide array of plant derived active principles representing numerous chemical compounds has demonstrated activity consistent with their possible use in the treatment of insulin dependent diabetes mellitus. Among these are alkaloids, glycosides, galactomannan gun, polysaccharides, peptidoglycans, hypoglycans, guani-dine, steroids, carbohydrates, glycopeptides, terpenoids, amino acids and inorganic ions. Even there is the discovery of widely used hypoglycemic drugs, metformin came from the traditional approach by using *Galega officinalis*. Thus, plants are a potential source of antidiabetic drugs (and others too) but this fact has not gained enough momentum in the scientific community. Out of the several medicinal plants used in the treatment of diabetes, some were reviewed in the present study[3-6].

2. Adverse effects of current treatment

Currently insulin and oral hypoglycemic agents are used in the treatment of diabetes mellitus. The main undesirable effect of insulin is that hypoglycemia can cause brain damage. Swelling, erythema and stinging occur specially in the beginning. Allergy to human by insulin is unusual but can occur. Some patients develop short-lived dependent edema (due to Na^+ retention) when insulin

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therapy is started. The commonest unwanted effects of metformin are gastrointestinal disturbances, abdominal pain, and metallic taste. Lactic acidosis is rare but has potentially toxic effect and metformin should not be given to patients with renal or hepatic disease, hypoxic pulmonary disease, heart failure or shock. Vitamin B_{12} deficiency due to interference with its absorption can occur with high dose of metformin. The commonest adverse effects of sulfonylureas are hypoglycemia, which can be severe and prolonged. The allergic skin rashes can occur, and bone marrow damage, although very rare can be severe. Thiazolidinediones causes serious hepatotoxicity, weight gain, gastrointestinal disturbances.

In order to overcome these problems it is essential to search new class of compounds. Several traditional medicines are used for the treatment of diabetes patients in different ethnic societies of Asia, Africa and the South America. Even in developed countries of Europe, North America and Japan, several plant products/ herbal drugs are used for the treatment of diabetes. Medicinal plants are of great importance for health of individuals and communities. The medicinal value of these plants lies in some chemical substances that produce a definite physiological action on the human body[7].

3. Indian medicinal plants with antidiabetic potential

3.1. Acacia arabica (A. arabica) (Leguminosae)

Powdered seeds of *A. arabica* demonstrate significant hypoglycemic effect at 2, 3 and 4 gm/kg in normal rabbits by initiating the release of insulin from pancreatic β cells. No acute toxicity and behavioral changes were observed at these doses[8]. Yasir *et al* evaluated an aqueous and hydro alcoholic extracts of *A. arabica* for its hypoglycemic property and found that both extracts possess significant hypoglycemic property at 400 mg/kg[9]. The hydro alcoholic and chloroform extracts of *A. acacia* bark demonstrate significant antidiabetic property at 250 and 500 mg/kg dose dependently in alloxan induced diabetic rats[10,11].

3.2. Aegle marmelos (Rutaceae)

The aqueous extract of leaf normalizes the blood glucose and lipid parameters in streptozotocin induced diabetic mice at a dose of 300 mg/kg. Also the same extract shows hypoglycemic effect by releasing insulin *in vitro*[12]. Methanolic extract of leaf and callus possesses significant antidiabetic effect at a dose of 1 g/kg in streptozotocin induced diabetic rabbits comparable to petroleum ether, benzene and chloroform extracts[13]. Oral administration of leaves of plants at 5 g/day significantly ameliorates blood glucose level in non insulin dependent diabetes mellitus patients[14].

3.3. Agrimonia eupatoria (Rosaceae)

Zhang and Cheng, isolated nine compounds *viz.* apigenin-7-O-3-D-glucopyranoside, catechin, quercetin, rutin, kaempferol-3-O-alpha-L-rhamnoside, kampferol-3-O-beta-D-glucopyranoside, lutcolin-7-O-beta-D-glucopyranosidc, 19alpha, 24-dihydroxy ursolic acid, 3,3′-di-O-mcthyl ellagic acid4-O-beta-D-glucopyranoside form agrimony which reduce blood glucose level[15].

