

A Review on Medicinal Plants of Gujarat with Anti-diabetic Potential

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ABSTRACT

Diabetes Mellitus is a syndrome of disordered metabolism, due to a combination of hereditary and environmental causes, resulting in abnormally high blood sugar levels (hyperglycemia), caused by defects in either insulin secretion or its action in the body. A diabetes epidemic is underway and currently available therapeutic options for non-insulin-dependent diabetes mellitus are dietary modifications, oral hypoglycemic or insulin administration, which though have a lot many potentials to cure diabetes, but, may result in unwanted side effects. However, recent updates suggest that natural products and herbal medicines are more recommended for the treatment of diabetes. The present review attempts to list all plants and their preparations used for cure of diabetes along with their ethnomedicinal backgrounds and list of plants experimental or clinically listed from Gujarat State, India, with antidiabetic potential. It also includes the various preparations which can be safely used to cure diabetes in the form of daily diet as plant potentials for future generations. The studies are a move towards awareness in changing our diet system with a potential input of Ethnomedicinal knowledge for cure of incidence of diabetes.

Keywords: Diabetes Mellitus, medicinal plants

INTRODUCTION

Diabetes mellitus has become a major problem for the individual, medicine and society as a whole. The alarming find is that, when with diagnosed type 2 Diabetes, a high percentage of people already have chronic complications and/or morbid association. Diabetes mellitus is a group of chronic metabolic disorders of the endocrine system which is caused due to lack of insulin or reduced insulin activity that result in hyperglycemia and abnormalities in carbohydrate, fat and protein metabolism^{1,2}. Depending on the etiology of diabetes, factor leading to hyperglycemia include decreased glucose use and increased production of glucose. Non-insulin dependent diabetes mellitus is a major health problem due to modernization in lifestyle of developing countries. Besides oral agents and insulin therapy, phytotherapy can be alternative source which can provide a wide range of natural resources with hypoglycemic effects. A range of plants that provide raw materials can be therefore recommended for people with diabetes. The evaluation of traditional medicinal plants which are considered to be excellent candidates for oral diabetic therapy has been recommended by the World Health Organization (WHO) as they are effective, non-toxic and with less or no side effects³. However some herbal extracts have been confirmed for hypoglycemic effects in human and animal models in type 2 diabetes. For example, Metformin, a less toxic biguanide and potent oral glucose lowering agent, was actually developed from *Galenga officinalis* and is being used to treat diabetes. Medicinal plants in different oral formulations have therefore been recommended for the diabetic patients. In

our review, we have mentioned the most popular medicinal species of Gujarat with hypoglycemic effect.

Acacia arabica, Family: Leguminosae

Acacia arabica belonging to family Leguminosae, is commonly known as Babbula in Sanskrit, Bavad in Gujarat and Senegal in English. The ethno medicinal survey suggests that the plant *A. arabica* has diverse medicinal uses. The gum is used in diarrhea, dysentery and madhumeha (diabetes), ash of the seeds is used by the local folk of Gujarat in toothache and also as a tooth powder, while the flowers are used to treat ulcers of the mouth. It is a commonly used binding agent in various allopathic formulations.

The antidiabetic potential of chloroform extract of *A. arabica* was tested in alloxan induced diabetic albino rats which significantly decreased elevated levels of serum glucose and also caused to reverse the triglyceride, cholesterol, LDL and HDL values when compared to that of diabetic rats which were untreated⁴. *A. arabica* has been proven to be a good hypolipidemic, hypoglycemic and antioxidant agent⁵.

Aegle marmelos, Family: Rutaceae

Aegle marmelos is commonly known as Shivadrumah or Shreephal in Sanskrit and Bili in Gujarati, belonging to family, Rutaceae. It has a lot of synonyms in English like Holy fruit tree, Bengal quince, Wood apple and Stone Apple. Bili is commonly known as Bili patra in Gujarat has a spiritual significance in Hindu tradition. The trifoliate leaves of Bili emerge on the Hindu God Shiva's crown and trident, and point of trifoliate leaves also represent the holy trinity of Brahma, Vishnu and Shiva. Traditionally Bili is

used to treat an innumerable number of afflictions. The local traditional healers suggest the mixture of Bili fruit flesh with water is used to treat constipation and other bowel disorders, while drinking blended Bili fruit pulp with pepper and water reduces acidity.

