



Review Article

TRADITIONAL AYURVEDIC HERBS USED FOR TREATMENTS OF DIABETES MELLITUS: SCOPE AND A REVIEW

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ABSTRACT

Diabetes mellitus is a metabolic disorder affecting many organs of the body with severe complication if untreated. In India, diabetes is leading major disorder mainly affecting in the urban areas due to change of life style, lack of attention towards exercise and hectic schedule. There is huge availability of allopathic medicines for better treatment but have side effects also. Indian traditional herbs are also used from ancient times for different treatment. Herbal formulations for diabetes are the proven and effective medicines in India and variety of medicinal plant are used to treat complications of diabetes. These Ayurvedic plants and parts of plants have different chemical constituents and can be used as a medicine. These contents also have a rich sources of antioxidant property that used to control the free radical formation. In this research review, our aim is to cover traditional herb and plants from India having anti-diabetes activity, its chemical constitution and active ingredients used for treatment. These plants if we start to used with or without allopathic drug treatment on daily basis can make big differences for control and management of diabetes.

KEYWORDS: Traditional herbs, Diabetes Mellitus, Ayurvedic herbs, Hypoglycemia.

INTRODUCTION

In Ayurveda, The term diabetes mellitus is means as sweet urine. It stems from ancient times when physicians would taste a patient's urine as a part of a diagnosis. Diabetes mellitus is a common condition in which the amount of glucose in the blood is too high because the body is unable to use it properly. Food is taken in and travels through the gut. The pancreas secretes insulin when we eat. Food is broken into smaller molecules in the gut and some of these are Glucose. Glucose travels round the body in the blood. Glucose is used for energy. Insulin moves the glucose from the blood into the cells. After a meal, blood glucose levels rise and insulin is normally released into the blood. Insulin is crucial to stop blood glucose levels rising too high. Diabetes can occur at any age but incidence increases with age. The hormone called insulin controls the amount of glucose in the blood. Insulin is made in a gland called the pancreas.^[1] Diabetes develops when the pancreas is unable to produce insulin or when cells cannot use the insulin properly. Diabetes is classified into two types. Type 1 develops when there is a severe lack of insulin in the body because most or all insulin producing beta cells in the pancreas have been destroyed. This is treated by insulin injections and diet. Type 2 develops when pancreas still produces

insulin but there is cellular resistance and insulin cannot be used properly by the body. This is treated by diet alone or diet and tablets, or diet and insulin injections. Diabetes is the growing health problem in the United States and India also and has raised about six fold since 1950. It's now affecting about 17 million Americans and Indians and one third of those Americans (5.9 million) don't even now they have the disease. Today, not only are adults being diagnosed with this disease, but it's also affecting today's youth.^[2]

Diabetes Type 2 Development and symptoms

Glucose is a simple sugar that provides energy to all cells in the body. The cells take in glucose from the blood and break it down for energy, most of this is used for fuel. Glucose comes from the food you eat. Glucose gets absorbed from the intestines and distributed by the bloodstream to all cells. The body tries to maintain a constant glucose concentration in the blood. So, when over supply on glucose occurs, your body stores the excess in the liver and muscles by making glycogen. When glucose is in short supply, the body makes glucose from stored glycogen or from the food that's been eaten. To maintain a constant blood glucose level, the body

relies on two hormones produced in the pancreas that have opposite actions: insulin and glucagon. Type 2 diabetes is often without symptoms in its early stages. That's the reason there are 40% of people with Type 2 diabetes are unaware of their disease. When there are symptoms, they may occur gradually. If present, they usually are: feeling tired and weak, passing large volumes of urine especially during the night, having frequent infections, blurred eyesight, Weight-loss, Excessive hunger and thirst. Coma or death may occur as a result in Diabetic Ketoacidosis (caused by infection) and also People who smoke are a much higher risk at heart attacks, stroke, infections, and problems with poor circulation. [3]

Ayurvedic Treatment

Indian system of traditional knowledge i.e. Ayurvedic is well known for its effective herbal treatments. There are different plant species found in India. Although most of them have a long history in folk medicine, there is lack of written data on their efficacy and safety, esp. from human studies. Many of them are used to treat highly prevalent disorder diabetes mellitus. Few of common examples includes *Allium cepa*, *Allium sativum*, *Aloe vera*, *Coccinia indica*, *Caesalpinia bonducella*, *Eugenia jambolana*, *Mucuna pruriens*, *Murraya koeingii*, *Mormodica charantia*, *Swertia chirata*, *Syzgium cumini*, *Tinospora cordifolia*, and *Trigonella foenum graecum*. We have started to use some of these locally available herbal remedies for treatment of diabetes mellitus at hospital and surprisingly found the good result by these alternative medicines.