3.4. Allium cepa (Liliaceae)

Oral administration of juice of onion regulates blood glucose level and biochemical parameters in alloxan induced diabetic rats at a dose of 120 mg/kg. Furthermore, extract also normalizes the concentration of thiobarbituric acid reactive substances and the activity of glutathione S-transferase in plasma, liver, testes, brain, and kidney which were increased in alloxan-diabetic rats[16]. Administration of onion powder in high fat diet streptozotocin diabetic rats causes increase in insulin secretion[17]. The onion extract intake was effective in lowering plasma glucose concentrations and body weight in diabetes[18].

3.5. Allium sativum (A. sativum) (Alliaceae)

The intraperitoneal administration of (250 mg/kg) petroleum ether, ethyl acetate and chloroform fractions of the methanol extract of garlic reveals significant antidiabetic, antihyperlipidemic and hepatoprotective properties[19]. Administration of aqueous extract of *A. sativum* to diabetic subjects causes a significant antidiabetic and hypolipidemic effect[20]. Furthermore, an administration of alcoholic extract of garlic significantly reduces *Candida albicans* concentrations in liver and kidneys homogenates in infected control and streptozotocin induced diabetic rats[21]. The herbal formulation, DRF/AY/5001, containing a garlic, elicits hypoglycemic/antidiabetic effect in both normal and experimentally induced hyperglycemia (epinephrine and alloxan) rats at a dose of 500 mg/kg[22]. Mahesar *et al* reported a significant anti-hyperglycaemic effect of garlic (1% solution/kg) in alloxan-induced rabbits[23].

3.6. Aloe vera (A. vera) (Liliaceae)

Rajasekaran *et al* reported that, ethanol extract of *A. vera* leaf gel shows significant antihyperlipidaemic effect in streptozotocin induced diabetic rats at 300 mg/kg for 21 days[24]. The treatment of *A. vera* in diabetic rats showed a marked increase in body weight, liver glycogen, decreased blood and urine glucose levels and normalized serum lipids[25]. Oral administration of processed *A. vera* gel for 8 weeks in diet induced non insulin dependent diabetes mellitus in mice inhibits significantly plasma glucose level[26]. The high molecular weight (MW) fractions of *A. vera* containing less than 10 ppm of barbaloin and polysaccharide (MW: 1 000 kDa) with glycoprotein, verectin (MW: 29 kDa) showed a significant hypoglycemic as well as antihyperlipidaemic activity[27]. Oral administration of polyphenol-rich *A. vera* extracts (350 mg/kg) with known concentrations of aloin (181.7 mg/g) and aloe-emodin (3.6 mg/g) for 4 weeks to insulin resistant ICR mice decreases significantly both body weight and blood glucose levels[28]. The lophenol and cycloartanol, phytosterols isolated from *A. vera* gel inhibits blood glucose level at 25 g/kg/day respectively for 44 days in animal model of type-2 diabetes[29].

3.7. Azadirachta indica (A. indica) (Meliaceae)

Administration of leaf extract of neem possesses antihypeglycemic and antidyslipidemic activity by normalizing blood glucose level and lipid parameters in streptozotocin induced diabetic rats[30,31]. The polyherbal formulation containing neem and bitter leaf possesses significant antidiabetic and antihyperlipidemic activity at 400 mg/kg[32]. The combined leaf extracts of *Vernonia amygdalina* and *A. indica* cause increase in insulin level and show antihyperglycemic action in diabetic rats[33].

3.8. Benincasa hispida (B. hispida) (Cucurbitaceae)

B. hispida fruit was found to be effective in oxidative stress against indomethacin induced gastric ulcer by decreasing malondialdehyde with concomitant increasing superoxide dismutase and vitamin C levels[34]. The hydro alcoholic and chloroform extracts of *B. hispida* fruit demonstrate significant antidiabetic property at 250 and 500 mg/kg dose dependently in alloxan induced diabetic rats[10,11].

