International Journal of Pharmaceutical Research and Development (IJPRD)
Platform for Pharmaceutical Researches & Ideas
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# ANTI-DIABETIC POTENTIAL OF HERBAL MEDICINES: A REVIEW

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***ABSTRACT***

*Diabetes mellitus (DM) is the commonest endocrine disorder that affects more than 100 million people worldwide (6% of the population) (WHO/Acadia, 1992). It is caused by the deficiency or ineffective production of insulin by pancreas which results in increase or decrease in concentrations of glucose in the blood. It is found to damage many of the body systems, particularly the blood vessels and nerves. Many herbal plants with hypoglycemic properties are known from across the world. In India, diabetes has been known for a long time, but its incidence is not of the same magnitude across the subcontinent. The wide range of structures of the plant constituents, which appear to be the active hypoglycemic principles, suggests different sites of action within the body. Whether these plants truly possess hypoglycemic properties needs to be investigated for those plants that are commonly used in the management of diabetes. Researches conducted in the last few decades on plants, mentioned in ancient literature or used traditionally for diabetes, have shown antidiabetic property. Among them, 30 plants and their products (active natural principles and crude extracts) that have been mentioned used in the Indian traditional system of medicine have shown experimental or clinical antidiabetic activity. Trigonella foenumgraecum, Momordica charantia, Tinospora cordifolia, Enicostema littorae, Gymnema sylvestre, Azadirachta indica, Syzigium cumini are some of the most effective and the most commonly studied Indian plants in relation to diabetes. Some of these herbal plants and their active chemical constituents and mechanism of action which have a role in the management of diabetes mellitus are compiled here and discussed in this review.*

**Key words:** diabetes mellitus, hypoglycaemic, antidiabetic plants, herbal medicines, Active chemical constituents.

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**INTRODUCTION**

Diabetes mellitus is a clinical syndrome characterized by inappropriate hyperglycemia caused by a relative or absolute deficiency of insulin or by a resistance to the action of insulin at the cellular level. It is the most common endocrine disorder, affecting 16 million individuals in the United States and as many as 200 million worldwide[1]. Diabetes has been a clinical model for general medicine. The primary defect in fuel metabolism results in widespread, multi-organ complications that ultimately encompass virtually every system of the body and every specialty of medicine. It has been said that to know diabetes is to know medicine and health care. Although from a clinical standpoint this may be true, our increasing knowledge of the pathophysiology of the syndrome, together with the mechanisms of long-term complications, has placed diabetes research at the frontier of immunology and molecular biology.[1] Diabetes mellitus has been known since ages and the sweetness of diabetic urine has been mentioned in Ayurveda by Sushruta. Its pharmacotherapy however is over 80 years old. The word diabetes was coined by the Greek physician Aeretaeus in the first centuryA.D. In the 17th century, Willis observed that the urine of diabetics as wonderfully sweet as if imbued with honey or sugar. The presence of sugar in the urine of diabetics was demonstrated by Dobson in 1755[2].

Diabetes mellitus is now recognized as a serious global health problem[3]. Westernized cultures and populations experiencing rapid acculturation are showing a sharp rise in non-insulin-dependent diabetes mellitus[4-5]. The prevalence of NIDDM is increasing exponentially[6]. It is estimated that more than 300 million people in the world will have diabetes by the year 2025. Only in U.S.A., there are 8 million diagnosed diabetic patients, another 8-12 million undiagnosed diabetic individuals and still an additional 23 million Americans with prediabetes or impaired glucose tolerance (IGT). Various epidemiological studies in India have shown that the prevalence and manifestations of diabetes are very high[7]. At present, approximately 18-20 million people are diabetic in India, and it is projected that by 2025, there will be 20-60 million diabetics in India, and it will have the second largest number of diabetics in the world.

There are different approaches to the treatment of diabetes, like insulin treatment in type 1 diabetes: Sulphonylureas, which release insulin from pancreas by blocking the ATP-sensitive potassium channels[8]; Biguanides, which decrease the insulin resistance; Thizaolidinediones, which increase the insulin sensitivity; alpha-glucodase inhibitors like acarbose, which decrease glucose absorption from intestine, thereby decreasing postprandial hyperglycemia; metiglinides like repaglimide and nateglamide, which are insulin secretogogues. Traditional herbal mineral plays an important part in the treatment of diabetes. If we were able to even identify some 5-6 herbal drugs that can reduce dose of insulin by increasing resistance sensitivity, reducing insulin resistance, then we would have positively contributed in the treatment of diabetes.

