

Herbal Medicines for Diabetes Mellitus: A Review

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Abstract: Diabetes mellitus is one of the common metabolic disorders and 2.8% of the population suffers from this disease throughout the world and it may cross 5.4% by the year 2025. Oral hypoglycemic agents like sulphonylureas and biguanides are still the major players in the management of the disease but there is growing interest in herbal remedies due to the side effects associated with the oral hypoglycemic agents. Herbal medicines have been the highly esteemed source of medicine throughout human history. They are widely used today indicating that herbs are a growing part of modern, high-tech medicine. The medicinal plants, besides having natural therapeutic values against various diseases and considerable works have been done on these plants to treat diabetes mellitus, describes that the antidiabetic activity of medicinal plants is due to the presence of phenolic compounds, flavonoids, terpenoids, coumarins and other constituents which show reduction in blood glucose levels. Some of these herbal plants and their active chemical constituents which have a role in the management of diabetes mellitus are compiled here and discussed in this review.

Key words: Diabetes mellitus, hypoglycemic agents, herbal medicines, sulphonylureas, biguanides.

Introduction

Diabetes mellitus is a systemic metabolic disease characterized by hyperglycemia, hyperlipidemia, hyperaminoacidemia, 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 complications³. The worldwide prevalence of diabetes for all age groups was estimated to be 2.8% in 2000 and it is projected to be 5.4% in 2025. Currently available therapies for diabetes include insulin and various oral antidiabetic agents such as sulfonylureas, biguanides, α -glucosidase inhibitors and glinides. In developing countries as products are expensive and not easily accessible.

Presently, there is growing interest in herbal remedies due to the side effects associated with the oral hypoglycemic agents (therapeutic agent) for the treatment of diabetes mellitus. So the traditional herbal medicines are mainly used which are obtained from plants, it plays important role in the management of diabetes mellitus.⁴ In recent years, herbal medicines have started to gain importance as a source of hypoglycemic agents. Marles and Farnsworth estimated 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. Herbal products or plant products are rich in phenolic compounds, flavonoids, terpenoids, coumarins, and other constituents which show reduction in blood glucose levels.^{6, 7, 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.¹⁰ Medicinal and herbal plant

products are traditionally used from long ago in many countries for the treatment of diabetes mellitus.

The ethnobotanical information reports about 1000 plants that may possess antidiabetic potential among them, this review article enumerates some medicinal plants possessing hypoglycemic properties and elucidating their mechanisms of action such as *Bauhinia forficata*, *Combretum micranthum*, *Elephantopus scaber*, *Gymnema sylvestre*, *Liriope*

spicata, *Parinari excelsa*, *Ricinus communis*, *Sarcopoterium spinosum*, *Smallanthus sonchifolius*, *Swertia punicea*, *Vernonia anthelmintica* etc. and method of experiment on animals and therapeutic efficiency of plant extracts were exploited. Some of the important anti-diabetic potential herbal plants source and their active principles are given in the