Allopathic drugs used for the treatment of diabetes have their own side effect & adverse effect like hypoglycaemia, nausea, vomiting, hyponatremia, flatulence, diarrhoea or constipation, alcohol flush, headache, weight gain, lactic acidosis, pernicious anaemia, dyspepsia, dizziness, joint pain. So instead of allopathic drugs, herbal drugs are a great choice which is having more or less no side effect & adverse effects. Ethno-botanical information identified about 800 Indian plants which may have antidiabetic potential. Ayurvedic interventions may benefit patients with higher base line HbA1c value, warranting further research.

1. *Dioscorea opposita* (Yam)



Figure 1: Plant and tubers of *Dioscorea opposita*
Dioscorea opposita (nagaimo, Chinese yam, Korean yam) is a name commonly used for two plants correctly known as *Dioscorea polystachya* and *Dioscorea oppositifolia* as shown in figure 1. The plant correctly called *D. opposita* is now considered to be the same species as *D. oppositifolia*. It mainly refers to the roots of *Dioscorea opposita*. Yam is the common name for some plant species in the genus *Dioscorea* (family *Dioscoreaceae*) that form edible tubers. These are perennial herbaceous vines cultivated for the consumption of their starchy tubers in Africa, Asia, Latin America, and The Caribbean Oceania. Chinese yam is native to China. The Chinese yam plant is somewhat smaller than the African, with the vines about 3 meters (10 feet) long. It is tolerant to frost and can be grown in much cooler conditions than other yams. Yam products generally have a lower glycaemic index than potato products, which means that they will provide a more sustained form of energy, and give better protection against obesity and diabetes. It contains diosgenin, mucilage, choline, starch, sugar, protein, free amino acids, abscisic acid, vitamin C, amylase. [4]

2. *Gymnema sylvestre* (Gurmar)



Figure 2: Leaves of *Gymnema sylvestre*

The common names include gymnema, Cowplant, Australian cowplant, gurmari, gurmarbooti, purmar, meshasringa, Bedki cha pala and miracle fruit. *Gymnema sylvestre* is an herb native to the tropical forests of southern and central India and Sri Lanka as shown in figure 2. Chewing the leaves suppresses the sensation of sweet. This effect is attributed to the eponymous gymnemic acids. *G. sylvestre* has been

used in herbal medicine as a treatment for diabetes for nearly two millennia. The drugs consist of dried leaves of *Gymnema sylvestre* belonging to family Asclepidaceae. The Chemical constituents are gymnemic acid, inositol, hentriacontane, pentatriacontane. The major bioactive constituents of *G. sylvestre* are a group of oleanane-type triterpenoid, saponins known as gymnemic acids. The latter contain several acylated (tigloyl, methylbutyroyl etc.,) derivatives of deacylgymnemic acid (DAGA) which is the 3-O-Glucuronide of Gymnemagenin (3, 16, 21, 22, 23, 28-hexahydroxy-olean-12-ene). The individual gymnemic acids (saponins) include gymnemic acids I-VII, gymnemosides A-F, and gymnemasaponins.

The literature search gave conclusion that a water-soluble extract of *G. sylvestre* caused reversible increases in intracellular calcium and insulin secretion in mouse and human β -cells when used at a concentration (0.125 mg/ml) without compromising cell viability. This in-vitro data suggests that extracts derived from *G. sylvestre* may be useful as therapeutic agents for the stimulation of insulin secretion in individuals with type 2 diabetes. The rise in insulin levels may be due to regeneration of the cells in the pancreas. *G. sylvestre* can also help to prevent adrenal hormones from stimulating the liver to produce glucose in mice, thereby reducing blood sugar levels. Clinical trials with type 2 diabetics in India have used 400 mg per day of water-soluble acidic fraction of the *Gymnema* leaves administered for 18–20 months as a supplement to the conventional oral drugs. During supplementation, the patients showed a significant reduction in blood glucose, glycosylated Haemoglobin and glycosylated plasma proteins, and conventional drug dosage could be decreased. The patients were able to discontinue their conventional drug and maintain their blood glucose homeostasis with herb formulation alone. These data suggest that the beta cells may be regenerated/repared in Type 2 diabetic patients on this supplementation. This is supported by the appearance of raised insulin levels in the serum of patients after supplementation. [5-7]