Herbal medicines are often used as therapeutic remedies in combination with allopathic drugs[9]. Most of the doctors did not report any complication, but nausea, vomiting, gastric problems were the common adverse effects reported with PHFs (Polyherbal formulations). Usually ayurvedic drugs are being used due to their minimum toxicity[10]. The basis prescription of ayurvedic drugs was mainly found to be past experience of the patients. Practicing physicians expected that controlled clinical trials of the herbal antidiabetic should be conducted in humans at different hospitals to substantiate the efficacy claim. Ginger, jamun, karela, methi are being used as home remedies in diabetes mellitus due to their proved antihyperglycemic activity. Many of the pharmacists are interested in providing counseling to all their customers (patients) regarding herbal products[11]. Herbal medicines can be relevant today only if they are applied and tested within the framework of modern sciences and subjected to the rigorous criteria for quality, safety and efficacy. Only then, herbal products can be comparable with

modern medicines and can bring necessary confidence in prescribing doctors.

In present investigation attempts have been made to study the indigenous plants which show inhibitory effect of glucose utilization and are in use as antidiabetic agents in traditional system of medicine. Hence, the present study was performed with the aim of producing an inventory of the plants used to treat diabeties, simultaneously also included those plants which are scientifically justified as antidiabetic agents.

**Antidiabetic plants:**

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 for□cata, 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 [ 12 ] 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.

**Important medicinal plants having antidiabetic potential:**

**Allium sativum:**

Srivastava K, et.al suggested that the extract of A. sativum inhibits the formation of diabetic cataract due to excessive accumulation of polyols and hydration of the lenses of diabetic rats fed with galactose-, glucose- and xylose-rich diet. 5- Methyl cysteine sulphoxide, a sulphurcontaining amino acid isolated from A. cepa, showed antidiabetic effect on oral administration of the compound at dose 200 mg/kg for a period of 45 days to alloxan diabetic rats. Kumar V, et.al suggested that it controlled the blood glucose in serum and altered the activities of liver hexokinase glucose-6-phosphatase and hemoglobin coenzyme-A reductase towards normal. Administration of aqueous extract of Allium sativum (garlic) in the concentration of 10 ml/kg/day to rabbits significantly increased liver glycogen and free amino acids, which resulted in significant decrease in fasting blood sugar, triglycerides (in serum, liver and aorta) and liver serum proteins as compared to those in sucrose-fed group.

The pectin isolated from the fruits of Coccinia indica significantly reduced blood glucose levels when orally administered to normoglycemic rats. The reduction may be due to decreased absorption of glucose from the intestine, higher rate of glycolysis by the higher activity of hexokinase (one of the key enzymes of glycolysis) and enhanced rate of glycogenesis as evidenced by the higher amount of liverglycogen present in the pectin-administered groups.

**Azadirachta indica:**

Effect of Azadirachta indica leaf extract on serotonin inhibition in glucose-mediated insulin release in rat pancreas was reported to elucidate the possible mechanism of antihyperglycemic effect. A. indica leaf extract blocks significantly the inhibitory effect of serotonin on insulin secretion mediated by glucose. Hypoglycemic effect observed with Azadirachta indica when given as leaf extract and seed oil was comparable to that of glibenclamide. A. indica could be of benefit in diabetes mellitus for controlling the blood sugar or may also be helpful in preventing or delaying the onset of the disease.

**Bauhinia forficate:**

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) [ 13 ]. The fresh leaves are the essential part of this plant which shows the hypoglycemic activity and the genus Bauhinia belongs to the family Caesalpiniaceae[ 14 ]. The initial reports of Bauhinia forficata antidiabetic activity in diabetic patients were made by Juliani (1941) [ 15 ] and Juliani (1931) [ 16 ]. According to M.T. Pepato et al (2002) Bauhinia forficate 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 g/kg body weight, after 3 days the serum and urinary glucose levels were increased. Then one group was injected with Bauhinia for□cata 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 diabete[17].

**Combretum micranthum:**

Combretum Micranthum is a medicinal plant used for treating diabetes in Northwestern Nigeria. It iscommonly known as 'geza' in Hausa, belong to the family of Combretaceae. It is a widely known ethnomedicinal plant used in West Africa for treating several diseases[18-19]. In Nigeria, more than 80% of the people depend on herbal medicines for treating their illnesses[20].The plant have also been documented to show antioxidant, antimicrobial[21]. as well as antiin □ammatory[22]. properties. The Aqueous extract of Combretum Micranthum was prepared by using Soxhlet extractor and it was dried in an evaporator at 45ºC and stored at 4ºC 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 signi□cant 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[23].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.