Table: 1

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

Botanical name	Family	Parts used	Main Active components
<i>Allium sativum</i>	Alliaceae.	Bulbs	Allyl propyl disulphide, allicin
<i>Annona squamosa</i>	Annonaceae	Fruits	Liriodenine, moupinamide
<i>Areca catechu</i>	Arecaceae	Seed	Arecaine and arecoline
<i>Artemisia pallens</i>	Asteraceae	Leaves and flowers	Germacranolide
<i>Azadirachta indica</i>	Meliaceae	Leaves, flowers & seed	Azadirachtin and nimbin
<i>Bauhinia forficata</i>	Leguminosae	Leaf	Astragalin, kaempferitrin
<i>Beta vulgaris</i>	Amaranthaceae	Root	Phenolics, betacyanins
<i>Boerhavia diffusa</i>	Nyctaginaceae	Whole plant	Punarnavine and ursolic acid
<i>Camellia sinensis</i>	Theaceae	Leaves	caffeine and catechins
<i>Capparis decidua</i>	Capparidaceae	Fruit	Spermidine Isocodonocarpine
<i>Cinnamomum zeylanicum</i>	Lauraceae	Bark	Cinnamaldehyde, eugenol
<i>Combretum micranthum</i>	Combretaceae	Leaves	Polyphenols
<i>Elephantopus scaber</i>	Asteraceae	Whole plant	Terpenoid and 2,6,23 - trienolide
<i>Ficus bengalensis</i> Linn	Moraceae	Bark	Leucodelphinidin and leucopelargonin
<i>Gymnema sylvestre</i>	Asclepiadaceae	Leaf	Dihydroxy gymnemic triacetate
<i>Gynandropsis gynandra</i>	Capparidaceae	Root	<i>N,N</i> -diethyltoluamide
<i>Lantana camara</i>	Verbenaceae	Leaves	Lantanoside, lantanone
<i>Liriope spicata</i>	Liliaceae	Root	Beta-sitosterol, stigmasterol
<i>Momordica charantia</i>	Cucurbitaceae	leaves	Charantin, sterol
<i>Ocimum sanctum</i>	Labiatae	whole plant	Eugenol
<i>Panax quinquefolius</i>	Araliaceae	root	Ginsenosides, protopanaxadiol
<i>Parinari excelsa</i>	Chrysobalanaceae	Bark	Myricetin, quercertin
<i>Phyllanthus amarus</i>	Phyllanthaceae	whole plant	Phyllanthin
<i>Prunus amygdalus</i>	Rosaceae	Seeds	amygdalin
<i>Pterocarpus marsupium</i>	Leguminosae	Whole plant	Kenotannic acid, pyrocatechin
<i>Punica granatum</i>	Lythraceae	Fruit	Punicalagin, punicalin
<i>Ricinus communis</i>	Euphorbiaceae	Root	Ricinolic acid
<i>Salacia oblonga</i> wall	Celastraceae	Root bark	salacinol
<i>Sarcopoterium spinosum</i>	Rosaceae	Root	Catechin and epicatechin
<i>Smallanthus sonchifolius</i>	Asteraceae	Leaves	Sonchifolin, uvedalin, enhydrin, fluctuanin
<i>Swertia punicea</i>	Gentianaceae	Whole plant	Methyl swertianin and bellidifolin
<i>Tinospora cordifolia</i>	Menispermaceae	Root	Tinosporone, tinosporic acid

<i>Trigonella foenum graecum</i>	Fabaceae	Leaves and seeds	4-hydroxy isoleucine
<i>Vernonia anthelmintica</i>	Asteraceae	Seed	Epoxy acid or vernolic acid
<i>Withania somnifera</i>	Solanaceae	Cuscohygrine and withasomnine	Somniferine, withananine and cuscohygrine

Important medicinal plants having anti-diabetic potential:

Bauhinia forficata

Bauhinia forficata is the most widely used herbal medicine for control of diabetes in Brazil, where it is known as Pata de Vaca (cows hoof).¹¹ The fresh leaves are the essential part of this plant which shows the hypoglycemic activity and the genus *Bauhinia* belongs to the family Caesalpiniaceae.¹² The initial reports of *Bauhinia forficata* antidiabetic activity in diabetic patients were made by Juliani (1941)¹³ and Juliani (1931).¹⁴ According to M.T. Pepato *et al* (2002) *Bauhinia forficata* decoction was prepared by boiling 150 g of fresh leaves in 1 litre of water for 5 min, allowed the decoction to stand for 30 min and filtered. The rats which are used for the experiment were fed a normal laboratory chow diet containing (wt./wt.) 16% protein, 66% carbohydrate and 8% fat and were housed under a 12:12 h light: dark cycle at 22-25°C. In this experiment they divided the rats into two groups i.e., diabetic and non diabetic groups, followed by administered the streptozotocin (STZ) 40 mg/kg body weight, after 3 days the serum and urinary glucose levels were increased. Then one group was injected with *Bauhinia forficata* decoction and another with the drinking-water as control group. After 31 days of treatment the diabetic group treated with decoction showed a significant reduction in plasma glucose and urinary glucose. So the pharmacological, biochemical, histological and chemical studies are needed to elucidate the exact mechanism of action of *Bauhinia forficata* leaf decoction and to isolate any active compounds. Such investigations should also be carried out regarding type 2 diabetes¹⁵.