3. *Momordica charantia* (Karela, bitter gourd)



Figure 3: The fruits of *Momordica Charantia*

Momordica charantia is known as bitter melon, bitter gourd, bitter squash or balsam pear. It is a Tropical and subtropical vine of the family *Cucurbitaceae*, widely grown in Asia, Africa, and the Caribbean for its edible fruit, which is extremely bitter. Its many varieties differ substantially in the shape and bitterness of the fruit. It is shown in figure 3. The Chemical constituents are Chiratin (steroidal saponin) and mimordicin. *Momordica charantia* is not only a nutritious vegetable, but is also used in traditional medical practices to treat type 2 diabetes mellitus. In India it is used in food (which is considered a medicinal food for diabetics). Other uses are stomachic, carminative, tonics, treatment of rheumatism, gout, disorder of spleen and liver. Bitter melon originated on the Indian subcontinent, and was introduced into China in the 14th century. With regard to the use of *Momordica charantia* for diabetes, several animal studies and small scale human studies have demonstrated a hypoglycaemic effect of concentrated bitter melon extracts. In addition, a 2014 review shows evidence that *Momordica charantia*, when consumed in raw or juice form, can be efficacious in lowering blood glucose levels. Contrary to this evidence, multiple reviews have found that *Momordica charantia* does not significantly decrease fasting blood glucose levels or A1c, indicators of blood glucose control, when taken in capsule or tablet form. *Momordica charantia* is beneficial in diabetes, however the effects seem to depend on how it is consumed. More studies need to be performed in order to verify this effect. Reported side effects include diarrhoea, abdominal pain, fever, hypoglycaemia, urinary incontinence, and chest pain. Symptoms were generally mild, did not require treatment, and resolved with rest. Bitter melon is contraindicated in pregnant women because it can induce bleeding, contractions, and abortion.[8-10]

4. *Syzygium cumini*(Jamun, Jambul)



Figure 4: Fruits of Jamun

Syzygium cumini commonly name as jambul, jambolan, jamblang, or jamun, is an evergreen tropical tree in the flowering plant family Myrtaceae. *Syzygiumcumini* is native to the Indian Subcontinent and adjoining regions of Southeast Asia, it is shown in Figure 4. The species ranges across

India, Bangladesh, Pakistan, Nepal, Sri Lanka, Malaysia, the Philippines, and Indonesia. *Syzygium cumini* has been spread overseas from India by Indian emigrants and at present is common in former tropical British colonies. The seed is also used in various alternative healing systems like Ayurveda (to control diabetes), Unani and Chinese medicine for digestive ailments. The pulp of the fruit, extracts from the bark and seeds is of great benefit when it comes to lowering of blood glucose level. Taking dried extract of the seeds orally, greatly reduces the blood sugar and glucosuria. The leaves and bark are used for controlling blood pressure and gingivitis. Wine and vinegar are also made from the fruit. It has a high source in vitamin A and vitamin C. The Chemical constituents are anthocyanin, delphinidine-3-entiobioside, malvidin 3 laminaribiose and ferulic acid. Many research studies have shown that Jamun is one of the best medicines for treatment of diabetes. It is an anti-diabetic drug and Diabetic persons are advised to consume 1 tsp of this jamun seed powder in empty stomach early morning.^[11,12]

5. *Azadirachta indica* (Neem)