It has been scientifically proven that aqueous seed extract of *A. marmelos* show antidiabetic and hypolipidemic effects in diabetic rats⁶. The leaf extract of *A. marmelos* has remarkable hypoglycemic and hypolipidemic effects⁷.
Allium cepa, Family: Liliaceae

Allium cepa, commonly known as onion in English, Yavanesta in Sanskrit or Dungri in Gujarati, belongs to the family Liliaceae. It is widely cultivated throughout Gujarat. Our Ethnomedicinal survey highlights the use of onion in medicine rather than its culinary uses. Onion juice is a popular remedy amongst the rural folk of Gujarat to expel worms from stomach and intestines. It is also used to arrest hair fall and improve the sheen. In case of migraines, onion paste is heated, wrapped in a cloth and placed on the temples.

Scientific evidence suggests that amongst other extracts tested, ethyl ether extract of *A. cepa* showed most potent hypoglycemic action⁸. Administration of a petroleum ether insoluble fraction of the ether extract of dried onion powder showed a significant antihyperglycemic effect in alloxanized diabetic rabbits⁹. A similar study on healthy volunteers showed that oral administration of various doses of aqueous onion extract increased glucose tolerance and the effect was comparable to tolbutamide. In the same experiment, there was no difference in the antihyperglycemic activity of raw and boiled onion extracts in these human volunteers¹⁰.

Allium sativum, Family: Liliaceae

Allium sativum L. belonging to family Liliaceae is a common spicy flavouring agent used since ancient times known all over India as Lehsun. Traditional uses of Lehsun include strengthening of bones and hence used in fractures, when raw cloves are used. The ethnomedical data suggest the use of Lehsun in the treatment of rheumatoid arthritis, while lehsun paste or poultice is used for improvement of blood circulation, relieving pain and inflammation.

The allin compound derived from *A. sativum* has been found to possess a significant blood sugar lowering action. It lowers blood sugar level either by exciting the pancreas to boost insulin synthesis, or positively affects insulin-receptors^{11,12}. Clinical studies have suggested that active compounds from garlic lower blood sugar levels by comparing with insulin sited in the liver, which results in an increase in free insulin¹³.

Aloe vera, Family: Liliaceae

Among different antidiabetic plants, Aloe vera is one of the main accepted herbs. Commonly known as Kumari in Gujarati, it is used in Ayurveda for managing painful conditions¹⁴. Hypoglycemic effect of aloe and its bitter principle is medicated through stimulation of synthesis and/or release of insulin from the β -cells of Langerhans^{15,16}.

Azadirachta indica, Family: Meliaceae

Azadirachta indica is native of India especially Gujarat. It is the most useful traditional medicinal plants. The

beneficial properties of neem have been recognized in the Indian tradition for thousands of years. Each part of this plant has some medicinal property. The biological activities of some of the neem components, pharmacological actions of neem extracts, clinical study and plausible medicinal applications of neem along with their safety evaluation¹⁷. Aqueous extract of leaves significantly decreases blood sugar level. Recently, hypoglycemic effect was observed with leaf extract and seed oil, in both normal as well as alloxan-induced diabetic rabbits¹⁸. Hydroalcoholic extract of *Azadirachta indica* showed hypoglycemic effect in normal, glucose fed and STZ diabetic rats¹⁹. It also increased glucose uptake and glucose deposition in isolated rat hemidiaphragm²⁰. The plant blocks the action of epinephrine on glucose metabolism, so peripheral glucose utilization is increased²¹.

Brassica juncea, Family: Cruciferae, Brassicaceae

The aqueous seed extract of the medicinally valued plant *Brassica juncea* clearly envisaged hypoglycemic effect by developing the serum glucose levels in STZ-induced diabetic animals. The hypoglycemic effect of the seed extract of *B. juncea* was attributed to stimulation of glycogen synthesis leading to increase in hepatic glycogen content and suppression of glycogen phosphorylase and other gluconeogenic enzymes. Upon oral administration of *B. juncea* diet (10% w/w) in normal rats for 60 days showed hypoglycemic activity²². The oral administration of aqueous seed extract of *B. juncea* has a beneficial effect on diabetic rat²³.

Cajanus cajan, Family: Fabaceae

Cajanus cajan, locally known as Tuar, belonging to family Fabaceae, is traditionally used in the treatment of diabetes mellitus. The effect of roasted and unroasted seeds of *C. cajan* was examined on serum glucose levels of normal and alloxan diabetic mice²⁴. The glucose tolerance enhancing activity of aqueous leaf and stem extract has been observed in OGTT²⁵. Cooked diet of *C. cajan* has also shown significant hypoglycemic effect in healthy human volunteers²⁶.