Gymnema sylvestri

Gymnema sylvestri (Asclepiadaceae) is emerging as a potential treatment for the management of diabetes, the leaves of this plant is used in herbal medicine preparations. *Gymnema* is a plant used in India and parts of Asia as a natural treatment for diabetes or "sweet urine." The hypoglycemic (blood sugar lowering) action of *Gymnema* leaves was first documented in the late 1920s.¹⁶ The *Gymnema sylvestri* crude extracts and its isolated compound dihydroxy gymnemic triacetate shows hypoglycemic effect against streptozotocin induced diabetic rats in dose and time dependent manner¹⁷. This hypoglycemic effect was due to the ability of gymnemic acids to delay the glucose absorption in the blood. Because

Gymnemic acid molecules fill the receptor location in the absorptive external layers of the intestine thereby preventing the sugar molecules absorption by the intestine, which results in low blood sugar level.¹⁸ And also the reduced glucose levels are exerted by the crude extract due to the presence of dihydroxy gymnemic triacetate had the ability to release the insulin by the stimulation of a regeneration process and revitalization of the remaining beta cells.^{19, 20, 21} Liu *et al.* (2009) also demonstrated the *Gymnema sylvestri* aqueous extract of leaves (termed OSA) stimulates insulin secretion from mouse cells and isolated human islets in vitro, without compromising cell viability.²² The plasma glucose and insulin levels of the normal rats administered with dihydroxy gymnemic triacetate were not altered indicating its normoglycemic effect of the novel compound. The characteristic loss of body weight associated with STZ-induced diabetes is due to increased muscle wasting in diabetes.²³ By reviewing all the literature we conclusively affirm that the novel compound dihydroxy gymnemic triacetate which was isolated from the leaves of *Gymnema sylvestri* represent a good candidate for alternative and/or complementary medicine in the management of diabetes mellitus, since they exhibited beneficial effects on the blood glucose levels and associated biochemical parameters of STZ induced diabetic animals. Further clinical trials on human subjects are recommended for further prospects of the compound can be used as a drug.

Ricinus communis

Ricinus communis is the traditional medicine which was used for the management of Diabetes mellitus. It is called as Erandah in Sanskrit, Amudam in Telugu and Arandi in Hindi and is also known as castor oil. It belongs to the family Euphorbiaceae, and it was cultivated all over India for getting its seed oil. Castor oil have been used in classical Egyptian and Greek medicine and their use has been described in the Susruta and Ayurveda as early as sixth century B.C.²⁴ In the Indian system of medicine, the leaf, root and seed oil of this plant have been used for the treatment of inflammation and liver disorders.²⁵ Fifty percent of ethanolic extract of the root, stem and leaves of this plant showed hypoglycemic activity in normal animals and antihyperglycemic activity in diabetic animals in initial screening studies.²⁶ The Administration of the ethanolic extract for a long duration led to a significant diminution of Blood Glucose in the diabetic rats, while