**Cyamposis tertragonoloba:**

Cyamopsis tetragonolobus (gower) has been reported to reduce postprandial hyperglycemia in normal and diabetic volunteers. The petroleum extract of C. tertragonoloba when given orally reduced the hyperglycemia induced by streptozotacin in male albino rats. Clinical studies in UK revealed that the dietetic supplementation with guar gum could decrease the need of insulin and oral antidiabetics, improving the glycemic profile and the control of the metabolic state, showing progressive decrease in the amount of HbA1c. Five grams of guar granules thrice a day reduced fasting and postprandial plasma glucose levels. Cuminum nigrum reduced the blood sugar levels of normal as well as diabetic rabbits without decreasing the total lipid levels, which indicated that the drug might be acting partly by inhibiting the absorption of glucose from the gastrointestinal tract.

**Elephantopus scaber:**

Elephantopus scaber is an ethnomedicnal plant, having the property to reduce the blood glucose levels in streptozotocin induced diabetic rats signi□cantly. 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, cardiotonic and diuretic[24] and decoction of the roots and leaves is used as emollient and it was given in dysuria, diarrhea, dysentery and stomach pain[25].The aqueous extract of leaves is applied externally to treat eczema and ulcers[26].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[ 27 ].The antidiabetic property of plants shows their mechanisms by improving insulin sensitivity, augmenting glucosedependent insulin secretion and stimulating the regeneration of islets of langerhans in pancreas of STZ- induced diabetic rats[ 28 ].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 ß-cells of the pancreas or increased cellularity of the islet tissues and regeneration of the granules in the ß-cells[ 29 ].The signi□cant 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.

**Gymnema sylvestre:**

Gymnema sylvestre leaves cause hypoglycemia in experimental animals, which sets in soon after the administration either by mouth or by injection. The main constituent of Gymnema is gymnemic acid, which is a complex mixture of at least nine closely related acidic glycosides, the main ones being Gymnemic acid A-D. The drug acts indirectly through stimulation in insulin secretion of the pancreas, as it has no direct action on the carbohydrate metabolism. The study showed that while Gymnema significantly reduced glucose levels in the hyperglycemic rats, it had no effect on normal rats. One study examined treatment by Gymnema for streptozotocin diabetic rats. Oral administration of Gymnema corrected the hyperglycemia in moderately diabetic rats, and the results continued for more than 2 months after Gymnema was discontinued. Gymnema did not reduce blood sugar levels in the severe and toxic groups of diabetic rats, but it did prolong their survival time. Srivastava, Y. et al, revealed that the lack of results in lowering blood glucose levels in the severe and toxic diabetic rats may have been due to complete destruction of the â-cells by alloxan. Gymnema has recently been tested in open clinical trials. Administration to 27 patients with insulin-dependent diabetes on insulin therapy significantly reduced insulin requirements, fasting blood glucose, and glycosylated hemoglobin and serum lipids over a 6- to 34-month period. Shanmugasundaram, ER, et.al suggested that gymnema appeared to enhance endogenous insulin, possibly by regeneration of the residual β-cells. The effectiveness of Gymnema in noninsulin-dependent diabetes was investigated in 22 patients with a history of poor blood sugar control. A significant reduction in blood glucose, glycosylated hemoglobin and conventional drug usage was observed over a period of 20 months.

**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[ 30 ].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 □ltered, combined, and then concentrated by using rotary evaporator at 45ºC under reduced pressure. In previous reports, STZ-induced type 2 diabetic studies were made by using prescribed methods in C57BL/6J and ICR mice[ 31-32 ].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 signi□cant improvement on glucose tolerance and insulin resistance in STZ-induced type 2 diabetic mice, and thus proving the hypoglycemic effects of aqueous extract [33]. 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.

**Momordica charantia:**

Fruits of Momordica charantia have been successfully used by diabetic patients and their crude extract has been shown to possess hypoglycaemic activity. Khanna and jain isolated a hypoglycaemic peptide (polypeptide-P) from seeds and other tissues of Momordica charantia. They reported that polypeptidep is a very effective hypoglycaemic agent when administered subcutaneously to langurs and humans. Singh et al. have reported hypoglycaemic effect of acetone extract of whole fruit powder of Momordica charantia.