Figure 5: Flowers and leaves of *Azadirachta Indica*

Source of *Neem* is *Azadirachta indica* of family *Maliaceae*. The Flowers and leaves of *Neem* are shown in figure 5. The provisional naming was *nimbin* (sulphur-free crystalline product with melting point at 205 °C), *nimbinin* (with similar principle, melting at 192 °C), and *Nimbidin* (cream-coloured containing amorphous sulphur, melting at 90–100 °C). *Nimbidin* is as the main active antibacterial ingredient, and the highest yielding bitter component in the *Neem* oil. The *neem* leaf extracts and seeds are used as an active ingredient as an effective cure for diabetes. It has been scientifically proven after a number of tests and research by leading medical institutes, that *Neem* parts have high efficacy in treating the disease. Natural *Neem* tablets are being manufactured and exported the world over for treating large number of patients. *Neem* leaf extracts improve the blood

circulation by dilating the blood vessels and also helpful in reducing the need for hypoglycaemic drugs. Products made from *Neem* trees have been used in India for over two millennia for their medicinal properties. *Neem* products are believed by Siddha and Ayurvedic practitioners to be anthelmintic, antifungal, antidiabetic, antibacterial, antiviral, contraceptive and sedative. It is considered a major component in Siddha medicine, Ayurvedic and Unani medicine and is particularly prescribed for skin diseases. *Neem* oil is also used for healthy hair, to improve liver function, detoxify the blood, and balance blood sugar levels. *Neem* leaves have also been used to treat skin diseases like eczema, psoriasis, etc. However, insufficient research has been done to assess the purported benefits of *Neem*. In adults, short-term use of *Neem* is safe, while long-term use may harm the kidneys or liver; in small children, *Neem* oil is toxic and can lead to death. *Neem* may also cause miscarriages, infertility, and low blood sugar.^[13]

6. *Aegle Marmelos*: (Bengal Quince, *Bel* or *Bilva*)



Figure 6: Fruit of *Aegle marmelos*

Aegle marmelos, commonly known as bael, Bengal quince, golden apple, stone apple, wood apple. It is a species of tree native to India, its fruit is shown in figure 6. It is present throughout Southeast Asia as a naturalized species. Its fruits are used in traditional medicine and as a food throughout its range. Bael is the only member of the monotypic genus *Aegle*. It is a mid-sized, slender, aromatic, armed, gum-bearing tree growing up to 18 meters tall. It has a leaf with three leaflets. The bael fruit has a smooth, woody shell with a green, gray, or yellow peel. Aegeline (N-[2-hydroxy-2 (4-methoxyphenyl) ethyl]-3-phenyl-2-propenamamide) is a known constituent of the bael leaf and consumed as a dietary supplement for a variety of purposes. Administration of aqueous extract of leaves improves digestion and reduces blood sugar and urea, serum cholesterol in alloxanized rats as compared to control. Along with exhibiting hypoglycemic activity, this extract also prevented peak rise in blood sugar at 1hr in oral glucose tolerance test.^[14]

7. *Allium cepa* (Onion)



Figure 7: bulb of onion

The onion (*Allium cepa* L.) also known as the bulb onion or common onion, is a vegetable and is the most widely cultivated species of the genus *Allium* shown in figure 7. Onions contain photochemical compounds such as phenolic that are under basic research to determine their possible properties in humans. There are considerable differences between onion varieties in polyphenol content.

Yellow onions have the highest total flavonoid content, an amount 11 times higher than in white onions. Red onions have considerable content of anthocyanin pigments, with at least 25 different compounds identified representing 10% of total flavonoid content. Various ether soluble fractions as well as insoluble fractions of dried onion powder show anti-hyperglycemic activity in diabetic rabbits. *Allium cepa* is also known to have antioxidant and hypolipidaemic activity. Administration of a sulfur containing amino acid from *Allium cepa*, 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 and normalized the activities of liver hexokinase, glucose 6-phosphatase and HMG CoA reductase. When diabetic patients were given single oral dose of 50 g of onion juice, it significantly controlled post-prandial glucose levels.^[15]

8. *Allium sativum* (Garlic)



Figure 8: Bulbs of *Allium sativum*

Allium sativum, commonly known as garlic, and it is shown in figure 8. It is a species in the onion genus, *Allium*. Its close relatives include the onion, shallot, leek, chive, and rakkyo. Fresh or crushed garlic yields the sulphur containing compounds alliin, ajoene, diallylpolysulfides, vinylthiins, S-allylcysteine, and enzymes, saponins, flavonoids, and Maillard reaction products, which are not sulfur-containing compounds. The composition of the bulbs is approximately 84.09% water, 13.38% organic matter, and 1.53% inorganic matter, while the leaves are 87.14% water, 11.27% organic matter, and 1.59% inorganic matter.