there was no significant alteration in the Blood Glucose of the control animals. The 50% ethanolic root extracts of *Ricinus communis* showed a dose-dependent effect on Blood Glucose of diabetic animals up to a dose of 500 mg/kg body weight. But, higher doses up to 2000 mg/kg body weight did not show any dose-dependent effect and a maximum decrease in blood Glucose was observed at 8th hour. The significant hypoglycemic effect was observed at 500 mg/kg body weight of 50% ethanolic extract which decreases the Blood Glucose to 166 ± 19 from an initial level of 371 ± 21 mg/dl. Out of the twenty column-purified fractions of 50% ethanolic root extracts were tested for antihyperglycemic activity in diabetic rats, only one fraction (R18) showed a significant decrease in blood glucose of the diabetic rats. Fraction R18 decreased the Blood Glucose to 294 ± 60 (22.4% decrease), 284 ± 36 (25% decrease) 184 ± 23 mg/dl (51.4% decrease), 182 ± 40 mg/dl (51.9% decrease) and 149 ± 11 mg/dl (60.6% decrease) at 1st, 2nd, 4th, 6th and 8th hour, respectively from an initial value of 379 ± 72 mg/dl at the beginning of the experiment.²⁷ The results of this plant showed a potent blood glucose lowering activity, both in the normal as well as alloxan diabetic rats. The effective dose of *Ricinus communis* was found to be 500 mg/kg body weight. Administration of this ethanolic extract to the diabetic rats for 20 days, not only significantly lowered the Blood Glucose of the diabetic animals to almost normal level, but also increased the insulin levels and caused improvement in lipid profile and body weight of the diabetic animals. It seems to have a promising value for the development of a potent phytomedicine for diabetes, though further comprehensive pharmacological investigations are needed to elucidate the exact mechanism of action of the *Ricinus communis* root extract.

Swertia punicea

Swertia plants are most widely used traditional medicines in the treatment of diabetes.²⁸ The whole plant of *Swertia punicea* (5.6 kg) was extracted with 90% Ethanol at room temperature to obtain 940 g of crude extract, which was treated successively with petroleum ether, EtOAc, and n-butanol. It belongs to the family Gentianaceae. Some plant extracts and xanthonoids, the major class of compounds among the chemical constituents of this genus, have been reported to show significantly hypoglycemic activities.²⁹ According to the Pen and Fang (2003) studies the plant *Swertia Punicea* shows a good hypoglycemic activity in alloxan-induced diabetic mice,³⁰ and can reduce oxidative injury in diabetic mice.³¹ In addition, the Ethanol extracts and Ethyl acetate soluble fraction of *Swertia Punicea* showed hypoglycemic effects in STZ-induced type-2 diabetic mice and may be

beneficial to improvement of insulin resistance (IR).³² The hypoglycemic activity of this plant is due to the presence of two important constituents which are *Methylswertianin* and *Bellidifolin*. The 90%ethanolic extract of *Swertia Punicea* was administered to the diabetic and control group of rats. After 28 days of treatment the fasting blood glucose levels of both groups were observed. The Fasting Blood Glucose level of the diabetic control was significantly higher than that of normal control. The essential constituents of this plant i.e., *Methylswertianin* and *Bellidifolin* at both doses significantly reduced Fasting Blood Glucose after 1 week of administration, and the Fasting Blood Glucose levels were stable within 4 weeks. Both *Methylswertianin* and *Bellidifolin* at 200 mg/kg body wt. /day produced more antidiabetic effect (significant decreases of 44.04% and 44.48% after 4 weeks of oral administration, respectively) than them at 100 mg/kg body wt. / day (decreases of 37.99% and 38.93%, respectively).³³ In previous study reports mention that the ethanol extract and the Ethyl acetate fraction of *Swertia Punicea* showed high anti-diabetic activities. Now the present studies states that xanthone derivatives named as *Methylswertianin* and *Bellidifolin*, shows significant anti-diabetic effects as well as the potential mechanism(s) of action in STZ induced type-2 diabetes in mice. The mechanism of action of hypoglycemic effect of *Swertia Punicea* was found i.e., by the improvement of Insulin resistance. So the herbal medicine *Swertia Punicea* plays an important role in the management of type-2 Diabetes mellitus and supports the development of new phyto-medicines for Diabetes. It is therefore possible that we may find more useful species of *Swertia* for the treatment of type-2 diabetes.