**Ocimum sanctum:**

Oral administration of an alcoholic extract of leaves of Ocimum sanctum Linn. (Tulasi) reduced glycaemia in normoglycaemic, glucose-fed hyperglycaemic and streptozotocin-induced diabetic rats. Furthermore, the extract potentiated the action of exogenous insulin in healthy rats. The activity of the extract was 91% and 70 % that of tolbutamide in healthy and diabetic rats, respectively [34].Reduction in fasting blood glucose was obtained after one month of treatment of healthy and diabetic rats with O. sanctum leaf powder. The effect of the aqueous extract of Mangifera indica leaves on blood glucose level was assesed in normoglycemic glucoseinduced hyperglycemic and streptozotocin (STZ) induced diabetic rats.

**Panax ginseng:**

Ginseng polypeptide, isolated from the root of Panax ginseng, was demonstrated to decrease the level of blood sugar and liver glycogen when injected intravenously to rats. Mice were injected subcutaneous daily dose of 50 and 100 mg/kg for 7 successive days. GPP was also found to decrease blood glucose and liver glycogen and various experimental hyperglycemia induced by injection of adrenaline glucose and alloxan. The aqueous extract of root of panax ginseng showed a remarkable hypoglycemic activity on administration to mice. The hypoglycemic effect of pongamia pinnata flowers, in normal persons and outdoor patients suffering from non-insulin dependent diabetes mellitus (NIDDM). Thus the flowers of P. pinnata, causing a consistent hypoglycemic effect both in normal subjects and patients with NIDDM, have been attributed to direct insulin-like action.

**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[35].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[36-38].The hypoglycemic effect of Parinari excelsa was similar to that of glibenclamide is already observed with some other plant extracts[39-41].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[42].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.

**Pterocarpus marsupium:**

Rajasekharan and Tuli carried out clinical trials and found that Pterocarpus marsupium bark is effective in Type 1 diabetes mellitus. Later Charkravarthy et.al. reported epicatechin to be the active hypoglycaemic constituent. The decoction of P. marsupium was administered for diabetes mellitus patients for 30 days. Singh, AK et.al. revealed that the decoction is effective in the management of diabetes mellitus. Feeding the ethyl acetate soluble fraction of an absolute ethanol extract of P. marsupium wood for 5 days to alloxan diabetic rats significantly lowered blood sugar level [Ahmad,1991]. Chakrabarti D et.al suggested that aqueous extract of P. marsupium exhibited antidiabetic activity in diabetic rats and human beings. The blood sugar lowering effect of 95% ethanolic extract of Red Sandal hyperglycemic and streptozotocin diabetic albino rats. It was found to be effective in lowering the glucose level. Epicatechin, isolated from the heartwood of Pterocarpus marsupium, showed regeneration of the b-cell population of the islets, which were earlier necrosis by alloxan.

**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[43].In the Indian system of medicine, the leaf, root and seed oil of this plant have been used for the treatment of in□ammation and liver disorders[44].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[45].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 signi□cant alteration in the Blood Glucose of the control animals. The 50% ethanolic root extracts of Ricinus communis showed a dosedependent 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-puri□ed fractions of 50% ethanolic root extracts were tested for antihyperglycemic activity in diabetic rats, only one fraction (R18) showed a signi□cant 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[46].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 signi□cantly lowered the Blood Glucose of the diabetic animals to almost normal level, but also increased the insulin levels and caused improvement in lipid

pro□le 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

**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”) [47 -48].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[49].Dafni et al. were tested that the root extract of this plant was used for treating diabetes in Muslim folk medicine[50] and a very few studies have con□rmed 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[51].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 insulinlike 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[52].The extract increases glucose uptake in hepatocytes, adipocytes and myotubes. The Sarcopoterium spinosum extract also increases GSK3 Phosphorylation in myotubes. The identi□cation of active compounds in the Sarcopoterium spinosum plant extract may be the source for the development and improvement of new antidiabetic drugs.

**Swertia punicea:**

Swertia plants are most widely used traditional medicines in the treatment of diabetes[53].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 signi□cantly hypoglycemic activities[54].According to the Pen and Fang (2003) studies theplant Swertia Punicea shows a good hypoglycemic activity in alloxan-induced diabetic mice, [55] and can reduce oxidative injury in diabetic mice[56].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 bene□cial to improvement of insulin resistance (IR) [57].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 signi□cantly higher than that of normal control. The essential constituents of this plant i.e., Methylswertianin and Bellidifolin at both doses

signi cantly 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 (signi cant 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) [58].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 mices. 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 phytomedicines for Diabetes. It is therefore possible that we may nd more useful species of Swertia for the treatment of type-2 diabetes.

