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A review on herbal medicinal plants used in diabetic treatment

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Abstract
Diabetes is a serious metabolic disorder and plenty of medical plants are used in traditional medicines to treat diabetes. These plants have no side effects and many existing medicines are derived from the plants. The purpose of this systematic review is to study diabetes and to summarize the available treatments for this disease, focusing especially on herbal medicine.
Traditionally, there are some medicinal plants believed to treat diabetes, as they have been proven in research studies to possess antidiabetic properties, such as improved insulin sensitivity and hypoglycemic activities, due to their high level of phenolic compounds, flavonoids, terpenoids, alkaloids, and glycosides. We conducted a systematic review to identify potential medicinal plants used during human clinical trials in the Association of Southeast Asian Nation (ASEAN) countries on prediabetic or type 2 diabetic individuals and to potentially identify any bioactive compounds involved in effectively treating symptoms of diabetes such as lowering of blood glucose.

Keywords: Herbal plants and medicinal plants, hypoglycemic, antidiabetic

Introduction
Diabetes mellitus is a systemic metabolic disease characterized by hyperglycemia, hyper lipedemia, hyper aminoacidemia, and hypo insulinaemia it leads to decrease in both insulin secretion and insulin action [1, 2]. It is frequently associated with the development of micro and macro vascular diseases which include neuropathy, nephropathy, cardiovascular and cerebrovascular diseases. The disease is associated with reduced quality of life and increased risk factors for mortality and morbidity.
Diabetes is a chronic medical condition, meaning that although it can be controlled, it lasts a lifetime. 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.
Diabetes mellitus, commonly referred to as diabetes was first identified as a disease associated with "sweet urine," and excessive muscle loss in the ancient world. Elevated levels of blood glucose (hyperglycemia) lead to spillage of glucose into the urine, hence the term sweet urine. Normally, blood glucose levels are tightly controlled by insulin, a hormone produced by the pancreas. [3, 4] Insulin lowers the blood glucose level. When the blood glucose elevates (for example, after eating food), insulin is released from the pancreas to normalize the glucose level Inpatients with diabetes, the absence or insufficient production of insulin causes hyperglycemia.
It is a heterogeneous group of diseases, all of which ultimately lead to an elevation of glucose in the blood (hyperglyce mia) and loss of glucose in the urine as hyperglycemia increases. It is characterized by increased urine production (polyurea) excessive thirst (polydipsia) and excessive eating (polyphagia)
In the absence of proper treatment, cardiac, vascular, neurological, and renal damage and neuropathy may occur. Treatment includes diet, exercise, and medication. Currently, the main and effective treatment for diabetes is the use of insulin and hypoglycemic drugs, but these compoundsalso have many adverse side effects.

Classification of Diabetes
It is of two types *viz*.
Type 1 i.e. insulin dependent Type 2 i.e. non-imsulin dependent

Type 1 diabetes
Type 1 diabetes (previously known as insulin-dependent, juvenile or childhood-onset) is characterized by deficient insulin production and requires daily administration of insulin.

In 2017 there were 9 million people with type 1 diabetes; the majority of them live in high- income countries. Neither its cause nor the means to prevent it are known.

Type 2 diabetes
Type 2 diabetes (formerly called non-insulin-dependent, or adult-onset) results from the body's ineffective use of insulin. More than 95% of people with diabetes have type 2 diabetes. This type of diabetes is largely the result of excess body weight and physical inactivity.

Medicinal plants used for diabetes treatment
1. Fenugreek

Family: Fabaceae

Scientific Name: *Trigonella foenum-graecum*

Part of plant: Seed

Therapeutic Uses: Diabetes, Menstrul cramps, Enlarged prostate, High cholesterol, Obisity.

The present study showed that the administration of *Trigonella foenum-graecum* seed powder solution had pronounced effects in improving lipid metabolism in type II diabetic patients with no adverse effects. Research in the past two decades has shown that Fenugreek seeds help to lower blood glucose in patients with diabetes. Its role as an antidiabetic, by reducing fasting blood glucose levels and improved glucose tolerance in human subjects was reported This effect of lowering blood sugar without changing insulin levels demonstrates improved insulin action. Fenugreek has also been shown to decrease glucose absorption by inhibiting intestinal disaccharidases [5, 6].