Combretum micranthum

Combretum Micranthum is a medicinal plant used for treating diabetes in Northwestern Nigeria. It is commonly known as 'geza' in Hausa, belong to the family of Combretaceae. It is a widely known ethno medicinal plant used in West Africa for treating several diseases.^{34, 35} In Nigeria, more than 80% of the people depend on herbal medicines for treating their illnesses.³⁶ The plant have also been documented to show antioxidant, antimicrobial³⁷ as well as anti-inflammatory³⁸ properties. The Aqueous extract of *Combretum Micranthum* was prepared by using Soxhlet extractor and it was dried in an evaporator at 45°C and stored at 4°C until ready for use. The hypoglycemic activity of this plant extract was tested by using glucose tolerance test and fasting blood sugar assessment in normal rats. The antihyperglycemic potential of this plant was performed by taking two group of animals i.e., diabetic group and nondiabetic groups. The aqueous leaf extract of *Combretum*

Micranthum dissolved in normal saline (N/S) and administered to the both groups at 100 mg/kg, 200 mg/kg, and 400 mg/kg body weight, but 100 mg/kg of the extract was found to be the optimum dose of the 3 doses. The aqueous leaf extract of 100 mg/kg body weight dose produced a significant reduction in blood glucose level and 24.6% maximum reduction when compared to the maximum decrease of 21.9% and 18.9% produced by 200 mg and 400 mg/kg body weight doses, respectively.³⁹ In this study of this plant was showed that the aqueous leaf extract of *Combretum Micranthum* has potential antidiabetic property for both type 1 and type 2 Diabetes mellitus. Hence further studies are needed to study the various active constituents responsible for these properties.

Sarcopoterium spinosum

Sarcopoterium spinosum species is a common medicinal plant in the Mediterranean region, and it is widely used as an antidiabetic drug by Bedouin healers. The ethnobotanical surveys reported as a medicinal plant, used by traditional Arab and Bedouin medicine for the management of diabetes, digestive problems, pain relief or cancer. It is also known as thorny burnet (syn: *Poterium spinosum* L.; in Hebrew, "sira kotsanit", in arabic, "natsh" or "bilan")^{40, 41} is an abundant and characteristic species of the semi-steppe shrublands (phrygana) and Batha of the Eastern Mediterranean region. The plant *Sarcopoterium spinosum* is a chamaephyte of the Rosaceae family.⁴² Dafni et al. were tested that the root extract of this plant was used for treating diabetes in Muslim folk medicine⁴³ and a very few studies have confirmed this information and measured its antidiabetic activity. In the late 1960s and 1980s, several studies were performed to show the root extract of *Sarcopoterium spinosum* exhibits a hypoglycemic effect in rats.⁴⁴ The aqueous root extract of *Sarcopoterium spinosum* was prepared by cutting the 100gms of fresh roots into small pieces and roots were boiled in 1 Litre of water for 30 min. The aqueous extract was used to carry out experiment in 0.001–10 mg/ml concentrations. The *Sarcopoterium spinosum* extract (0.01, 0.1 and 1 mg/ml) exhibited an insulin-like effect on glucose uptake in hepatocytes by inducing a 148 ±10, 133 ±23 and 119 ±14% increase in glucose uptake, respectively, compared to 160 ±12% increase in glucose uptake obtained by insulin. The root extract of this plant at 0.01 mg/ml concentration showed maximum activity than lower or higher doses. The aqueous root extract was assumed that it shows antidiabetic effect in the progressive hyperglycemia of genetically diabetic mice. Hence the aqueous root extract of *Sarcopoterium spinosum* shows an insulin-like actions in targets tissues, increases insulin secretion in vitro, and have an improved glucose

tolerance in vivo. So that these results support the traditional use of herbal medicine *Sarcopoterium spinosum* has an antidiabetic activity.⁴⁵ The extract increases glucose uptake in hepatocytes, adipocytes and myotubes. The *Sarcopoterium spinosum* extract also increases GSK3 Phosphorylation in myotubes. The identification of active compounds in the *Sarcopoterium spinosum* plant extract may be the source for the development and improvement of new antidiabetic drugs.

