

## ANTIDIABETIC HERBAL DRUGS: A REVIEW

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### ABSTRACT

Traditional medicines derived from medicinal plants are used by about 60% of the world's population. This review focuses on Indian herbal drugs and plants used in the treatment of diabetes, especially in India. More than 400 traditional plant treatments for diabetes mellitus have been recorded, but only a small number of these have received scientific and medical evaluation to assess their efficacy. Traditional treatments have mostly disappeared in occidental societies, but some are prescribed by practitioners of alternative medicine or taken by patients as supplements to conventional therapy. However, plant remedies are the mainstay of treatment in underdeveloped regions. A hypoglycemic action from some treatments has been confirmed in animal models and non-insulin-dependent diabetic patients, and various hypoglycemic compounds have been identified. A botanical substitute for insulin seems unlikely, but traditional treatments may provide valuable clues for the development of new oral hypoglycemic agents and simple dietary adjuncts. A list of medicinal plants with proven antidiabetic and related beneficial effects and of herbal drugs used in treatment of diabetes is compiled. These include *Aegle marmelos*, *Allium cepa*, *Allium sativum*, *Eugenia jambolana*, *Momordica charantia*, *Ocimum sanctum*, *Phyllanthus amarus*, *Pterocarpus marsupium*, *Tinospora cordifolia*, *Coccinia indica*, *Gymnema sylvestre*, *Enicostemma littorale* Blume.

**Keywords:** Medicinal plant, Antidiabetic drugs, Herbal drugs, Diabetes.

### INTRODUCTION

Herbal medicine, also called botanical medicine or phytomedicine, refers to the use of any plant's seeds, berries, roots, leaves, bark, or flowers for medicinal purposes. Long practiced outside of conventional medicine, herbalism is becoming more mainstream as up-to-date analysis and research show their value in the treatment and prevention of disease. In the last few years there has been an

exponential growth in the field of herbal medicine and these drugs are gaining popularity both in developing and developed countries because of their natural origin and less side effects. Many traditional medicines in use are derived from medicinal plants, minerals and organic matter. The World Health Organization (WHO) has listed 21,000 plants, which are used for medicinal

purposes around the world<sup>(1)</sup>. Among these 2500 species are in India, out of which 150 species are used commercially on a fairly large scale. India is the largest producer of medicinal herbs and is called as botanical garden of the world. Since the availability of insulin, folklore medicines for diabetes have almost disappeared in occidental societies, although they continue to be the cornerstone of therapy in underdeveloped regions. Renewed attention to alternative medicines and natural therapies has stimulated a new wave of research interest in traditional practices, and the World Health Organization expert committee on diabetes has listed as one of its recommendations that traditional methods of treatment for diabetes should be further investigated<sup>(2)</sup>. Traditional antidiabetic plants might provide a useful source of new oral hypoglycemic compounds for development as pharmaceutical entities, or as simple dietary adjuncts to existing therapies. Sulfonylureas and metformin are valuable treatments for hyperglycemia in non-insulin-dependent diabetes mellitus (NIDDM), but they are often unable to lower glucose concentrations to within the normal range, or to reinstate a normal pattern of glucose homeostasis. The current review focuses on herbal drug preparations and plants used in the treatment of diabetes mellitus, a major crippling disease in the world leading to huge economic losses.

### **Diabetes mellitus**

Diabetes mellitus is a syndrome of disordered metabolism, usually due to a combination of hereditary and environmental causes, resulting in abnormally high blood sugar levels (hyperglycemia). Blood glucose levels are controlled by a complex interaction of

multiple chemicals and hormones in the body, including the hormone insulin made in the beta cells of the pancreas. Diabetes mellitus refers to the group of diseases that lead to high blood glucose levels due to defects in either insulin secretion or insulin action<sup>(3)</sup>. Diabetes develops due to a diminished production of insulin (in type 1) or resistance to its effects. Both lead to hyperglycemia, which largely causes the acute signs of diabetes: excessive urine production, resulting compensatory thirst and increased fluid intake, blurred vision, unexplained weight loss, lethargy, and changes in energy metabolism. Monogenic forms, e.g. MODY, constitute 1-5 % of all cases.