Fig 1: Fenugreek Seed

2. Safflower
Family: Compositae
Scientific Name: *Carthamus tinctorius*
Part of plant: flower
Therapeutic Uses: Preventing Heart disease, Lower blood pressur, Antioxidant, Diabetes,

Safflower seed oil improves steroidogenesis and spermatogenesis in rats with type II diabetes mellitus by modulating the genes expression involved in steroidogenesis, inflammation and oxidative stress Diabetes: Safflower oil might increase blood sugar. This might make it harder to control blood sugar levels in people with diabetes. Surgery: Safflower oil might slow blood clotting. This mightincrease therisk of bleeding during and after surgery [7].

Fig 2: Safflower

3. Onion
Scientific Name: *Allium cepa*
Family: Liliaceae
Part Use: Seed
Therapeutic Uses: Antioxidant, Asthama, Skin disease, Painkiller, Diabetes

Allium cepa is known only in cultivation but related wild species occur in Central Asia. Various ether soluble fractions as well as insoluble fractions of dried onion powder show antihyperglycemic activity in diabetic rabbits. Cepa also known to have antioxidant and hypolipidemic activity. Administration of a sulfur containing amino acid, S-methyl cysteine sulphoxide (SMCS) (200 mg/kg for 45 days) to alloxan induced diabetic rats significantly controlled blood glucose as well as lipids in serum and tissues. It normalizes the activities of liver hexokinase, glucose 6- phosphatase and HMG Co Areductase [8].

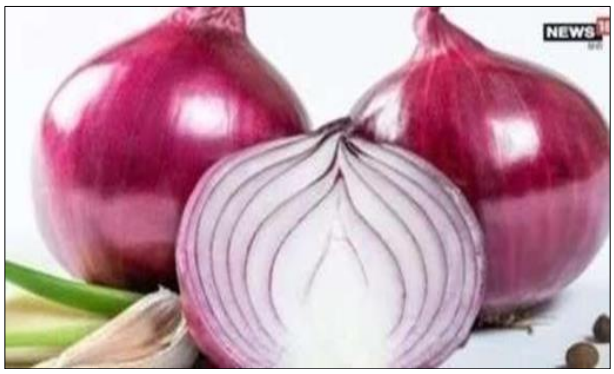

Fig 3: Onion

4. Garlic
Scientific Name: *Allium sativum* L
Family: Liliaceae
Part Use: Whole bulb
Therapeutic Uses: Cardiovascular disease, Antimicribial, High blood glucose, Immune system

It is a perennial herb cultivated throughout India. Oral administration of the garlic extract significantly decreases serum glucose, total cholesterol, triglycerides, urea, uric acid, creatinine, AST and ALT levels, while increases serum insulin in diabetic rats but not in normal rats when compared with antidiabetic drug glibenclamide. The antidiabetic effect of the extract was more effective than glibenclamide [9].

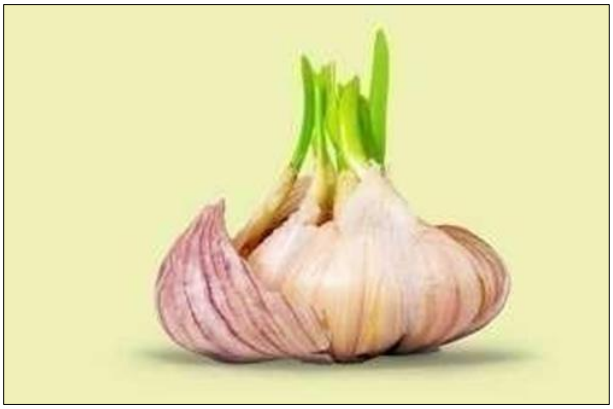

Fig 4: Grarlic

5. *Aloe vera*
Family: Liliaceae
Scientific name: Barbadensis miller
Part Use: leaves
Therapeutic Uses: Skin problem (burns, wounds, anti-inflammatory), Anticancer, Antioxidant, Antidiabetic

It grows in arid climates and is widely distributed in Africa, India and other arid areas. *Aloe vera* gel at200 mg/kg possesses significant antidiabetic, cardio protective activity, reduces the increased TBARS, maintains the Superoxide dismutase and Catalase activity up to the normal level and increases reduced glutathione by four times in diabetic rats.
Aloe vera is good for diabetes. It helps regulate your blood glucose levels. Moreover, it helps reduce diabetes-associated symptoms and further complications. In addition, people with diabetes can take *aloe vera* to improve the wound healing process, manage weight, and lower inflammation [10].