Parinari excelsa

Senegalese traditional herbals are used to manage the Diabetes mellitus; the decoction of *Parinari excelsa* is one of the most widely used medicinal plant. It is a big tree that grows up to a 25 m of height. In Africa, it is found in Guinea, in Congo and in Senegal particularly in Casamance.⁴⁶ *Parinari excelsa* bark is used for the treatment of diabetes mellitus and it belongs to the family Chrysobalanaceae. Jayaprakasam B et al. studies reported the flavonoids of *Parinari excelsa* shows the hypoglycemic effect and the ability to induce insulin secretion in diabetic animal models.^{47, 48, 49} The hypoglycemic effect of *Parinari excelsa* was similar to that of glibenclamide is already observed with some other plant extracts.^{50, 51, 52} The aqueous bark extract was prepared by using (25 g) dried and powdered barks and these were infused in 200 ml of aqueous Ethanol (3.1), to overnight. After that, the infusion is subjected to filtration, and the solvent was evaporated to give the extract (yield 4%). The hypoglycemic activity of this plant was studied by using two groups of animals i.e., alloxan induced diabetic and normoglycemic rats. The aqueous extract of *Parinari excelsa* is administered to both the groups at doses of 100 and 300 mg/kg/day for 7 days. The antidiabetic activity of extract was performed on overnight fasting (16 h) rats. The Plant aqueous extract at 100 and 300 mg/kg/day reverse the permanent hyperglycemia induced by alloxan and the blood glucose level decreased from 3.11 ± 0.24 to 0.91 ± 0.02 g/l and 3.60 ± 0.12 to 0.85 ± 0.04 g/l, respectively.⁵³ The oral administration of aqueous extract of *Parinari excelsa* at the dose of 100 and 300 mg/kg was also reduced significantly the blood glucose level at 1/2 h, after glucose administration. Further more studies of biochemical, toxicological and pharmacological investigations are underway to better characterize the active principle(s) and to evaluate the mechanism of their antidiabetic effect.

Vernonia anthelmintica

Folk medicine for the treatment of Diabetes mellitus from Rayalaseema reports 26 plants with antidiabetic activity, one of such plant is *Vernonia*

anthelmintica.⁵⁴ The popular name of this plant is wild cumin/purple /wormseed and in Hindi it is known as Kalizeeri. It belongs to the family Asteraceae. The ethnobotanical information reports about 800 plants that may possess antidiabetic activity.⁵⁵ *Vernonia anthelmintica* was found throughout in India and is an annual herbaceous plant. The ethanolic extract of this plant seeds having the significant hypoglycemic effect in STZ induced diabetic rats. The ethanolic extract of *Vernonia anthelmintica* was prepared by using (200 g) powdered seeds and these were extracted with 1 litre of 95% ethanol in a soxhlet extractor for 24 h. The antidiabetic activity of this plant extract was studied by using normal and STZ induced diabetic rats and the blood glucose levels were determined Glucose oxidase-peroxidase method.⁵⁶ The ethanolic extract of plant at a dosage of 0.25 and 0.75 g/kg body weight showed a decrease of 30.6% and 17.5% in the blood glucose levels in the diabetic rats after 6 h of treatment, respectively. But at a dose of 100 mg/kg body weight of extract showed a significant antihyperglycemic activity in the diabetic treated rats with a maximum fall of 82.3% in the blood glucose level after the 6th hour of treatment when compared with other fractions.⁵⁷ The other species of this genus *Vernonia amygdalina*⁵⁸ and *Vernonia colorata*⁵⁹ have been reported to have antidiabetic activity. Hence the present study of this *Vernonia anthelmintica* seeds shows the antihyperglycemic property in diabetic rats without any hypoglycemic action in normal rats and without evident toxic effects. So the herbal medicines have been developed for the treatment of Diabetes mellitus in the future.