**Tinospora cordifolia:**

Tinospora cordifolia have insulin-like action and can significantly reduce the blood glucose but not the lipid levels in alloxan-induced rabbits. Literature supports the traditional belief that T. crispa extract effects in the treatment of diabetes by its action on the endocrine pancreas. Oral administration of the extract of Tinospora cordifolia roots for 6 weeks resulted in significant reduction in blood and urine glucose and in lipids in serum and showed its hypoglycemic action.

**Trigonella foenumgraecum:**

The effect of fenugreek seeds (Trigonella foenumgraecum) on blood glucose and the serum lipid profile was reported in insulin-independent (type 1) diabetes patients. Jha N, et.al suggested that the antidiabetic property of fenugreek seed is associated with the defatted seed material, which is rich in fibers, saponins and proteins. The results show that the antidiabetic properties of fenugreek seeds are contained in the testa and endosperm. This sub-fraction is rich in fibers; it is not possible to exclude the existence of one or more unknown active pharmacological compounds in this sub-fraction of the seed. Study reported that fenugreek given in a dose of 2.5 g twice daily for 3 months to healthy individuals did not affect the blood lipids and blood sugar. Fenugreek decreased significantly the blood sugar in mild NIDDM cases and slightly decreased it in severe condition. Mechanism of action of fenugreek seeds as an orally active hypoglycemic effect may be mediated through stimulating insulin synthesis and or secretion from the beta pancreatic cells of Langerhans. The effect may also be evident by increasing the sensitivity of tissues to available insulin. The hypoglycemic effect was observed to be slow but sustained, without any risk of developing severe hypoglycemia. The activities of gluconeogenic enzymes were higher in both liver and kidney during diabetes; however, the activities of the lipogenic enzymes decreased in both tissues during diabetes. The therapeutic role of Trigonella seed powder in type 1 diabetes is due to change of glucose and lipid metabolizing enzyme activities to normal values, thus stabilizing glucose homeostasis in the liver and kidney.

**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[59].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[60]. 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[61].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 signi□cant 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[62].The other species of this genus Vernonia amygdalina [63] and Vernonia colorata [64] 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 medicineshave been developed for the treatment of Diabetes mellitus in the future.

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

| Botanical name | Family | Parts used | Main Active components |
|---|---|---|---|
| Allium sativum | Alliaceae. | Bulbs | Allyl propyl disulphide, allicin |
| Annona squamosa | Annonaceae | Fruits | Liriodenine, moupinamide |
| Areca catechu | Arecaceae | Seed | Arecaine and arecoline |
| Artemisia pallens | Asteraceae | Leaves | Germacranolide |
| Azadirachta indica | Meliaceae | flowers and seed | Azadirachtin and nimbin |
| Bauhinia for□cata | Leguminosae | Leaf | Astragalin, kaempferitrin |
| Beta vulgaris | Amaranthaceae | Root | Phenolics, betacyanins |
| Boerhavia diffusa | Nyctaginaceae | Whole plant | Punarnavine and ursolic acid |
| Camellia sinensis | Theaceae | Leaves | caffeine and catechins |
| Capparis decidua | Capparidaceae | Fruit | Spermidine Isocodonocarpine |
| Cinnamomum zeylanicum | Lauraceae | Bark | Cinnamaldehyde, eugenol |
| Combretum micranthum | Combretaceae | Leaves | Polyphenols |
| Elephantopus scaber | Asteraceae | Whole plant | Terpenoid and 2,6,23 - Trienolide |
| Ficus bengalensis Linn | Moraceae | Bark | Leucodelphinidin and Leucopelargonin |
| Gymnema sylvestre | Asclepiadaceae | Leaf | Dihydroxy gymnemic triacetate |
| Gynandropsis gynandra | Capparidaceae | Root | N,N-diethyltoluamide |
| Lantana camara | Verbenaceae | Leaves | Lantanoside, lantanone |
| Liriope spicata | Liliaceae | Root | Beta-sitosterol, stigmasterol |
| Momordica charantia l | Cucurbitaceae | leaves | Charantin, stero |
| Ocimum sanctum | Labiatae | whole plant | Eugenol |
| Panax quinquefolius | Araliaceae | root | Ginsenosides, protopanaxadiol |