Fig 5: *Aloe vera*

6. *Elephantopus Scaber*
Family: Asteraceae
Scientific name: *Elephantopus Scaber*
Part Use: Flower
Therapeutic Uses: Headaches, Colds, Diarrhea, Hepatits, Bronchitis, Diuretic, Antidiabetic

Elephantopus Scaber is an ethnomedicnal plant, having the property to reduce the blood glucose levels in streptozotocin induced diabetic rats signifcantly. It is popularly known as Elephant's foot, and it isfamily 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 and decoction of the roots and leaves is used as emollient and it was given in dysuria, diarrhea, dysentery and stomach pain. The aqueous extract of leaves is applied externally to treat eczema and ulcers [11].

Fig 6: *Elephantopus Scaber*

7. *Bidens pilosa*
Family: Asteraceae
Scientific name: Bidnes
Part Use: leaves
Therapeutic Uses: Ulcer, Diabetes, All type infection, Hypertension

It is known as Spanish Needle. The butanol fraction of B. pilosa inhibits the differentiation of naivehelper T (ThO) cells into Thl cells but enhances their transition into type II helper T (Th2) cells, thus can prevent diabetes pausibly via suppressing the differentiation of ThO cells into Thlcells and promoting that of ThO cells into Th2 cells, thus preventing autoimmune diabetes in non-obese diabetic mice. The B. pilosa formulation reduced the level of FBG and HbA1c in diabetics but increased fasting serum insulin in healthy subjects. Moreover, combination of *B. pilosa* formulation with antidiabetic drugs had better glycemic control in diabetics [12].

Fig 7: *Bidens Pilosa*

8. Chaenomeles
Family: Rosaceae
Scientific name: *Chaenomeles sinensis*
Part Use: Leaves
Therapeutic Uses: Vitamin C, Diabetes, Tumor, Allergies, Liver diseasaes

Ethyl acetate fraction of Chaenomeles sinensis (*C. sinensis*) (Thouin) Koehne fruits is very good Antidiabetic effect. Chaenomeles sinensis is belongs to family Rosaceae. Doses which have antidiabetic activity were reported as 50 and 100 mg/kg body weight. The present study was intended to examine the effects of the supplementation of active α-glucosidase, α- amylase and lipase inhibitory ethyl acetate (CSE) fraction from the fruits of Chaenomeles sinensis (Thouin) Koehne on blood glucose (BG), triglyceride (TG), total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), alanine aminotransferase (ALT), aspartate aminotransaminase (AST), acetylcholinesterase (AChE) and antioxidant levels [13].

Fig 8: Chaenomeles Sinensis

9. Mango
Family: Anacradiaceae
Scientific name: *Mangifera Indica*
Part Use: Fruit, leaves
Therapeutic Uses: Vitamin C, Cholesterol, Diabetes, Blood pressure, Respiratory problem

The aqueous extract produces reduction of blood glucose level in normoglycemic and glucose- induced hyperglycemia, but does not have any effect on streptozotocin-induced diabetic mice under the same conditions when compared with that of an oral dose of chlorpropamide. The resultindicates that the aqueous extract of the leaves of M. indica possess hypoglycemic activity. Various phytochemicals present in mango leaves are thought to be responsible for its anti-hyperglycemia activity.
Previously, it was shown that foliamangiferosides such as mangiferin had exerted their antidiabetic effect through increasing insulin sensitivity and inhibiting alpha-glucosidase activity Mango leaves have the capability to improve insulin production and distribution of glucose.
They can help in stabilising blood sugar levels. Mango leaves are also loaded with pectin, vitamin C and fibre. Together they are beneficial for both diabetes and cholesterol [14].