Elephantopus scaber

Elephantopus scaber is an ethnomedicinal plant, having the property to reduce the blood glucose levels in streptozotocin induced diabetic rats significantly. It is popularly known as Elephant's foot, and it is family of Asteraceae. It is a scabrescent aromatic herb distributed in the moist deciduous forests of the central Western Ghats. As per the previous studies, the roots of *Elephantopus scaber* are used as an antipyretic, cardiotoxic and diuretic⁶⁰ and decoction of the roots and leaves is used as emollient and it was given in dysuria, diarrhea, dysentery and stomach pain.⁶¹ The aqueous extract of leaves is applied externally to treat eczema and ulcers.⁶² The Acetone extract of *Elephantopus scaber* was prepared from 1 kg dried powdered plant and it was extracted by using hexane, acetone and methanol in a soxhlet extraction apparatus sequentially and the extracts were evaporated to dryness under reduced pressure. The Antidiabetic property of acetone extract was determined by taking control and streptozotocin induced diabetic rats. After 60 days of treatment with

the acetone extract of *Elephantopus scaber* showed a significant decrease in blood glucose level from the initial 534.6 mg/dl to 86.14 mg/dl and reached a level closer to the untreated control of 85.6 mg/dl.⁶³ The antidiabetic property of plants shows their mechanisms by improving insulin sensitivity, augmenting glucose-dependent insulin secretion and stimulating the regeneration of islets of langerhans in pancreas of STZ- induced diabetic rats.⁶⁴ The administration of *Elephantopus scaber* acetone extract lowering the blood sugar level in streptozotocin induced hyperglycemic animals it may be due to a stimulating effect on insulin release from regenerated β -cells of the pancreas or increased cellularity of the islet tissues and regeneration of the granules in the β -cells.⁶⁵ The significant and consistent antidiabetic effect of acetone extract of *Elephantopus scaber*, in diabetic rats indicates that this effect can be mediated by stimulation of glucose utilization by peripheral tissues. Now the present studies indicate that the novel terpenoid isolated from *Elephantopus scaber* can be a useful in the management of Diabetes mellitus.

Liriope spicata

Liriope spicata is a Chinese medicinal plant, which belongs to Liliaceae family. It is frequently used as "maidong" in prescriptions of traditional Chinese medicine for the treatment of Diabetes mellitus, because of the high availability and safety. The antidiabetic effect it is due to presence of two important main active components in water extracts as well as crude polysaccharides.⁶⁶ The aqueous extract of *Liriope spicata* tuberous roots was prepared by using 500 gm of powdered material and it was boiled in distilled water for three times (1:4, 1:4, 1:2, w/v), 0.5 hr each time. After that the extract was filtered, combined, and then concentrated by using rotary evaporator at 45°C under reduced pressure. In previous reports, STZ-induced type 2 diabetic studies were made by using prescribed methods in C57BL/6J and ICR mice.^{68, 69} The aqueous extract was administered at dose of 100mg/kg and 200gm/kg to both the groups i.e., control and diabetic rats, after 28 days of treatment it shows significant decrease in the blood glucose level in streptozotocin induced diabetic rats. The results of this study demonstrate that aqueous extract of *Liriope spicata* did not have any appreciable effect on Fasting Blood Glucose level in normal mice, but it caused a marked decrease of Fasting Blood Glucose level and a significant improvement on glucose tolerance and insulin resistance in STZ-induced type 2 diabetic mice, and thus proving the hypoglycemic effects of aqueous extract.⁷⁰ However, further pharmacological evaluations are required to isolate and identify the active hypoglycemic and hypolipidemic principles in

the plant as well as elucidating their mechanisms of action.

Conclusion

Diabetes mellitus is a most common endocrine disorder, affecting more than 300million people worldwide. For this, therapies developed along the principles of western medicine (allopathic) are often limited in efficacy, carry the risk of adverse effects, and are often too costly, especially for the developing world. Therefore, treating diabetes mellitus with plant-derived compounds which are accessible and do not

require laborious pharmaceutical synthesis seems highly attractive. In this review article, an attempt has been made to compile the reported hypoglycemic plants from India and abroad and may be useful to the health professionals, scientists and scholars working the field of pharmacology and therapeutics to develop evidence-based alternative medicine to cure different kinds of diabetes in man and animals. Isolation & identification of active constituents from these plants, preparation of standardized dose & dosage regimen can play a significant role in improving the hypoglycemic action.

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