The term *diabetes*, without qualification, usually refers to diabetes mellitus, which is associated with excessive sweet urine (known as "glycosuria") but there are several rarer conditions also named diabetes. The most common of these is diabetes insipidus in which the urine is not sweet (insipidus meaning "without taste" in Latin); it can be caused by either kidney or pituitary gland damage. Most cases of diabetes mellitus fall into one of two broad categories. The term "type 1 diabetes" has universally replaced several former terms, including childhood-onset diabetes, juvenile diabetes, and insulin-dependent diabetes (IDDM). Likewise, the term "type 2 diabetes" has replaced several former terms, including adult-onset diabetes, obesity-related diabetes, and non-insulin-dependent diabetes (NIDDM). Beyond these two types, there is no agreed-upon standard nomenclature. Various sources have defined "type 3 diabetes" as, among others, gestational diabetes, insulin-resistant type 1 diabetes (or "double

diabetes”), type 2 diabetes which has progressed to require injected insulin, and latent autoimmune diabetes of adults (or LADA or “type 1.5” diabetes.) There is also maturity onset diabetes of the young (MODY) which is a group of several single gene (monogenic) disorders with strong family histories that present as type 2 diabetes before 30 years of age<sup>(4)</sup>.

### **AYURVEDIC HERBS IN THE TREATMENT OF DIABETES MELLITUS**

Diabetes mellitus in Ayurveda is covered under the heading of Prameha. Several Ayurvedic formulations have been used in the treatment of Diabetes mellitus for centuries. In addition to herbs, minerals find wide application in Ayurvedic prescription for diabetes. Medicinal herbs like Aegle marmelos, Allium cepa, *Allium Sativum*, Momordica charantia, Gymnema sylvestre, Enicostermma littorale, Pterocarpus marsupium, Coccinia indica, and Trigonella foneum gracieum are prescribed as single powder drugs or in combination (poly-herbal). Scientists have studied the chemical composition of the Antidiabetic medicinal herbs used in Ayurveda. The article deals with work done on Indian medicinal plants with anti-diabetic potential.

#### **Aegle marmelos: Bael or Shripal (Hindi), Holy Fruit Tree (English)**

**Family:** Rutaceae.

#### **Pharmacodynamics:**

*Rasa : Madhura, Tikta, Kasaya*

*Guna : Laghu, Ruksha, Ushna*

*Virya : Ushna*

*Vipaka : Katu*

*Karma : Kapha-vata-hara, Pittakara,*

**Common name:** Wood apple.

**Parts used:** Fruit & leaves.

**Geographical source:** India.

**Chemistry:** Tannins, active principle (marmelosin), alkaloids (aegelin & aegelinin) and coumarin (marmesin).

**Pharmacological study:** Das, Padayatil and Paulose (1996) studied the hypoglycemic activity of leaf extract of Aegle marmelos in streptozocin induced diabetes. The extract significantly reversed altered parameters in tissue of the experiment rats. According to authors, the drug seems to repair the injured pancreas<sup>(5)</sup>

**Allium cepa: Pyaj (Hindi) and Onion (English)**

**Family:** Amaryllidaceae

**Parts used:** whole plant

#### **Pharmacodynamics:**

*Rasa : Madhur, katu*

*Guna : Guru, tikshna, snigdh*

*Vipaka : Madhur*

*Virya : Ishad Ushna*

*Doshaghnata : Kaphapittasamak*

**Geographical source:** all over world

**Pharmacological study:** It is cultivated throughout India and is an important dietary constituent. Various ether soluble fractions of onion as a single oral dose (0.25 mg/kg) showed significant hypoglycemic effect in normal fasted rabbits. Ethyl ether extract showed most potent hypoglycemic action<sup>(6)</sup>. Petroleum ether insoluble fraction of the ether extract of dried onion powder (100 mg/kg) given orally for 7 days to alloxanized (180 mg/kg) diabetic rabbits caused a significant anti-hyperglycemic effect. Oral administration of 250 mg/kg of ethanol, petroleum, chloroform and acetone extract of powder dried onion showed maximal reduction of 18.57, 8.35, 3.0 and 3.20% in fasting blood glucose of alloxanized (150 mg/kg IP) diabetic rabbit<sup>(7)</sup>. In a

preliminary study of seven different fractions obtained from onion bulb, only petroleum ether and chloroform extracts significantly lowered blood sugar in OGTT (2 gm/kg) in rabbits<sup>(8)</sup>. Feeding of diet containing 3% freeze-dried onion powder for 8 weeks produced a significant hypoglycemia along with partial reversion of abnormal plasma albumin, urea, creatinine and inorganic phosphorus in STZ diabetic albino rats.

Administration a sulfur containing amino acid isolated from *Allium cepa* Linn. called S-methyl cysteine sulphoxide (SMCS) (200 mg/kg for 45 days) to alloxanized rats significantly controlled blood glucose and lipids in serum and tissues and normalized the activities of liver hexokinase, glucose 6-phosphatase and HMG CoA reductase. The effect was comparable to that of glibenclamide and insulin. Also showed beneficial effect of SMCS and S-allylcysteine sulfoxide (SACS) in alloxanized diabetic rats on glucose intolerance, weight loss and liver glycogen. It also decreased hyperglycemic peak in subcutaneous glucose tolerance tests conducted in rabbits<sup>(9)</sup>.