| | | | |
|---|---|---|---|
| Parinari excelsa | Chrysobalanaceae | Bark | Quercertin,Myricetin |
| Phyllanthus amarus | Phyllanthaceae | whole plant | Phyllanthin |
| Prunus amygdalus | Rosaceae | Seeds | Amygdalin |
| Pterocarpus marsupium | Leguminosae | Whole plant | Kenotannic acid, pyrocatechin |
| Punica granatum | Lythraceae | Fruit | Punicalagin, punicalin |
| Ricinus communis | Euphorbiaceae | Root | Ricinolic acid |
| Salacia oblonga wall | Celastraceae | Root bark | Salacinol |
| Sarcopoterium spinosum | Rosaceae | Root | Catechin and epicatechin |
| Smallanthus sonchifolius | Asteraceae | Leaves | Sonchifolin, uvedalin, enhydrin, uctuanin |
| Swertia punicea | Gentianaceae | Whole plant | Methyl swertianin and Bellidifolin |
| Tinospora cordifolia | Menispermaceae | Root | Tinosporone, tinosporic acid |
| Trigonella foenum graecum | Fabaceae | Leaves and seeds | 4-hydroxy isoleucine |
| Vernonia anthelmintica | Asteraceae | Seed | Epoxy acid or vernolic acid |
| Withania somnifera | Solanaceae | Cuscohygrine and roots | Somniferine,withananine and Cuscohygrine |

**CONCLUSION**

All the drugs discussed in this review have exhibited significant clinical & pharmacological activity. The potency of herbal drugs is significant & they have negligible side effects than the synthetic antidiabetic drugs. There is increasing demand by patients to use the natural products with antidiabetic activity. In recent times there has been renewed interest in the plant remedies. Plants hold definite promises in the management of Diabetes mellitus. Isolation & identification of active constituents from these plants, preparation of standardized dose & dosage regimen can play a significant role in improving the hypoglycemic action.

**REFERENCES**


1. Debra HJ, Management of Diabetes Mellitus, Perspective of care across the life span, 2nd Edition, Vol I, Haven Press, New York,1991, pp. 346-54.
2. Satoskar RS, Bhandarkar SD, Ainapure SS, Pharmacology and Pharmacotheraputics, 16th Edition, Vol I ,Popular Prakashan, Mumbai, 1999, pp.444-51.
3. King H, Rewers M, WHO Adhoc Diabetes Reporting Group- Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults, Diabetes Care, 16, 1993, 157-177.
4. Bennett PH, Knowler WC, Increasing prevalence of diabetes in Prima Indians over a ten year period. In Diabetes, Excerpta Medica, 1, 1980, 507-11.
5. Zimmer P, Type 2 (Non insulin- dependent) diabetes: overview Diabetologia prevalence, numerical estimates and projections, Diabetes Care, 21, 1998, 1414-31.
6. Harri SB, Zinman B. Primary prevention of type-2 diabetes in high-risk populations, Diabetes Care, 25, 2000, 879-881.