Capparis decidua, Family: Capparaceae

Capparis decidua belonging to family Capparaceae is locally known as kerda. Oral feeding of diet containing (30%) *C. decidua* fruit powder for 3 weeks to alloxanized (80mg/kg IP) diabetic rats showed significant hypoglycemic activity. This extract also reduced alloxan induced lipid peroxidation significantly in erythrocytes, kidney and heart. *C. decidua* was also found to alter superoxide dismutase and catalase enzyme levels to reduce oxidative stress^{27,28}. The action of alkaloids on various targets for the treatment of diabetes and its multiple therapeutic effects has proved that the alkaloid rich fraction isolated from *C. decidua* has a potential antidiabetic as well as anti hyperlipidemic effect²⁹.

Citrullus colocynthis, Family: Cucurbitaceae

Citrullus colocynthis is an annual or perennial herb, belonging to family Cucurbitaceae. The fruit of this plant is traditionally used as antidiabetic. The aqueous extract of its fruit showed dose-dependent increase in insulin release from isolated islets, when administered orally in normal

rabbits. The Glycosidic fraction was found to be more effective in lowering fasting glucose when compared to alkaloidal fraction. The saponin and glycosidic component levels of the rind of *C. colocynthis* were shown to be responsible for its hypoglycemic effect and also an insulinotropic effect^{30,31}. Blood glucose lowering activity of aqueous seed extract was also observed in normal and STZ-induced diabetic rats upon daily oral administration for 2 weeks³².

Coccinia indica, Family: Cucurbitaceae

Coccinia indica belonging to family Cucurbitaceae, commonly known as Ivy gourd in Hindi. Hypoglycemic action of *C. indica* could be due to potentiating the insulin effect of plasma by increasing the pancreatic secretion of insulin from the existing β -cells³³. *C. indica* is also believed to bring about its antidiabetic action by stimulating glucose transport³⁴. Oral administration of pectin isolated from *C. indica* fruits showed a significant hypoglycemic action in normal rats due to stimulation of glycogen synthetase activity and reduction of phosphorylase activity³⁵. Oral administration of *C. indica* leaves showed significant hypoglycemic in alloxan diabetic dogs and increased glucose tolerance in normal and diabetic dogs (OGTT and IVGT), respectively³⁶. Oral administration of ethanolic extract of *C. indica* root (250mg/kg) to normal rats significantly lowered blood sugar in fasted models and depressed the peak value in glucose loaded model³⁷.

Hibiscus rosa-sinensis, Family: Malvaceae

The administration of single dose of ethanol extract of *Hibiscus rosa-sinensis* in glucose loaded rats at 120 min has showed hypoglycemic activity but it produced blood glucose lowering effect after repeated administration for seven consecutive days at 30, 90 or 120 min after glucose loading³⁸. Administration of an alcoholic leaf extract for seven consecutive days was shown to exert hypoglycemic activity in glucose induced hyperglycemia model in rats³⁹. The ethanolic flower extract in STZ induced diabetic rats exerted the blood glucose lowering activity along with a reduction in total cholesterol and serum triglycerides⁴⁰. It stimulates insulin secretion from pancreatic β -cells and increases utilization of glucose, either by direct stimulation of glucose uptake or via the mediation of enhanced insulin secretion³⁹.

Ipomoea batatas, family: Convolvulaceae

The oral administration of *Ipomoea batatas* reduced hyperinsulinemia in Zucker fatty rats. In addition, inhibition of blood glucose level after glucose loading was observed after 7 weeks of treatment along with re-granulation of pancreatic β -cells and reduction in insulin resistance. It acts by reducing insulin resistance⁴¹ and possibly by maltase inhibition and not by sucrose or glucose transport inhibition at the intestinal membrane⁴².

Mangifera indica, Family: Anacardiaceae

Mangifera indica belonging to family Anacardiaceae, is a well-known perennial tree commonly known as Mango, distributed and widely cultivated in Gujarat. Oral administration of aqueous extract of the leaves failed to alter the blood glucose levels in STZ induced diabetic rats. However, the extract showed anti-diabetic effect when

given 60 min before or concurrently with glucose and this is due to reduction in intestinal absorption of glucose⁴³. Upon chronic administration for 14 days in STZ induced diabetic rats showed hypoglycemic activity and improvement in OGT in glucose-loaded normal rats⁴⁴. This plant possibly acts through intestinal reduction of the absorption of glucose as well as pancreatic and extrapancreatic mechanisms^{43,44}.