***Allium Sativum :Lahsun (Hindi) and Garlic (English)***

**Family:** Liliaceae.

**Parts used:** Ripe Bulbs.

**Pharmacodynamics:**

*Rasa : All except Amla*

*Guna : Picchil,sara*

*Vipaka : Katu*

*Virya : Ushna*

*Doshaghnata :Kaphasamaka*

**Geographical source:** Central Asia, Southern Europe, USA, India.

**Chemistry:** It contains a wealth of sulphur compounds; most important for the taste is

Allicin , which is produced enzymatically from allin. It also contain 65% water, 28% carbohydrate, 2.3% organosulphur compound, 2% proteins,! .2% free amino acid(mainly arginine) , 1.5% fiber, 0.15% lipids, 0.08% phytic acid, 0.07% saponins<sup>(10)</sup>

**Pharmacological study:** S-allyl cystein sulfoxide (SACS), the precursor of Allicin and garlic oil, is a sulfur containing amino acid, which controlled lipid peroxidation better than glibenclamide and insulin. It also improved diabetic conditions. SACS also stimulated *in vitro* insulin secretion from beta cells isolated from normal rats. Apart from this, *Allium sativum* exhibits antimicrobial, anticancer and cardio protective activities.

***Andrographis paniculata Nees.l***

**Kalmegh(Hindi)**

**Family:** Rutaceae

**Parts used:** Whole plant

**Pharmacodynamics:**

*Rasa : Tikta*

*Guna : Laghu, Ruksa*

*Vipaka : Katu*

*Virya : Ushna*

*Doshaghnata :Kaphavatasamak*

**Geographical source:** India

**Chemistry:** Diterpene lactones (andrographolide, Kalmegh and neoandrographolide).

**Pharmacological study:** Ahmad and Asmawi (1992) reported hypoglycemic activity of *Andrographis paniculata*. A significant decrease in blood glucose levels was observed on glucose tolerance test as compared to the untreated group. The authors concluded that the drug inhibits glucose absorption in the intestine.<sup>(11)</sup>

***Azadirachta indica: Nim or Neem (Hindi)***

**Family:** Meliaceae

**Parts used:** Whole plants.

**Pharmacodynamics:**

*Rasa : Tikta*

*Guna : Laghu,*

*Vipaka : Katu*

*Virya : Ushna*

*Doshaghnata : kaphavatsamaka*

**Chemistry:** Nimbidin is major source from seed oil, It is crude bitter principle. It also contain nimbin, nimbinin, nimbidenin, nimbolide, nimbilic acid. Gedunin obtained from neem's seed. It also contain mahmoodin, Azadirachtin. It also contains some tannin like, Gallic acid. There are also present of Margolonon, Polysaccharide.

**Pharmacology:** Anti diabetic, Anti Inflammatory, Anti pyretic, Anti fungal, Anti bacterial, Anti malarial, Anti arthritis, Spermicidal, Anti tumour, Diuretic, Immunomodulatory.

**Pharmacological study:**

Hydroalcoholic extract of *Azadirachta indica* showed hypoglycemic and anti-hyperglycemic effect in normal, glucose fed and STZ diabetic rats. The plant exerts its pharmacological activity independent of its time of administration i.e. either prior or after alloxan administration . The plant blocks the action of epinephrine on glucose metabolism, thus increasing peripheral glucose utilization It also increased glucose uptake and glycogen deposition in isolated rat hemidiaphragm.<sup>(12)</sup>

***Caesalpinia bonduc*:Karanja (Hindi)**

Nicker tree(English) .

**Family:** Leguminosae

Part used: Twak, leaves, flower seeds

Synonyms: *Naktamala, Chirabilvaka,*

*Gucchaprspaka,*

*Ghrtapura, Snigdhapatra*

**Gana :**

*Charaka : Kandughna, Katukskanda*

*Sushruta : Aragvadhadi, Varunadi, Arkadi,*

*Syamadi*

*Vagbhata : Aragvadhadi, Varunadi,*

*Arkadi, Syamadi*

**Pharmacodynamics:**

*Rasa : Tikta, Katu, Kashaya*

*Guna : Laghu, Tiksna*

*Vipaka : Katu*

*Virya : Usna*

*Dosaghnata : Kaphavatasamaka*

**Parts used:** Seed, leaves & oil expressed from kernel of seeds.

**Geographical Source:** It is found in tropical parts of Asia & Africa.

**Chemistry:** Bitter principle bonducin

**Pharmacological study:** Biswas and workers studied the hypoglycemic activity of aqueous extract of *Caesalpinia bonduc*. The drug was tested in fasted, fed, glucose loaded, streptozocin induced diabetes extract administered was 250 mg/kg of rat body weight. The extract was found to be effective in glucose loaded, streptozocin induced diabetes and alloxan induced diabetic rats. According to authors, the drug should be regarded as good oral hypoglycemic agents.<sup>(13)</sup>