3.9. Beta vulgaris (B. vulgaris) (Chenopodiaceae)

The vitexin-200O-rhamnoside, its demethylated form 200-xylosylvitexin, isorhamnetin 3-gentiobioside, and rutin of phenolic fraction, obtained from *B. vulgaris* showed no toxicity to human lymphocytes and slight toxicity to macrophages. Vitexin-200O-rhamnoside strongly inhibited DNA synthesis in MCF-7 cells, whereas 200-xylosylvitexin and isorhamnetin 3-gentiobioside were activators. Combinations of activators and inhibitors maintained the over-all inhibitory effect[35].

3.10. Brassica juncea (Brassicaceae)

Admninistration of (200 mg/kg) aqueous extract of seeds to streptozotocin induced diabetic rats daily once for one month causes significant antidiabetic and antihyperlipidaemic activity[36].

3.11. Caesalpinia bonducella (Cisalpineaceae)

The fraction isolated from seeds shows hypoglycemic activity in type-2 acute diabetic models and also shows insulin secretagogue activity in isolated islets[35]. Oral administration of seed extract produces significant antihyperglycemic action due to blocking glucose absorption in alloxan induced diabetic rats at 300 mg/kg[38].

3.12. Cajanus cajan (Fabaceae)

The methanol extract of leaves showed significant reduction of fasting blood sugar in alloxan induced diabetic rats at 400 and 600 mg/kg in a dose-related manner[39].

3.13. Capparis decidua (C. decidua) (Capparaceae)

Alkaloid rich fraction from *C. decidua* shows antidiabetic potential in mice[40].

3.14. Citrullus colocynthis (C. colocynthis) (Cucurbitaceae)

The feeding of *C. colocynthis* oil supplementation normalizes blood glucose level in streptozotocin induced diabetic rats by partly preserving or restoring pancreatic β cell mass[41]. The administration of capsules (100 mg *C. colocynthis* fruit) thrice a day for two months, causes significant reduction of blood glucose level in type-2 diabetic patients[42].

3.15. Coccinia indica (C. indica) (Cucurbitaceae)

Combined extracts of *Musa paradisiaca* and *C. indica* ameliorate indices of protein metabolic disorders in streptozotocin induced diabetes rats[43]. Aqueous extract of leaf shows antidiabetic activity in streptozotocin induced diabetes rats[44]. The ethanolic extract of aerial parts, normalizes blood glucose level and lipid parameters in streptozotocin induced diabetic rats at 100 or 200 mg/kg[45]. Chronic administration of fruit extracts (200 mg/kg) for 14 days reduces the blood glucose level in alloxan induced diabetic rats[46].

3.16. Eucalyptus globulus (Myrtaceae)

Administration of leaves extract to alloxan induced diabetic rats ameliorates blood glucose by enhancement of peripheral glucose uptake and oxidative stress by increase in catalase, superoxide-dismutase and gluthatione-peroxidase activities in liver and kidney[47].

3.17. Ficus bengalensis (Moraceae)

Oral administration of aqueous bark extract (500 mg/kg) ameliorates the blood glucose level, lipid parameters and hepatic enzymes in streptozotocin induced diabetic rats[48].

3.18. Gymnema sylvestre (Asclepiadaceae)

The leaves extract stimulates insulin secretion *in vitro* using MIN6 β-cell line and isolated human islets of Langerhans[49]. Aqueous leaf extract shows hypolipidemic and hypoglycemic activity in alloxan induced diabetic rats at 400-800 mg/kg[50]. The conduritol, isolated from stem shows antidiabetic activity by increasing thymus, pancreas, splencia index or inhibiting the atrophy of thymus, pancreas, splencias of the diabetic rats induced by alloxan[51]. The bioactivity guided isolation of novel dihydroxy gymnemic triacetate from acetone extract of *G. sylvestre* leaves possesses hypoglycemic and antihyperlipdemic property in streptozotocin induced diabetic rats[52].