7. Verma NP, et al., Prevalence of known diabetes in an urban Indian environment: the Darya Ganj Diabetes Survey, Br Med J., 293, 1986, 423-27.
8. Aslam M, Pharmacognosy', in Trease & Evans, 5 Edition, Vol II, Saunders Press, NewYork, 1988, pp. 467-81.
9. Ramesh G, Jayesh P, Adverse Drug Reaction-What we need to know, Hosp Pharm., 3, 2003, 99-101.
10. Babara M, Lawrence C, Development, Implementation and Results of a Successful multi disciplinary adverse drug reaction reporting Programme in a University teaching hospital, Hosp Phar., 28, 1993, 1199-1240.
11. Ponnusankar S, Benny MG, Pinku PB, Interpersonal Perception:Pharmacists Vs Consumers, Hosp Phar, 6, 2003, 217-19.
12. Rao MU, Sreenivasulu M, Herbal Medicines for Diabetes Mellitus: A Review, Int. J. of Pharm. Tech Research, 2(3), 2010, 1883-92.
13. Miyake ET, Akisue G, Akisue MK, Pharmacognostic characterization of pata-devaca Bauhinia for□cata, Revista Brasileira de Farmacognosia, 1, 1986, 58-68.
14. Viana EP, et al., Constituents of the stem bark of Bauhinia guianensis, Fitoterapia, 70, 1999, 111-12.
15. Juliani C, hipoglicemiante da 'Bauhinia for□cata, link /Novos estudos clinicose experimentais, Jornal dos Cli´nicos, 3, 1941, 93-112.
16. Juliani C, Acao hipoglicemiante de Bauhinia for□cata link. Novos estudos experimentais, Revista Sudamericana de Endocri- nologia Immunologia e Quimioterapia, 14, 1931, 326-34.
17. Pepato MT, et al., Antidiabetic activity of Bauhinia for□cata decoction in streptozotocin-diabetic rats, J of Ethnopharmacology, 81, 2002, 191-97.
18. Muhammad S, Amusa NA, The important food crops and medicinal plants of bnorthwestern Nigeria, Research J of Agriculture and Biological Sciences, 1,2005, 254-60.
19. Inngjerdingen K, et al., An ethnopharmacological survey of plants used for wound healing in Dogonland, Mali, West Africa, Journal of Ethnopharmacology, 92, 2004, 233-44.
20. Hostettmann K, Marston A, Twenty years of research into medicinal plants: results and Perspectives, Phytochemistry Reviews, 1, 2002, 275-85.
21. Karou D, et al., Antioxidant and antibacterial activities of polyphenols from ethnomedicinal plants of Burkina Faso, African Journal of Biotechnology ,4, 2005, 823-28.
22. Olajide OA, et al., Evaluation of the anti-in□ammatory property of the extract of Combretum micranthum G. Don (Combretaceae, In□ammopharmacology, 11, 2003, 293-98.
23. Aminu CS, Oricha B, Antihyperglycaemic activity of aqueous leaf extract of Combretum micranthum (Combretaceae) in normal and alloxan-induced diabetic brats, journal of Ethnopharmacology, 129, 2010, 34-37.
24. Nadkarni AK, Indian Materia Medica, 5th Edition, Vol II, Dhootapa-peshwar Prakashan Ltd, Mumbai, 1954, pp.223-31.
25. Kirtikar KR, Basu BD, Indian Medicinal Plants, 3rd Edition, Vol II, Periodical Experts Book Agency, Delhi, 1991, pp.432-38.
26. Chopra RN, Nayar SL, Chopra IC, Glossary of Indian Medicinal Plants, 2nd Edition, Vol I, CSIR, Delhi, 1956, pp.32-36.
27. Daisy PM, et al., A novel Steroid from Elephantopus scaber L. an Ethnomedicinal plant with antidiabetic activity, Phytomedicine, 16, 2009, 252-257.
28. Sezik EM, et al., Hypoglycemic activity of Gentiana olivieri and isolation of the active Constituent through bioassay-directed fractionation techniques, Life Sci., 76, 2005, 1223-38.
29. Palanichamy S, Nagarajan S, Devasagayam M, Effect of Cassia alata leaf extract on