***Coccinia indica*: Bimbi or Kanturi (Hindi) and Ivy Guard (English)**

**Family:** Cucurbitaceae.

**Parts used:** Leaves.

**Pharmacodynamics:**

*Rasa : Tikta*

*Guna : Laghu, Ruksa, tikhna*

*Vipaka : Katu*

*Virya : Ushna*

*Doshaghnata : Kaphavatasamaka*

**Pharmacological study:** Antia B.S, et al.1999 to study Dried extracts of *Coccinia indica* (*C. indica*) (500 mg/kg body weight)

were administered to diabetic patients for 6 weeks. These extracts restored the activities of enzyme lipoprotein lipase (LPL) that was reduced and glucose-6-phosphatase and lactate dehydrogenase, which were raised in untreated diabetics. Oral administration of 500 mg/kg of *C. indica* leaves showed significant hypoglycemia in alloxanized diabetic dogs and increased glucose tolerance in normal and diabetic dogs. (14)

***Curcuma Longa Haldi(Hindi) and Turmeric (English)***

**Family:** Zingiberaceae (Ginger Family)

**Pharmacodynamics:**

*Rasa : Tikta,katu*

*Guna : Laghu, Ruksa*

*Vipaka : Katu*

*Virya : Ushna*

*Doshaghnata : Kaphavat samaka*

**Chemistry:** Curcumin, Turmeric Extract, Food Color E100 , diferuloylmethane,1,7-Bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione Chemical Formula: C21H20O6

**Clinical study:**

The effect of Aqueous Extract of Curcumalonga (AEC) on insulin secretion in pancreatic tissues with acute incubations under hyperglycaemic conditions and also chronic incubations under both basal and hyperglycaemic conditions were examined in vitro. Under hyperglycaemic culture conditions all the doses of AEC over 30 min of incubation showed an inhibited insulin release which was significantly different from the control ( $p < 0.05$ ). No significant difference was observed between the 0.1, 1 and 10 mL doses of AEC ( $p > 0.05$ ), but the highest dose of AEC (100 mL) was significantly different from the control and the other doses of AEC

( $p < 0.05$ ). Tolbutamide, on the other hand, significantly stimulated insulin secretion. Pancreatic tissues over 15 min of incubation with various doses of AEC in hyperglycemic culture conditions were not significantly different in insulin secretion from the control. (15)

***Enicostemma littorale Blume***

**:Mamajjaka(Hindi)**

Mamajjaka was not mentioned in Vedic Kala and Samhita Kala. In Nighantu Kala, Mamajjaka is mentioned in Shodhal Nighantu in Lakshmanadi Varg only.

**Family:** Gentiaceae

**Parts used:** Whole plant.

**Pharmacodynamics:**

*Rasa : Tikta*

*Guna : Laghu, Ruksa*

*Vipaka : Katu*

*Virya : Ushna*

*Doshaghnata : Kapha-Pitta Shamaka*

**Geographical source:** It is found throughout India up to height of 1500ft.

**Chemistry:** Bitter principle (swertimarine) two alkaloids (one gentianine and other's name not confirmed), ophelic acid and tannins.

**Pharmacological study:** In a study, Maroo and workers have shown hypoglycemic and antioxidants activity of methanol extract of Enicostema littorale. Administration of methanol extract (2.5 g/kg body weight/day) to diabetic rats for 20 days reduced blood glucose levels from 466.5+37.07 to 237.20+28.22. The extract not only raised the serum Insulin levels but improved the antioxidants status of the rats also. (16) in a clinical trial done by shukla& shukla 2010 it was found that it reduces the blood glucose label highly significantly (17).