3.19. Hibiscus rosa-sinesis (Malvaceae)

The ethanol extract of flowers at 250 and 500 mg/kg significantly reduces the blood glucose level in both acute and sub acute treatments in alloxaninduced diabetic rats[53]. Fractions isolated from ethanol extract of leaves show antidiabetic and antihyperlipidemic properties[54].

3.20. Ipomoea batatas (I. batatas) (Convolvulaceae)

The acive ingredients isolated from *I. batatas* showed antidiabetic property and also stimulated immune system[55]. The flavonoids isolated from leaf ameliorate blood glucose level and lipid parameters in alloxan induced diabetic mice at 50-150 mg/kg[56].

3.21. Jatropha curcas (J. curcas) (Euphorbiaceae)

The hydro alcoholic and chloroform extracts of *J. curcas* leaves demonstrate significant antidiabetic property at 250 and 500 mg/kg dose dependently in alloxan induced diabetic rats[11,57].

3.22. Lantana camara (Verbenaceae)

Methanol extracts of leaves possess antidiabetic and antihyperlipidemic properties[58]. In addition to this, ethanol extracts possess antidiabetic property in rats[59].

3.23. Mangifera indica (M. indica) (Anacardiaceae)

Intraperitoneal administration of aqueous extract of stem bark (50-800 mg/kg) produces significant hypoglycemic effect in streptozotocin induced diabetic rats in a dose dependent manner[60]. The oral administration of peel extract at 200 mg/kg to streptozotocin induced diabetic rats possesses significant antidiabetic and antihyperlipidemic activity[61]. Mangiferin, a polyphenol isolated from *M. indica* significantly prevents progression of diabetic nephropathy and improves renal function in diabetic nephropathy rat model and cultured rat mesangial cells[62].

3.24. Momordica charantia (M. charantia) (Cucurbitaceae)

Oral administration of seed extracts at a concentration of 150 mg/kg b.w. for 30 days showed a significant decrease in fasting blood glucose, hepatic and renal thiobarbituric acid reactive substances and hydroperoxides. Also it shows significant increase in reduced glutathione, superoxide dismutase, catalase, glutathione peroxidase and glutathione-s-transferase in the liver and kidney of diabetic rats[63]. Subcutaneous administration of juice and alcoholic extract to alloxan induced diabetic rats causes anti-diabetic, hepato-renal protective and hypolipidemic effect[64]. Bitter fruit attenuates development of diabetes and its complications[65]. The Dihar a polyherbal formulation containing bitter fruit showed significant antidiabetic and antihyperlipidemic acivity in streptozotocin induced diabetic rats[66]. Oral administration of freeze dried extract at 50 and 100 mg/kg demonstrates, no activity on plasma glucose/insulin levels, energy expenditure, substrate mixture and appetite scores following an oral glucose load in non-diabetic overweight[67]. The alcalase hydrolysate from *M. charantia* showed stronger hypoglycemic effect[68]. The saponin from aqueous extract of bitter fruit shows significant hypoglycemic activity in hyperglycemic and normal mice at 500 mg/kg[69]. Oral administration of lipid and saponin fractions of fruit possesses significant antidiabetic activity by ameliorating biochemical parameters in db/db mice at 150 mg/kg[70].

3.25. Morus alba (M. alba) (Moraceae)

The oral administration (600 mg/kg/day for ten days) of flavonoid rich fractions from alcoholic extract of root bark significantly reduces blood glucose by increasing insulin level and also shows decrease in the lipid peroxides in streptozotocin induced diabetic rats[71]. Arayens *et al* reported that, the methanolic extract of *M. alba* inhibits glucose diffusion *in vitro*[72]. Oral administration of leaves at 0.5 and 1 g/kg, significantly reduces blood glucose level, also decreases the high blood pressure in streptozotocin induced chronic diabetic rats[73]. The moracin M, steppogenin-4′-O-beta-D-glucosiade and mullberroside-A, isolated from root bark show hypoglycemic effect at a dose of 100 mg/kg in alloxan induced diabetic mice[15].