Momordica charantia, Family: Cucurbitaceae

The plant *Momordica charantia* is a slender, climbing annual vine commonly known as 'bitter gourd' and 'karela' grows in Gujarat and other tropical regions. It is a very common folklore remedy for diabetes. Extract of fruit pulp, seed, leaves and whole plant has shown hypoglycemic effect in various animal models. An ethanolic extract of *M. charantia* was shown to significantly lower blood sugar in fasted as well as glucose loaded non-diabetic rats⁴⁵. Oral administration of acetone extract of fruit powder of *M. charantia* to alloxan-diabetic rats for 15-30 days lowered the blood sugar level and serum cholesterol level to the normal range and the blood sugar was found normal even after 15 days of discontinuation of the treatment⁴⁶. Aqueous juice of *M. charantia* fruit exerted anti-hyperglycemia and antioxidant effect in pancreas of STZ-diabetic mice⁴⁷. The fruit juice significantly increased the number of β -cells ($P < 0.004$) in diabetic rats⁴⁸. Oral administration of different extracts showed a varying pattern of anti-hyperglycemic effect without altering the insulin response thereby suggesting a mechanism of action which is independent of intestinal glucose absorption and probably involves an extrapancreatic effect⁴⁹. In a clinical trial, water-soluble extract of the fruits of *M. charantia* significantly reduced blood glucose concentrations in the 9 NIDDM diabetics on OGTT. Fried karela fruits consumed as a daily supplement produced a small but significant improvement in glucose tolerance in diabetic subjects without any increase in serum insulin levels⁵⁰.

Musa sapientum, Family: Musaceae

Musa sapientum commonly known as Banana in English, Kela in Hindi and Gujarati belongs to family Musaceae. Various parts of this plant are used for different medicinal purposes including diabetes. Intra-gastric administration of a fresh flower decoction to hyperglycemic rabbits was reported to significantly decrease the hyperglycemic peak and/or the area under the glucose tolerance curve⁵¹. Oral administration of various doses of chloroform extract of *M. sapientum* flowers for 30 days significantly reduced blood glucose and glycosylated hemoglobin and increased total hemoglobin in alloxanized rats⁵².

Nelumbo nucifera, Family: Nelumbonaceae

The plant *Nelumbo nucifera* is an aquatic perennial herb commonly known as Lotus in English or kamal in Hindi and Gujarati. Oral administration of an ethanolic extract of *N. nucifera* rhizomes markedly reduced the blood sugar level of normal rat, glucose fed hyperglycemic rat and STZ induced diabetic rats. The extract was also found to improve glucose tolerance and also potentiated the action of exogenously injected insulin in normal rats^{53,54}.

Ocimum sanctum, Family: Lamiaceae

Ocimum sanctum is a tropical much branched, annual herb, up to 18 inches tall, commonly known as Holy Basil and locally known as Tulsi. The ethanolic extract (50%) of leaves showed hypoglycemic effect.⁵⁵ In another study, the ethanolic (70%) extract of leaves has been shown to cause significant reduction of blood glucose level in normal, glucose fed hyperglycemic and STZ induced diabetic rats. This effect was 91.55 and 70.43% of that of tolbutamide in normal and diabetic rats, respectively⁵⁶. A diet containing leaf powder (1%) fed to normal and diabetic rats for 1 month significantly reduced fasting blood sugar, uronic acid, total amino acids, total cholesterol, triglycerides and total lipids⁵⁷. The oral administration of plant extract (200mg/kg) produced plasma glucose lowering effect in STZ induced diabetic animals for 30 days revealing the effect of extract on three important enzymes of carbohydrate metabolism, namely glucokinase, hexokinase and phosphofructokinase⁵⁸. Another study has demonstrated glucose and cortisol lowering activity of the plant in male mice which acts by cortisol inhibiting potency⁵⁹.