**Gymnema sylvestre: Gudmar or Merasingi (Hindi) and Periploca of the woods (English)**

**Family :** Asclepiadaceae

**Synonyms :** Ajasingika, Madhunasini, Visani

**Parts Used :** Leaves

**Pharmacodynamics:**

**Rasa :** Kashaya, Tikta

**Guna :** Laghu, Ruksa

**Vipaka :** Katu

**Virya :** Ushna

**Doshaghnata :** Kapha-Vata –Shamaka

**Chemistry:**

**Dried leaves:** Resin, pararabin, triterpene glycoside (gymnemic acid 6%), peptide gurmarin), alkaloids (gymnamine), bitter principle (having sialagogue activity), luponol, quercitol, coloring matter and anthraquinones.

**Bark:** Calcium and starch.

**Alcoholic extract:** Saponin.

**Ash:** Alkali, phosphoric acid and manganese.

**Use as herbal medicine:** The active ingredient is thought to be gurmenic acid which has structure similar to sac arose. Extracts of Gymnema is not only claimed to curb sweet tooth but also for treatment of as varied problems as hyperglycemia, obesity, high cholesterol levels, anemia and digestion. According to the Sushruta, the of the Ayurveda it helps to treat Madhumeha i.e glycosuria<sup>(18)</sup>

**Pharmacological study:**

Shanmugassundaram and workers (1991) tested the hypoglycemic activity of water-soluble acidic fraction of the *Gymnema sylvestre* leaves in rats. The drug was tested in streptozotocine induced diabetic rats. It was concluded that *G.sylvestre* raises levels of insulin. Mechanism of action however

remains unclear & gymnemic acid is a constituent of *Gymnema sylvestre*.<sup>(19)</sup>

**Ipomoea batatas: Sakkarkand or Mitha Alu (Hindi)**

**Family:** Convolvulaceae

**Pharmacodynamics:**

**Rasa :** Madhur, kasaya

**Guna :** guru, snighdha

**Vipaka :** madhur

**Virya :** sheet

**Doshaghnata :** vatasamaka

**Pharmacological study:** A trailing herb cultivated for its succulent tuberous roots. Oral administration of *Ipomoea batatas* reduces hyperinsulinemia in Zucker fatty rats by 23, 26, 60 and 50% after 3, 4, 6 and 8 weeks, respectively. In addition, inhibition of blood glucose level after glucose loading was observed after 7 weeks of treatment along with regranulation of pancreatic beta cells and reduction in insulin resistance. Hypolipidemic activity has also been described<sup>(20)</sup>.

**Syzygium cumini (Eugenia jambolana): Jamun (Hindi) and Black Berry (English)**

**Family :** Myrtaceae

**Part used :** Fruit, Leaf, stem bark

**Pharmacodynamics:**

**Rasa :** Kashaya, Madhura, Amla

**Guna :** Laghu, Ruksha

**Vipaka :** Katu

**Virya :** Sheeta

**Doshaghnata :** Vatavardhaka, Kapha-Pitta Shamaka

**Pharmacological study:** The present study evaluated the hypoglycemic activity of different parts of *Eugenia jambolana* seeds such as whole seed, kernel, and seed coat on streptozotocin-induced diabetic rats. Administration of the ethanolic extract of kernel at a concentration of 100 mg/kg of

body weight significantly decreased the levels of blood glucose, blood urea, and cholesterol, increased glucose tolerance and levels of total proteins and liver glycogen, and decreased the activities of glutamate oxaloacetate transaminase and glutamate pyruvate transaminase in experimental diabetic rats. Whole seed showed a moderate hypoglycemic effect, and seed coat did not show any hypoglycemic effect. The hypoglycemic efficacy was compared with that of glibenclamide, a standard hypoglycemic drug.<sup>(21)</sup>

#### **Momordica charantia: Karela (Hindi) and Bitter Gourd (English)**

**Family:** Cucurbitaceae.

**Rasa :** Tikta, Katu

**Guna :** Laghu, Ruksha

**Vipaka :** Katu

**Virya :** Ushna

**Doshaghnata :** Vatavardhaka, Kapha-Pitta

Shamaka

**Pharmacological study:** Ahmed, et al.(1999) studied the mechanism of action of juice in rats. Rats were rendered diabetic by single injection (60 mg/kg body weight) of streptozocin. One week after injection, treated animals were fed with juice of *M.charantia* (10 ml/kg) daily for three in glucose uptake and it attenuated the insulin induced increase in glucose uptake<sup>(22)</sup>.