Fig 9: *Mangifera indica*

10. *Pterocarpus marsupium* Rox
Family: Legumes
Scientific name: *Pterocarpus marsupium*
Part Use: Wood,
Therapeutic Uses
Antidiabetic, Leprosy, Arthritis, Skin diseases, Stomach pain

It is widely used in 'Ayurveda' as 'Rasayana' for management of various metabolic disorders. An aqueous extract of P. marsupium wood, at an oral dose of 250 mg/kg, shows statistically significant hypoglycemic activity. Marsupin, pterosupin and Iiquiritigenin obtained from this plant show antihyperlipidemic activity, its active principle, has been found to be insulinogenic, enhancing insulin release and conversion of proinsulin to insulin *in vitro*. Like insulin, (-) epicatechin stimulates oxygenuptake in fat cells and tissue slices of various organs, increases glycogen content of rat diaphragm in a dose dependent manner. It may primarily be concludedthat phenolic-C-glycosides present in P. marsupium heart wood are the phytoconstituents responsible for the antihyperglycemic activity and validate the claim of antidiabetic activity of heart wood of P [15].

Fig 10: Pterocarpus Marsupium Rox

11. Pterocarpus marsupium Rox
Family: Legumes
Scientific name: *Pterocarpus marsupium*
Part Use: Wood,
Therapeutic Uses: Antidiabetic, Leprosy, Arthritis, Skin diseases, Stomach pain

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Fig 11: Pterocarpus Marsupium Rox

12. Gourd
Family: Cucurbitaceae
Scientific Name: *Cocciniaindica*
Part of plant: Leaves, Shoots

Therapeutic Uses: Diabetes, Cough, Fever, Leprosy, Asthama, Ulcer, Wound

Oral administration of 500 mg/kg of C. indica leaf produced significant hypoglycemic effects in alloxan- diabetic dogs and increased glucose tolerance in both normal and diabetic dogs.
Lauki or bottle gourd is beneficial for diabetes as it contains huge amount of water content and fibre. It is one of the healthiest vegetables for diabetics. Consumption of lauki ka juice will result in reduction in blood sugar levels.
Bitter gourd (BG, *Momordica charantia*) exerts proven blood glucose- and body weight-lowering effects. To develop an effective and safe application, it is necessary to identify the bioactive compounds and biochemical mechanisms responsible for these effects in type 2 diabete [17].

Fig 12: Gourd

13. Bitter gourd
Family: Cucurbitaceae
Scientific Name: *Momordica charantia*
Part of plant: Seed, Leaves, Whole plant
Therapeutic Uses: Antidiabetes, Anticancer, Antivirus, Anti inflammation, Antioxidant.

Ethanolic extracts of M. charantia (200 mg/kg) showed an antihyperglycemic and hypoglycemic effect innormal and streptozotocin-diabetic rats. This may be because of inhibition of glucose-6- phosphatase and fructose-1, 6-biphosphatase in the liver and stimulation of hepatic glucose-6- phosphate dehydrogenase activities.
Bioactive compounds present in bitter gourd activate a protein called AMPK (AMP-activated protein kinase α), which regulates fuel metabolism and enabling glucose uptake processes which are impaired inpa- tients with diabetes [18].

Fig 13: Bitter Gourd

14. Perilla
Family: Lamiaceae
Scientific Name: *Perilla*
Part of plant: Leaves
Therapeutic Uses: Anxiety, Diabetic nephropathy, Asthama, Vommiting, Chest stuffiness, Flus, Allergies, Fever.

The flavonoid luteolin from perilla luteolin treatment prevented the development of diabetic nephropathy by significantly lowering BUN and creatinine in diabetic animals. This could be explained that there was increased clearance of blood urea and creatinine by the kidney or that there was decreased protein degradation. Moreover, luteolin also prevented the increase in 24-h urea protein in diabetic rats. The flavonoid luteolin from perilla luteolin treatment prevented the development of diabetic nephropathy by significantly lowering BUN and creatinine in diabetic animals. This could be explained that there was increased clearance of blood urea and creatinine by the kidney or that there was decreased protein degradation. Moreover, luteolin also prevented the increase in 24-h urea protein in diabetic rats [19].

Fig 14: Perilla

15. Chebulic myrobaln
Family: Combretaceae
Scientific Name: *Terminaliachebula*
Part of plant: Seeds
Therapeutic Uses: Laxative, Heart disease, Antioxidant, Renal function, Diabetic nephropathy

T. chebula is more effectively inhibited the incidence of diabetic nephropathy. Diabetic nephropathy is mainly associated with excess urinary albumin excretion, abnormal renal function as represented by an abnormality in serum creatinine.
The present study was aimed to evaluate the anti-diabetic potential of Terminalia chebula (*T. chebula*) fruits on streptozotocin (STZ)-induced experimental diabetes in rats [20].