3.26. Mucuna pruriens (Fabaceae)

Oral administration of aqueous extract (100 and 200 mg/kg) normalizes blood glucose level in streptozotocin induced diabetic rats[74]. Also the D-chiro-inositol and its two galacto-derivatives isolated from seeds show hypoglycemic potential[75].

3.27. Ocimum sanctum (O. sanctum) (Lamiaceae)

Gupta *et al* isolated three new compounds, *viz.* ocimumosides A, ocimumoside B and ocimarin from leaves of *O. sanctum* which were evaluated for antistress property. Out of these new compounds, ocimumosides A possesses antistress activity by normalizing hyperglycemia, plasma corticosterone, plasma creatine kinase, and adrenal hypertrophy[76]. The hydro alcoholic and chloroform extracts of *O. sanctum* aerial part demonstrate significant antidiabetic property at 250 and 500 mg/kg dose dependently in alloxan induced diabetic rats[10,11]. In addition to this, triterpenoid isolated from hydro alcoholic extracts of *O. sanctum* aerial possesses significant antidiabetic activity at 20 mg/kg in alloxan induced diabetic rats[77].

3.28. Pterocarpus marsupium (Fabaceae)

An aqueous extract of wood shows hypoglycemic activity in alloxan induced diabetic rats at oral dose of 250 mg/kg[78]. The butanol subfraction of alcohol extract of bark exhibits significant antidiabetic activity by ameliorating blood glucose and lipid parameters in alloxan induced diabetic rats[79].

3.29. Punica granatum (Punicaceae)

The oral administration of methanol extract of flowers at 500 mg/kg inhibits glucose loading-induced increase in plasma glucose levels in Zucker diabetic fatty rats[80]. Parmar and Kar, reported that, fruit peel extract normalizes all the adverse changes induced by alloxan mice, revealing the antidiabetic and anti peroxidative potential at 200 mg/kg[61]. In addition to this, oral administration of aqueous extract of flowers (250 and 500 mg/kg) ameliorates blood glucose, lipid parameters and oxidative stresses in streptozotocin induced diabetic rats[81]. Administration of pomegranate seed oil reduces blood glucose level and lipid parametars in mice[82].

3.30. Salacia oblonga (S. oblonga) (Hippocrateaceae)

The extract of *S. oblonga* lowers acute glycemia and insulinemia in type-2 diabetic patients after a high-carbohydrate meal[83] and decreases glycemia in healthy subject[84-92].

3.31. Eugenia jambolana (E. jambolana) (Myrtaceae)

Oral administration of ethanolic extract of *E. jambolana* seeds (100 mg/kg) in streptozotocin induced diabetic rats causes hypolipidemic effect[93]. The water and ethanolic extracts of the fruit-pulp of *E. jambolana* elicit antihyperglycemic effect. Water extract was found to be more effective than the ethanolic extract in reducing fasting blood glucose and improving blood glucose in glucose tolerance test[94]. Arayne *et al* reported that, the methanolic extract of *E. jambolana* inhibited glucose diffusion *in vitro*[72]. The flavonoid rich extract from *E. jambolana* seeds elicits both hypoglycemic effects by stimulating increase in insulin release *in vitro* from pancreatic islets and antihyperlipidemic effects in streptozotocin induced diabetic rats[95]. Oral administration of ethanolic extract of seeds (200 mg/kg) for 30 days in streptozotocin diabetic rats shows promising antidiabetic effect. In addition to this, seeds possess better ulcer healing effects by promoting defensive or reducing offensive mucosal factors in mild diabetic rats[96]. Furthermore, oral administration of ethyl acetate fractions of *E. jambolana* (200 mg/kg) for 90 days to streptozotocin induced diabetic rats causes optimum antihyperglycemic[97].