#### ***Musa Paradisiaca* (Banana)**

**Common name:** Banana, Pisang.

**Family:** Musaceae.

**Parts used:** Seed, fruit.

#### **Pharmacodynamics:**

**Rasa :** Madhura, Tikta, Kasaya

**Guna :** Mridu, laghu

**Virya :** Ushna

**Vipaka :** Madhura

**Karma :** Balya, Vrsya, Pittanasaka, Ruca,

**Kaphaghna.**

**Chemistry:** It is the rich source of Carbohydrate, fair source of Vitamins, Minerals. Starch (Amylose-20.5%) present in unripe fruit. It also contain Protein like; Albumin, Globulin, Glutelin, Prolamine. It also contain some free amino-acids. e.g. Glutamic acid, Gamma amino butyric acid. It also contain calcium, Iron, Potassium, Magnesium, Sodium, Phosphorous. Different vitamins present in fruits like; Carotene, Niacin, Ascorbic acid, Riboflavin, Folic acid, Biotin, Pyridoxine, Inositol.

**Pharmacological study:** Diabetes mellitus is a debilitating hormonal disorder in which strict glycemic control and prevention of associated complications are of crucial importance. This study was designed to evaluate the hypoglycemic effect of methanolic extract of mature, green fruits of *Musa paradisiaca* (MEMP) in normal (normoglycemic) and streptozotocin (STZ)-treated, diabetic (hyperglycemic) mice, using chlorpropamide as the reference Antidiabetic agent. MEMP (100-800 mg/kg p.o.) induced significant, dose-related ( $p < 0.05-0.001$ ) reductions in the blood glucose concentrations of both normal and diabetic mice. Chlorpropamide (250 mg/kg p.o.) also produced significant ( $p < 0.01-0.001$ ) reductions in the blood glucose concentrations of normal and diabetic mice. The results of this experimental study indicate that, in the mammalian model used, MEMP possesses hypoglycemic activity. Although the precise mechanism of the hypoglycemic action of MEMP is still unclear and will have to await further studies, it could be due, at least in part, to stimulation of insulin production and subsequent glucose utilization. Nevertheless, the findings of this

experimental animal study indicate that MEMP possesses hypoglycemic activity, and thus lends credence to the suggested folkloric use of the plant in the management and/or control of adult-onset, type-2 diabetic mellitus among the Yoruba-speaking people of South-Westerns Nigeria.<sup>(23)</sup>

**Ocimum sanctum: Tulsi (Hindi) and Holy basil (English)**

**Family:** Labiateae

**Pharmacodynamics:**

*Rasa :Katu, Tikta, Kasaya*

*Guna :Laghu, Ruksa,Tikhshna*

*Virya :Ushna*

*Vipaka :Katu*

*Karma: Hridya, Krimighna, Tridoshhar, Rucikrit, Dipana,*

**Chemistry:** Volatile oil (containing eugenol and caryophyllene), triterpenoid (rosmarinic acid and ursolic acid) Flavonoids and Saponin.

**Clinical study:** Agraval, Rai and Singh (1996) in randomized, placebo-controlled, single-bind, crossover trial studied the effects of *Ocimum sanctum* ( dried leaf 2.5g daily )on fasting and postprandial blood glucose and serum cholesterol levels in patients diagnosed with non-insulin dependent diabetes mellitus. 40 patients, 20 of whom were receiving oral hypoglycemic drugs and twenty of whom were newly diagnosed without a history of anti diabetic drug use, took 2.5 g of *Ocimum sanctum* leaf or placebo in water on an empty stomach upon Rising, Followed by the other treatment for four weeks. Investigators were blinded to the sequence of treatments. The results showed that *Ocimum sanctum* treatment caused a significant decrease in both fasting and postprandial blood glucose levels compared

with placebo. A mild reduction in total cholesterol levels was also observed. The mechanism responsible for the hypoglycemic activity of sacred basil is not known but *Gymnema sylvestre* raises levels of insulin.<sup>(24)</sup>

***Phyllanthus niruri (Bhumiamalaki)***

**Family:** Euphorbiaceae

**Pharmacodynamics:**

*Rasa : All - except - Lavana.*

*Guna : Laghu, Ruksa.*

*Veerya : Seeta.*

*Vipaka : Madhura.*

*Dosaghna : Tridosaghna.*

**Chemistry:** It is a rich source of plant chemicals, including many which have been found only in the *Phyllanthus* genus. The main plant chemicals in chanca piedra include alkaloids, astragalin, brevifolin, carboxylic acids, corilagin, cymene, ellagic acid, ellagitannins, gallic acid, geraniin, hypophyllanthin, lignans, lintetralins, lupeols, methyl salicylate, niranthin, nirtetralin, niruretin, nirurin, nirurine, niruriside, norsecurinines, phyllanthin, phyllanthine, phyllanthanol, phyllochrysine, phytetralin, repandusinic acids, quercetin, quercetol, quercitrin, rutin, saponins, triacontanol, and tricontanol.