hyperglycemic rats, J. Ethnopharmacol., 22, 1988, 81-90.
30. Chen WH, Qian H, Wang HZ, Effect of polysaccharide from ophiopogonis tuber on blood sugar in normal and experimental diabetic mice, Chinese Journal of Modern Applied Pharmacy, 15, 1998, 21-23.
31. Luo M, et al., Nongenetic mouse models of non-insulindependent diabetes mellitus, Metabolism, 47, 1998, 663-68.
32. 32.Cherng J, Shih M, Improving glycogenesis in streptozocin (STZ) diabetic mice after administration of green algae Chlorella, Life Sciences, 78, 2006, 1181-86.
33. Xianghong M, et al., Anti-diabetic effects of water extract and crude polysaccharides from tuberous root of Liriope spicata var. prolifera in mice, Journal of Ethnopharmacology, 122, 2009, 205-9.
34. Chattopadhyay RR, Hypoglycaemic effect of Ocimum sanctum leaf extract in normal and streptozotocin diabetic rats, Indian J Exp Biol., 31, 1993, 391-393.
35. Kerharo J, Adam JG, La pharmacopée sénégalaise traditionnelle, plantes médicinaleset Toxiques, Paris: Vigot frères, 2, 1974, 1011.
36. Al-Awwadi N, Azay J, Poucheret P, Cassanas G, Krosniak M, Auger CJ, Agric Food Chem, 52, 2004, 1008.
37. Adaramoye OA, Adeyemi EO, J Pharm Pharmacol., 58, 2006,121.
38. Jayaprakasam B, Vareed SK, Olson LK, Nair MG, J Agric Food Chem, 53, 2005, 28.
39. Alarcon-Aguilar FJ, Calzada-Bermejo F, Hernandez-Galicia E, Ruiz-Angeles C, Roman-Ramos, J Ethnopharmacol., 97, 2005, 447.
40. Kesari AN, Gupta RK, Watal G, J Ethnopharmacol., 97, 2005, 247.
41. Kothai R, Arul B, Kumar KS, Christina AJ, J Herb Pharmacother. 5, 2005, 49.
42. Ndiaye M, et al., Antidiabetic Properties of aqueous barks extract of Parinari excels in alloxan-induced diabetic rats, Fitoterapia, 79, 2008, 267-70.
43. Olsnes SM, et al., Rates of different steps involved in the inhibition of protein synthesis by the toxic lectins abrin and ricin, J Biol Chem, 251, 1976, 3985-92.
44. Kirtikar, KR, Basu BA, Indian Med. Plants, 3, 1991, 2274-77.
45. Dhar ML, et al.,Screening of Indian plants for biological activity, Part I, Indian J. Exp. bBiol., 6,1968, 232-47.
46. Shokeen P, et al., Antidiabetic activity of 50% ethanolic extracts of Ricinus communis and its puri□ed fractions, Food and Chemical Toxicology, 46, 2008, 3458 66.
47. Ali-Shtayeh MS, Yaniv Z, Mahajna J, Ethnobotanical survey in the Palestinian area: a classi□cation of the healing potential of medicinal plants, Journal of Ethnopharmacology, 73, 2000, 221-32.
48. Yaniv Z, et al., Plants used for the treatment of diabetes in Israel, Journal of Ethnopharmacology, 19, 1987,145-51.
49. Henkin Z, Seligman NG, Survival of Sarcopoterium spinosum seedlings growing on terra rossa soil, Israel Journal of Plant Sciences, 55, 2007, 4551.
50. Dafni A, et al., Ethnobotanical survey of medicinal-plants in Northern Israel, Journal of Ethnopharmacology, 10, 1984, 295-310.
51. Shani J, Joseph B, Sulman FG, Fluctuations in the hypoglycaemic effect of Poterium, Internationales de Pharmacody- namie et de Therapie, 185, 1970, 344-49.
52. Smirin P, et al., Sarcopoterium spinosum extract as an antidiabetic agent: In vitro and in vivo study, Journal of Ethnopharmacology, 129, 2010, 10–17.
53. Chhetri DR, et al., Antidiabetic plants used by Sikkim and Darjeeling Himalayan tribes, India J Ethnopharmacol, 99, 2005, 199-202.
54. Ghosal S, et al., Chemical constituents of Gentianaceae Xanthone and avonol constituents of Swertia hookeri, Phytochemistry, 19, 1980, 123-26.
55. Pen F, Fang CS, Effect of Swertia punicea Hemsl on protection of experimental

Diabetic Mice, Chin. J. Tradit. Med. Sci. Technol., 10, 2003, 96-97.
56. Liu XB, et al., The in□uence of Swertia punica on antioxygenic property of alloxan- induced diabetic mice, Mod. Med. Health, 24, 2008, 2381-82.
57. Wen L, Chen JC, Hypoglycemic activity of Swertia punicea Hemsl extracts in streptozotocin induced hyperglycemic mice, China Pharm, 10, 2007, 140-42.
58. Tian LY, et al., Anti-diabet ic effect of methylswertianin and bellidifolin from Swertia punicea Hemsl. and its potential mechanism, Phytomedicine, 17, 2010, 533-39.
59. Nagaraju N, Rao KN, Folk medicine for diabetes from Rayalaseema of Andhra Pradesh, Phytomedicine, 9, 1990, 50-53.
60. Ramos R, et al., Study of the antihyperglycaemic effect of plants used as antidiabetics, J. Ethnopharmacol, 61, 1998,101-10.
61. Kesari AN, et al., Hypoglycaemic and antihyperglycaemic activity of Aegle marmelos seed extract in normal and diabetic rats, J. Ethnopharmacol., 107, 2006, 374-79.
62. Shaik SF, et al., Antidiabetic and antihyperlipidemic activity of ethyl acetate:Isopropanol (1:1) fraction of Vernonia anthelmintica seeds in Streptozotocin induced diabetic rats, Food and chemical toxicology, 48, 2010, 495-501.
63. Akah P, Okafor C, Blood sugar lowering effect of Vernonia amygdalina in an experimental rabbit model, Phytother Res., 6, 1992, 171-73.
64. Sy GY, et al., Hypoglycaemic and antidiabetic activity of the acetonic extract of Vernonia colorata leaves in normoglycaemic and alloxan induced diabetic rats, J.Ethnopharmacol., 98, 2005, 171-75.

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