3.32. Tinospora cordifolia (T. cordifolia) (Menispermaceae)

The extract of *T. cordifolia* stem ameliorates the derangements in lipid metabolism caused by diabetes mellitus in streptozotocin induced diabetic rats[98]. The oral administration of various extracts (hexane, ethyl acetate and methanol) of *T. cordifolia* stem was found to have potent antidiabetic property by reducing blood sugar level in streptozotocin induced diabetic rats at a dose of 250 mg/kg[99]. The polyherbal formulation, Dihar containing eight different herbs *viz.*, *Syzygium cumini*, *Momordica charantia*, *Emblica officinalis*, *Gymnema sylvestre*, *Enicostemma littorale*, *Azadirachta indica*, *T. cordifolia* and *Curcuma longa* significantly reduces level of lipid peroxidation and increases activity of antioxidant enzymes in streptozotocin induced diabetic rats[66]. The ethyl acetate, dichloromethane, chloroform and hexane extracts of *T. cordifolia* stem were evaluated for alpha glucosidase inhibition activity and resulted that the dichloromethane extract was the most effective *i.e.* 100% inhibition of the alpha glycosidase than others[100]. The ethanol extract of *T. cordifolia* demonstrates an androgenic activity[101]. Saponarin isolated from leaf extract of *T. cordifolia* showed hypoglycemic activity at doses of 20-80 mg/kg[102]. The hydro alcoholic and chloroform extracts of *T. cordifolia* stem demonstrates significant antidiabetic property at 250 and 500 mg/kg dose dependently in alloxan induced diabetic rats[10,11].

3.33. Trigonella foenum graecum (Fabaceae)

Eidia *et al* reported that, oral administration of ethanolic extract fenugreek (0.1, 0.25, and 0.5 g/kg for 14 days) shows antidiabetic effect in streptozotocin induced diabetic rats by normalizing level of serum glucose, total cholesterol, triacylglycerol, urea, uric acid, creatinine, aspartate aminotransferase and alanine aminotransferase[103]. A diet controlled diabetic subjects receiving bread incorporating fenugreek (5%) shows remarkable decrease in blood glucose level[104]. The administration of fiber isolated from fenugreek (4 g or 8 g) to healthy obese subjects causes increased satiety and reduced energy intake[105]. The administration of ethanol extract of fenugreek seeds at different doses (2 g/kg, 1 g/kg, 0.5 g/kg and 0.1 g/kg) causes dose dependent hypoglycemic effect relative to standard antidiabetic drug in alloxan induced diabetic rats[106-109]. Administration of fenugreek seeds ameliorates abnormalities in lipid homeostasis due to its hypolipidemic properties inhibition of fat accumulation and upregulation of LDL receptor[110]. Fenugreek contains an unusual amino acid, 4-hydroxyisoleucine, demonstrated to have insulinotropic and antidiabetic properties in streptozotocin induced rats by altering levels of glucose or liver damage markers significantly[111]. Oral administration of 4-hydroxyisoleucine, an unusual amino acid isolated from fenugreek seeds (50 mg/kg) to db/db mice ameliorates blood glucose level and lipid parameters by enhancing insulin sensitivity and glucose uptake in peripheral tissue[112].

4. Conclusion

Most popularly used drugs of modern medicine such as atropine, quinine, artimisinine, digitalis, reserpine, metformin, *etc* have been originating from plant source. About less than 1% of estimated higher plants have been screened pharmacologically for diabetes mellitus. The main undesirable effects of current treatment include hypoglycemia, allergy, gastrointestinal disturbances, heart failure, lactic acidosis, *etc*. which may limit the use of these drugs in diabetes mellitus. It was reported that *M. charantia*, *E. jambolana*, *T. foenum graecum*, *O. sanctum*, *etc*. have shown varying degree of hypoglycemic and antihyperglycemic activity. This review of ethnomedicinal value of these plants may be helpful in the treatment of diabetes.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

The authors are gratefully acknowledged the Principal, Management of CEC School of Pharmacy, Bilaspur (CG) and CSVTU, Bhilai (CG) for facilities provided during the study.

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