**Clinical study:** In the above 1995 study, researchers also reported that blood sugar levels were reduced significantly in human subjects studied. Two other studies with rabbits and rats document the hypoglycemic effect of chanca piedra in diabetic animals. Yet another study documented chanca piedra with aldose reductase inhibition (ARI) properties. Aldose reductases are substances that act on nerve endings exposed to high blood sugar concentration and can lead to diabetic neuropathy and macular degeneration.

Substances which inhibit these substances can prevent some of the chemical imbalances that occur and thus protect the nerve. This ARI effect of chanca piedra was attributed, in part, to a plant chemical called ellagic acid. This well-studied plant chemical has been documented with many other beneficial effects in numerous clinical studies<sup>(25)</sup>.

**Polyalthia Longifolia:kasthadaru (Hindi)**

**Family:** Annonaceae.

**Parts used:** Bark

**Pharmacodynamics:**

*Rasa: Tikta, Katu*

*Guna: Lagu , rooksha*

*Veerya: Ushna*

*Vipaka: Katu.*

**Chemistry:** Preliminary phytochemical screening revealed the presence of alkaloids, glycoside, Saponin, polyphenolic compounds, diterpenoids & tannins.

**Pharmacological study:** The chloroform extract of stem bark of *Polyalthia* var. *Angustifolia* was evaluated for its Antidiabetic activity in alloxan induced diabetic rats and euglycaemic rats after a single dose of 200 mg/kg p.o and prolonged treatment of 100 mg/kg p.o for 10 days. The results revealed significant antihyperglycemic activity ( $P<0.01$ ). Glibenclamide showed hypoglycemic activity in euglycaemic rats but the said extract did not show hypoglycemic activity<sup>(26)</sup>

**Pterocarpus marsupium: Vijayasar or Bijasal (Hindi) and Indian Malabar (English)**

**Pharmacognostic profile**

**Family :** Leguminaceae

**Subfamily :** Papilionatae

**Part Used :** Sara

**Pharmacodynamic profile :**

**Properties :**

*Rasa : Tikta, Katu, Kashaya*

*Guna : Laghu, Ruksha*

*Virya : Ushna*

*Vipaka : Katu*

**Chemistry:** Pterostilbene, a constituent derived from wood of this plant Flavonoids fraction from *Pterocarpus marsupium* has been shown to cause pancreatic beta cell regranulation. Marsupin, pterosupin and liquiritigenin obtained from this plant. Epicatechin, its active principle.

**Pharmacological study:** It is a deciduous moderate to large tree found in India mainly in hilly region. Pterostilbene, a constituent derived from wood of this plant caused hypoglycemia in dogs showed that the hypoglycemic activity of this extract is because of presence of tannates in the extract. Flavonoids fraction from *Pterocarpus marsupium* has been shown to cause pancreatic beta cell regranulation. Marsupin, pterosupin and liquiritigenin obtained from this plant showed antihyperlipidemic activity. Epicatechin, its active principle, has been found to be insulinogenic, enhancing insulin release and conversion of proinsulin to insulin *in vitro*. Like insulin, epicatechin stimulates oxygen uptake in fat cells and tissue slices of various organs, increases glycogen content of rat diaphragm in a dose-dependent manner<sup>(27)</sup>.

**Trigonella foenum graecum: Methi or Mutti (Hindi) and Fenugreek (English)**

**Family :** Papilionaceae.

**Pharmacodynamics:**

*Rasa : Tikta Katu.*

*Guna : Snigdha , laghu.*

*Veerya : Usna*

*Vipaka : Katu*

Dosaghnata : Kaphavatahara

Dhatu : Meda, Asthi and Rasa.

Mala : Grahi

**Pharmacological study:** It is found as a wild plant and also cultivated in Northern India. The hypoglycemic effect of fenugreek seeds has been demonstrated in experimentally induced diabetic rats, dogs, mice and healthy volunteers (both IDDM and NIDDM) <sup>(28)</sup>. Isolated fibers, saponins and other proteins from fenugreek seeds given with meals for 21 day to alloxan-diabetic dogs showed significant anti-hyperglycemic and anti-glycosuric effect along with reduction in high plasma glucagon and somatostatin. Oral administration of 2 and 8 g/kg of plant extract produced dose-dependent fall (PB 0.05) in blood glucose both in the normal as well as diabetic rats <sup>(29)</sup>. 4-hydroxyisoleucine, a novel amino acid has been extracted and purified from fenugreek seeds. It increased glucose-induced insulin release (ranging from 100 mmol/l to 1 mmol/l) through a direct effect on the isolated islets of Langerhans in both rats and humans. This pattern of insulin secretion was biphasic, glucose dependent, occurred in the absence of any change in pancreatic alpha and delta cell activity and without interaction with other agonists of insulin secretion (such as leucine, arginine, tolbutamide, glycer aldehyde) <sup>(30)</sup>.