Punica granatum, Family: Punicaceae

The flowers of the plant *Punica granatum*, belonging to family Punicaceae, are used as anti-diabetic in Unani medicine called Gulnarfarsi. Oral administration of aqueous-ethanolic extract (50%) led to significant blood glucose lowering effect in glucose fed hyperglycemic and alloxanized diabetic rats with the maximum effect at the dose of 400mg/kg body weight⁶⁰. The administration of methanolic seed extract p.o. in STZ induced diabetic rats showed hypoglycemic activities at the end of 12hrs⁶¹. The methanolic extract of the flowering part of *P. granatum* in non-fasted Zucker Diabetic fatty rats exerted plasma glucose lowering activity. *P. granatum* was shown to inhibit intestinal α -glucosidase activity, leading to hyperglycemic property⁶².

Syzygium cumini, Family: Myrtaceae

Syzygium cumini commonly known as Jamun in Hindi and Black Berry in English, is belonging to family Myrtaceae. Indian folk medicine mentions its use for the treatment of DM^{63,64}. Preliminary studies on seeds have also shown hypoglycemic effect⁶⁵. Decoction of dry leaves provide hypoglycemic activity⁶⁶. Oral administration of pulp extract of the fruit of *S. cumini* to normi-glycemic and STZ induced diabetic rats showed hypoglycemic activity in 30 min possibly mediated by insulin secretion. In addition, that pulp extract inhibited insulinase activity from the liver and kidney⁶⁷. Oral administration of dried alcoholic extract of *S. cumini* seeds caused hypoglycemia and reduced glycosuria⁶⁸.

Trigonella foenum graecum, Family: Leguminosa

Commonly known as Fenugreek or Methi, is a well-known hypoglycemic agent used in traditional Indian medicines. Various extracts of different parts like fibers, proteins and saponins isolated from the seeds were investigated and found to possess significant hypoglycemic activity^{69,70}. The trigonella seeds and the major alkaloid component, trigonelline, exerted a mild hypoglycemic effect⁷¹. Isolated fibers, saponins and other proteins from fenugreek seeds given with meals for 21 days to alloxan-diabetic dogs

showed significant anti-hyperglycemic and anti-glycosuric effect along with reduction in high plasma glucagon and somatostatin⁶⁹. Oral administration of 2 or 8g/kg of plant extract produced dose-dependent fall ($P < 0.05$) in blood glucose in the normal as well as diabetic rats⁷⁰. Seed powder normalized the altered creatinine kinase activity in heart, skeletal muscle and liver of diabetic rats to almost control values⁷². It also normalized alteration in hepatic and renal glucose-6-phosphatase and fructose-1,6-biphosphatase activity⁷³. In a clinical trial administration of fenugreek seed powder (50gm each with lunch and dinner) in Type I diabetic patients for 10 days significantly reduced fasting blood sugar and improved OGTT along with 54% reduction in glycosuria. In addition, it also showed significant hypolipidemic effect⁷⁴.

Vinca rosea, Family: Apocynaceae

Vinca rosea, belonging to family Apocynaceae, is found throughout India in westlands and is also cultivated. Oral administration of the water-soluble fraction of ethanolic extract of *V. rosea* leaves respectively showed a significant dose-dependent reduction in blood sugar at 4 h, in normal rats. In addition, oral administration of 500 mg/kg 3.5 h before OGTT and 72 h after STZ administration (50 mg/kg IP) in rats showed significant anti-hyperglycemic effects. No gross behavioral changes and toxic effect were observed up to 4 gm/kg IP⁷⁵.

CONCLUSION

The review has presented a list of anti-diabetic plants of Gujarat that have been pharmacologically tested and shown to be some value in treatment of diabetes mellitus. Diabetes mellitus is one of the most prevalent chronic diseases throughout the world which leads to various complications on long standing. Treatment with oral hypoglycemic drugs ends with numerous side effects. The potency of herbal medicine is significant and they have negligible side effects than existing synthetic anti-diabetic drugs. The plant species have proved their efficacy in reducing blood glucose levels so they are the best alternative for the treatment of diabetes mellitus. Recently, herbal products have started gaining importance as an alternative and complementary medicine to treat diabetic mellitus. In line with World Health Organization (1980) expert committee on diabetes which recommends that traditional methods of management of diabetes should be further investigated. The use of herbal species for medicinal benefits has played an important role in nearly every culture on earth and for many years, the search for anti-diabetic agents will continue to focus on plants and other natural resources. Based on the World Health Organization recommendations, hypoglycemic agents of plant origin used in traditional medicine are important. In future the herbal plants will play a crucial role in modern system of medicine.

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