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Review

Antidiabetic Medicinal Plants Having Insulin Mimetic Property: A Review

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Abstract

Background: Diabetes mellitus (DM) is an endocrine metabolic disorder characterized by hyperglycemia, altered lipids, carbohydrates, proteins metabolism. Resulting from defects in insulin secretion, insulin action or both.

Aim and objectives: The present study deals with collection of data's available on plants which have antidiabetic activity.

Method: Plant profiles of 20 Species with antidiabetic properties were compiled and categorized according to their parts used, active phytoconstituents having insulin mimetic activity and mode of reduction in blood glucose (insulin mimetic or insulin secretagogues activity).

Result: Majority of plants are containing phytoconstituents such as flavonoids, terpenoids, coumarins and polyphenols. Among of them flavonoids including flavan-3-ols, flavanones, flavonols, anthocyanidins, flavones and is flavones. Terpenoids including Monoterpenoids, Diterpenoids, Triterpenoids and Polyterpenoids. Furthermore, phenolic compounds such as eugenol, eugenol acetate and Gallic acid are present. These are capable to produce insulinomimetic action.

Conclusion: The paper has presented a list of various antidiabetic plants used in the treatment of diabetes mellitus. It shows that these plants have hypoglycemic effects and can be used to treat various types of secondary complications of diabetes mellitus.

Key words: Diabetes; Insulin secretagogues; Insulin mimetics; Phytoconstituents; Pancrease; Blood glucose; Insulin; Beta cell; Antidiabetic activity; Medicinal plants; Metabolic disorder; Herbal medicine; Diabetes mellitus; Hypoglycaemic activity.

Introduction

Diabetes mellitus (DM) is not a single disease but it is a group of metabolic disorders affecting a huge number of populations in the world. It is mainly characterized by hyperglycemia, hyper aminoacidemia, hyperlipedemia, and hypoinsulinaemia. It leads to decrease in both insulin secretion and insulin action [1]. It is frequently associated with the development of micro and macro vascular diseases which include neuropathy, nephropathy, cardiovascular and cerebrovascular diseases [2]. The disease is associated with reduced quality of life and increased risk factors for mortality and morbidity. The long-term hyperglycemia is an important factor in the development and progression of micro- and macro vascular complications [3].

The worldwide prevalence of DM for all age groups was estimated to be 2.8% in 2000 and it is projected to be 5.4% in 2025. At present available therapies for the treatment of DM comprise insulin and various oral antihyperglycemic agents such as sulfonylurea's, biguanides and glinides. In developing countries as products are expensive and not easily accessible. Currently, there is growing interest in herbal formulations due to its fewer side effects. So the traditional herbal medicines are mainly used which are obtained from plants, it plays important role in the management of DM [4].

In modern, herbal medicines have started to achieve importance as a source of hypoglycemic agents. Marles and Farnsworth expected that more than 1000 plant species are being used as folk medicine for diabetes [5]. Biological actions of the plant products used as alternative medicines to treat diabetes are related to their chemical composition. Natural formulations are rich in phenolic compounds, flavonoids, terpenoids and other constituents which show gradually diminution in blood glucose levels [6-8].

Several species of herbal drugs have been described in the scientific and popular literature as having antidiabetic activity [9]. Due to their perceived effectiveness, fewer side effects in clinical experience and relatively low costs, herbal drugs are prescribed [9]. Herbal formulations are traditionally used from long time in many countries for the treatment of DM.

The aim of this review is to provide compile data about DM, its epidemiology, causes, pathophysiology, available treatment, diagnostic criteria, major available screening model system, herbal remedies to treat diabetes and pharmacologically tested herbal formulation.

The review also face certain plant materials which were screened in alloxan and streptozotocin induced diabetic rat's model and the data information were collected from the available literature search published in last three year using alloxan induced diabetic rat model. Moreover, only sub acute and chronic diabetic study of the plant material was included in the present review. [10]