Fig 15: Chebulic Myrobaln

16. Culinary
Family: Cactaceae
Scientific Name: *Opuntia megacantha*
Part of plant: Seed, Leaves
Therapeutic Uses: Mental health problem, Diabetic pathological conditions, Food culture.

Administration of the leaf extract was also associated with an increased GFR in STZ- diabeticrats. Although the rate was unaltered in non-diabetic rats.
Administration resulted in a lower plasma level of urea and creatinine in treated groups compared to the diabetic control group This Shows protective property of SCE Against renal damage [21].

Fig 16: Culinary

17. Cinnamomum verum
Family: Lauraceae
Scientific Name: *Cinnamon*
Part of plant: Whole plant
Therapeutic Uses: Piankiller, Diabetes, Arthritic Rheumatism, Inflammation

Cinnamon in the diet of patients with T2DM would reduce risk factors associated with diabetes and cardiovascular diseases. Cinnamon lowered hemoglobin A1c (HbA1C) by 0.83% compared with usual care alone lowering HbA1C by 0.37% in patients with T2DM in a randomized, controlled trial. It has long been believed that an intake of cinnamon (*Cinnamomum zeylanicum*) alleviates diabetic pathological conditions.
However, it is still controversial whether the beneficial effect is insulin-dependent or insulin- mimetic. This study was aimed at determining the insulin- independent effect of cinnamon.
Streptozotocin-induced diabetic rats were divided into four groups and orally administered withan aqueous cinnamon extract (CE) for 22 d [22].

Fig 17: Cinnamomum Verum

18. Ginseng
Family: Araliaceae
Scientific Name: Ginseng
Part of plant: Roots, Stalk, Leaves
Therapeutic Uses: Anti-inflammatory, Antiallergic, Antidibetic, Anticancer, Fatigue, Heart disease
Ginseng significantly decreased insulin resistance and fasting blood glucose (FBG) in T2DMpatients. Among 30 cases of T2DM treated with Renshen tangtai, an injection contained Ginseng polypeptide and polysaccharides; 86.7% of the patients showed appreciable effect on diabetic symptoms.

The mechanisms by which ginseng reduces blood glucose levels are unclear; some mechanisms have been proposed to explain its hypoglycemic effect, especially modulating effects on insulin sensitization and/or insulin secretion and regulating actions on digestion and intestinal absorption [23].

Fig 18: Ginseng

19. Jambolan
Family: Myrtaceae
Scientific Name: *Syzygium cumini*
Part of plant: Seeds
Therapeutic Uses: Diabetes, Diarrhea, Sore thort, Skin ulcer, Cough, Intestine ulcer

The extract of jamun pulp showed hypoglycemic activity in streptozotocin-diabetic mice within30 min of administration while the seed of the same fruit needed 24 h. These extracts also inhibited insulinaseactivity in the liver and kidney.
Jambolan seed and bark extracts might decrease blood sugar levels. Diabetes medications are also used to lower blood sugar. Taking jambolan seed or bark along with diabetes medicationsmight causeyour blood sugar to be too low. Monitor your blood sugar closely [24].

Fig 18: Jambolan

Future scope
- The present review helps to researcher and students for herbal plants used in diabetic condition and their pharmacological activities. Also helps for herbal industries.
- Now a days, diabetes mellitus a common and very prevelant disease affecting the citizens of both developed and developing countries.
- So proper cultivation, plantation and industrialisation of anti- diabetic plants have tremendous possibility to increase economy of India.

Conclusion
- Plants are natural antioxidants and effective herbal medicines, in part due to their anti-diabetic compounds, such as flavonoids, tannins, phenolic,
- Diabetes mellitus is the most common endocrine disorder, affecting more than 300 million people worldwide. For this, therapies developed along the principles of western medicine (allopathic) are often

limited in efficacy, carry the risk of adverse effects & are often too costly, especially for the developing world.

- Therefore, treating diabetes mellitus with plant derived compounds which are accessible & do not require laborious pharmaceutical synthesis, seems highly attractive.
- The utilization of indigenous drug resources with the collaboration of local industry will minimize the expenditure incurred on the purchase of foreign drugs.

In view of the economic importance of indigenous plants, research and developmental efforts should be focused on these plants.

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