#### **Tinospora cordifolia: Amarta or Guduci (Hindi)**

**Family:** Menispermaceae.

#### **Pharmacodynamics :-**

*Rasa* - Tikta, Katu, Kashaya

*Guna* - Laghu, Snigdha

*Veerya* - Ushna

*Vipaka* - Madhur

*Doshagnata* - Tridoshaghna

**Chemistry:** A variety of constituents have been isolated from *Tinospora cordifolia* plant and their structures were elucidated. They belong to different classes such as Alkaloids, diterpenoid lactones, glycosides, steroids, Sesquiterpenoid, phenolics, aliphatic compounds and Polysaccharides. Leaves of this plant are rich in protein (11.2%) and are fairly rich in calcium and phosphorus.

**Chemistry and medicinal properties:** Weight produces a temporary but marked fall in blood pressure and bradycardia in anaesthetized dogs. *T. cordifolia* is widely used in Indian Ayurvedic medicine for treating diabetes mellitus. Oral administration of an aqueous *T. cordifolia* root extract to alloxan diabetic rats caused a significant reduction

**Pharmacological study:** In blood glucose and brain lipids. Though the aqueous extract at a dose of 400 mg/kg could elicit significant anti-hyperglycemic effect in different animal models, Its effect was equivalent to only one unit/kg of insulin. It is reported that the daily administration of either alcoholic or aqueous extract of *T. cordifolia* decreases the blood glucose level and increases glucose tolerance in rodents. Aqueous extract also caused a reduction in blood sugar in alloxaninduced hyperglycemia in rats and rabbits in the dose of 400 mg/kg. However, histological examination of pancreas has not revealed any evidence. <sup>(31)</sup> Of regeneration of b-cells of islets of Langerhans and the possible mode of action of the plant is through glucose metabolism. The aqueous extract has also exhibited some inhibitory effect on adrenaline-induced hyperglycemia. Ethyl acetate extract of its roots has afforded a pyrrolidine derivative with hypoglycemic

activity in rabbits. Another study has also revealed significant hypoglycemic effect of extract of leaves in normal and alloxan diabetic rabbits. However, the extract had no significant effect on total lipid levels in normal or treated rabbits.<sup>(32)</sup>

## DISCUSSION

Advances have been made in the understanding of the hypoglycemic action of various herbs but many questions remain unanswered. As mentioned earlier, most of the plants exhibited hypoglycemic, hypolipidemic, and antioxidant effects in animals as well as in humans, which may be helpful in diabetes and associated complications. The exact mechanism of action of these plants still needs to be elucidated. On critical analysis of the available studies, it is observed that most of the plants stimulate beta cells to release insulin. Few plants such as *G. sylvestre*, *M. charantia*, *P. marsupium*, et cetera may also help in regeneration or increase in the number of beta cells, which is an important discovery because none of the conventional oral hypoglycemic agents exhibit this action. Plants such as *P. granatum* and *A. indica* also exhibit extrapancreatic effects via peripheral glucose utilization. Increased glucose uptake by tissues in vitro and decrease in gastric emptying has also been demonstrated by herbs such as *M. chirantia* and *T. foenum-graecum*.

These observations are based on few studies, most of which are animal studies of short duration and small sample size, which makes it inappropriate to comment on the efficacy of these herbs in humans. However, these observations need to be further evaluated in human beings. If proven to be effective, these herbs can be incorporated in the treatment of diabetes as

alternatives to conventional hypoglycemic agents, thereby overcoming the limitations of conventional oral hypoglycemic agents such as undesirable side effects and tolerance. These herbs can be better than other available oral hypoglycemic agents, because there are no uniform known toxic effects of these in therapeutic dosage, while they are traditionally being used since ancient times. However, further research is needed to evaluate the toxicity or adverse effects, if any, of these herbs.

## CONCLUSION

Diabetes is possibly the world's fastest growing metabolic disease, and as knowledge of the heterogeneity of this disorder increases, so does the need for more appropriate therapies. Traditional plant medicines are used throughout the world for a range of diabetic presentations. An oral hypoglycemic agent having hypolipidemic, and antioxidant action would be better for the treatment of diabetes. Few of the herbs mentioned above may have all these actions and prove to be promising in the treatment of diabetes and its complications in the near future. Therefore, there is a need of more well-documented clinical trials and more laboratory work to isolate the active principles, their pharmacological actions and toxicity.

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