Scientific Name (Family)	Parts Used	Extraction solvent	Diabetic induced by	Active Ingredient's	Probable Mechanism of action
Vernonia amygdalina (asteraceae)	Leaves	Hydroalcoholic, methanol, acetone and N-hexane	Alloxan	Anthraquinone, tannins, flavonoids, akaloids, saponins, glycosides, terpenoids	Hypoglycemic activity by enhancing insulin secretion and insulin activity, lipid metabolism and antioxidant. [11]
Aegle marmelos (Rutaceae)	Leaves, juice	Methanol	Alloxan Alloxan	Citral, cineole, citronellal, skimmianine, aegilin	Stimulates insulin secretion from beta cells inhibits insulin degradative process. [12]
Euonyrnus alatus (Celastraceae)	Leaves	Ethanol	STZ	Rutin, β-sitosterol and quercetin	Hypoglycemic activity by β-sitosterol, Stimulates insulin secretion from β cells inhibits insulin degradative process. [13]
Fructus Coini (Cornaceae)	Leaves, Seeds	Ether, benzene and chloroform	STZ	Bornyl acetate, camphor, borneol, beta-sitosterol, vanillic acid, stearic acid and palmitic acid	Increases gluconeogenesis and decreases Glycogenolysis. [14]
Tephrosia villosa (Leguminosae)	Whole plant	Alcohol/water	STZ	Flavones, flavanones, prenylated flavonoids, chalcones and rotenoids	Hypoglycemic, hypolipidemic and antioxidant property decreased influx of glucose in polyol pathway, increasing NADPH/NADP ratio and increased activity of glucose peroxidase. [15]
Zaleya decandra (Aizoaceae)	Whole plant	Methanol	STZ	Terpenes and triterpenoids, sterols and steroids, phenolics, flavonoids, gums, resins, quinones, anthocyanidine, saponins, antioxidants and fatty acids	Stimulates insulin secretion from beta cells inhibits insulin degradative process. [16]
Vernonia amygdalina (Asteraceae)	Leaves, flowers & Seed	Hydroalcoholic, methanol, acetone and N-hexane	STZ	Anthraquinones , tannins, flavonoids, alkaloids, saponins, glycosides, cyanogenic glycosides, terpenoids, tannins	Hypoglycemic activity by inhibiting oxidative Stress. [17]
Heinsia crinata (Rubiaceae)	Root, cortex	Methanol, hexane	Alloxan	Flavonoids, hydroxy-anthraquinones, saponins, steroids, tannins and glycoside	Hypoglycemic activity by lowering blood glucose and stimulating peripheral utilization of glucose. [18]

Barleria prionitis (Acanthaceae)	Rhyzomes	N-Hexane, ethyl acetate, methanol and water	Alloxan	Glycosides, methyl ester, 6-o-trans-p-coumaroyl-8-o-acetylshanzhiside methyl ester, barlerin, acetylbarlerin, 7-methoxydiderroside and lupulinoside	Increase in glucose uptake and glycogen deposition, inhibits activity of epinephrine on glucose metabolism resulting in utilization of peripheral glucose. does not alter cortisol concentration. [19]
Acacia Arabica (Leguminosae)	Seeds, leaves	Eyhanol, methanol	STZ	Kaempferol, quercetin, 3,4',7-trihydroxyl-3', 5-dimethoxyflavone, catechin, epicatechin, afzelechin, epiafzelechin, mesquitol, ophioglonin, aromadendrin and phenol	Hypoglycemic effect in rat, through release of insulin. [20]
Nymphaea Pubescens (Nymphaeaceae)	Flower, leaves	Ethanolic extract	Alloxan	Alkaloids, carbohydrates, glycosides, sterols, phenolic compounds and tannins, amino acids, proteins and flavonoids	Increase the insulin secretion or inhibit the intestinal absorption of glucose. [21]
Paspalum scrobiculatum (Poaceae)	Stem juice, rhizomes, roots	Aqueous and ethanolic extract	Alloxan	Steroids, lipids, amino acids and carbohydrates	Reduce the blood glucose and lipid parameters. [22]
Adina cordifolia (Rubiaceae)	Leaves	Hydro-alcoholic	Alloxan	Tannins, saponins and flavonoids.	Increase the insulin secretion or inhibit the intestinal absorption of glucose. [23]
Afzelia africana (Fabaceae)	Stem bark	Aqueous	STZ	Flavonoids, proanthocyanidins, tannins, phenols and Flavonols.	Potentiating of insulin from β cells or by increasing peripheral glucose uptake. [24]
Acanthopanax senticosus (Araliaceae)	Whole plant	Hydroalcoholic	Alloxan	Polysaccharide.	Potent antioxidant activity leads to antidiabetic activity. [25]
Aralia elata (Araliaceae)	Root cortex	Ethanol	STZ	β-sitosterol, oleanolic acid, daucosterol, oleanolic acido-28-o-β-d-glucopyranoside, araloside a and sucrose. except oleanolic acid	The hypoglycemic activity of A. elata is mainly mediated through inhibition of aldose reductase activity. [26]
Grewia Asiatica (Malvaceae)	Fruit, Stem bark and leaves	Ethanol	Aloxan	Anthocyanin, cyanidin 3- glycoside 9, vitamin C	reduction in serum glucose level of alloxan induced diabetic rabbits. This antihyperglycemic may be mediated by its antioxidant and radical scavenging activity rather than by stimulating the release of insulin. [27]

Gymnema sylvestre (Asclepiadaceae)	Leaves	Ethanool	STZ	Gymnemic acid, gurmarin, and saponins	Causinga prominent suppression in blood-glucose, glycosylated hemoglobin and glycosylated plasma proteins together with restoring blood glucose homeostasis in type 2 diabetic patients. [28]
Lawsonia inermis (Lythraceae)	Whole plant	Ethanol as well as 95% methanol	Alloxan	Carbohydrates, flavonoids, proteins, phenolic compounds, tannins, terpenoids, alkaloids, quinones, xanthones, coumarins	Extracts of the whole plant exhibited potent hypoglycemic and hypolipidaemic activities in alloxan induced diabetic mice causing significant reduction in serum glucose, cholesterol and triglycerides level exceeding the effect of glibenclamide. [29]
Panax ginseng (Araliaceae)	Root and leaves	Methanol	STZ	Triterpene glycosides, ginsenoside, peptides, fatty acids and polyacetylene alcohol	aqueous extract showed a remarkable hypoglycemic activity, increasing insulin production, reducing pancreatic β-cells death and resistance to insulin, thus improving postprandial glycemia in diabetic patients. [30]

Table 1: Important anti-diabetic potential herbal plants source and their active principles

Discussion

Diabetes is a disorder of carbohydrate, fat and protein metabolism caused due to insufficient production of insulin or its inhibitory action, which can be considered as a major source of high economic loss which can in turn obstruct the development of nations [31]. Before there were drugs from drug companies, natural cures were used and they can still be used today. There are many herbs with strong antidiabetic properties. Herbal treatments for diabetes have been used in patients with insulin dependent and noninsulin dependent diabetes, diabetic retinopathy, diabetic neuropathy etc [32]. The families of plants with the most potent hypoglycaemic effects include Leguminoseae, Lamiaceae, Liliaceae, Cucurbitaceae, Asteraceae, Moraceae, Rosaceae, Euphorbiaceae and Araliaceae [33]. The most commonly studied species are: Opuntia streptacantha, Trigonella foenum graecum, Momordica charantia, Ficus bengalensis, Polygala senega and Gymnema sylvestre. In the experiments, oral glucose tolerance test, streptozotocin and alloxan induced diabetic mouse or rat were most commonly used model for the screening of antidiabetic drugs. Numerous mechanisms of actions have been proposed for plant extracts [34]. Some hypothesis relates to their effects on the activity of pancreatic beta cells, increase in the inhibitory effect against insulinase enzyme, increase of the insulin sensitivity or the insulin-like activity of the plant extracts [35]. Other mechanisms may also be involved such as increase of peripheral utilization of glucose, increase of synthesis of hepatic glycogen or decrease of glycogenolysis, inhibition of intestinal glucose absorption, reduction of glycaemic index of carbohydrates and reduction of the effect of glutathione [36]. In this review, natural products classified into terpenoids, alkaloids, flavonoids, phenolics, and some other categories have shown antidiabetic potential through the insulinomimetic activity of the plant extract. Roseoside, epigallocatechin gallate, beta-pyrazol-1-ylalanine, cinchonain, leucocyandin 3-O-beta-d-galactosyl cellobioside, leucopelargonidin-3-O-alpha-L rhamnoside, glycyrrhetinic acid, dehydrotrametenolic acid, strictinin, isostrictinin and pedunculagin, epicatechin and christinin-A isolated from the plant material have shown significant insulinomimetic activity along with significant antidiabetic potential. Additionally, some flavonoids and polyphenols, as well as sugar derivatives, are found to be effective due to some other extrapancreatic mechanisms. In this review 20 plants are included which have shown antidiabetic action through relese of insulin and some extra pancreatic mechanisms [37].

Conclusion

Present study has described a list of 20 antidiabetic plants used in the treatment of diabetes mellitus. Majority of plants are containing phytoconstituents such as flavonoids, terpenoids, coumarins and polyphenols. Among of them flavonoids including flavan-3-ols, flavanones, flavonols, anthocyanidins, flavones and isoflavones. Terpenoids including Monoterpenoids, Diterpenoids, Triterpenoids and Polyterpenoids. Furthermore, phenolic compounds such as eugenol, eugenol acetate and gallic acid are present. These are capable to produce insulinomimetic action and also show that these plants have hypoglycemic effects and can be used to treat various types of secondary complications of diabetes mellitus.

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