Abundant sulfur compounds in garlic are also responsible for turning garlic green or blue during pickling and cooking. Under these conditions (*i.e.* acidity, heat) the sulfur-containing compound allinase react with common amino acids to make pyrroles, clusters of carbon-nitrogen rings. These rings can be linked together into polypyrrole molecules. Ring structures absorb particular wavelengths of light and thus appear colored. The two-pyrrole molecule looks red, the three-pyrrole molecule looks blue and the four-pyrrole molecule looks green (like chlorophyll, a tetrapyrrole). Like chlorophyll, the pyrrole pigments are safe to eat.

This is a perennial herb cultivated throughout India. Allicin, a sulfur-containing compound is responsible for its pungent odour and it has been shown to have significant hypoglycemic activity. This effect is thought to be due to increased hepatic metabolism, increased insulin release from pancreatic beta cells and/or insulin sparing effect. Literature reveals that Aqueous homogenate of garlic (10 ml/kg/day) administered orally to sucrose fed rabbits (10 g/kg/day in water for two months) significantly increased hepatic glycogen and free amino acid content, decreased fasting blood glucose, and triglyceride levels in serum in comparison to sucrose controls. 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 cardioprotective activities.^[16]

9. *Aloe vera* and *Aloe barbadensis***Figure 9: Aloe-Vera plant species**

Aloe vera is a succulent plant species and it is shown in figure 9. The species is frequently cited as being used in herbal medicine since the beginning of the first century AD. Extracts from *Aloe vera* are widely used in the cosmetics and alternative medicine industries, being marketed as variously having rejuvenating, healing, or soothing properties. There is, however, little scientific evidence of the effectiveness or safety of *Aloe vera* extracts for either cosmetic or medicinal purposes, and what positive evidence is available is frequently contradicted by other studies. Aloin, a compound found in the exudate of some *Aloe* species. The species has a number of synonym: *A. barbadensis* Mill., *Aloe indica* Royle, *Aloper foliata* L. var. *vera* and *A. vulgaris* Lam. *Aloe vera* may also cause diarrhea, which in turn can lead to electrolyte imbalance, kidney dysfunction, dry mouth, headache, and nausea, while topical application may induce contact dermatitis, erythema, or phototoxicity. Aloe, a popular houseplant, has a long history as a multipurpose folk remedy. The plant can be separated into two basic products: gel and latex. Aloe Vera gel is the leaf pulp or mucilage, aloe latex, commonly referred to as "aloe juice," is a bitter yellow exudate from the pericyclic tubules just beneath the outer skin of the leaves. Extracts of aloe gum effectively increases glucose tolerance in both normal and diabetic rats. Treatment of chronic but not single dose of exudates of *Aloe barbadensis* leaves showed hypoglycemic effect in alloxanized diabetic rats. Single as well as chronic doses of bitter principle of the same plant also showed hypoglycemic effect in diabetic rats. This action of *Aloe vera* and its bitter principle is through stimulation of synthesis and/or release of insulin from pancreatic beta cells. This plant also has an anti-inflammatory activity in a dose dependent manner and improves wound healing in diabetic mice. [17]

10. *Ocimum sanctum*: (Holy basil)**Figure 10: Leaves and flowers of holy basil**

Ocimum tenuiflorum, also known as *Ocimum sanctum*, holy basil, or *Tulasi* shown in figure 10. It is an aromatic plant in the family Lamiaceae which is native to the Indian subcontinent and widespread as a cultivated plant throughout the Southeast Asian tropics. It is an erect, many branched subshrub, 30–60 cm (12–24 in) tall with hairy stems and simple phyllotaxic green or purple leaves that are strongly scented. *Tulasi* is cultivated for religious and medicinal purposes, and for its essential oil. It is widely known across the Indian subcontinent as a medicinal plant and an herbal tea commonly used in Ayurveda, *Tulasi* has been used for thousands of years in Ayurveda for its diverse healing properties. It is mentioned in the Charaka Samhita, an ancient Ayurvedic text. Some of the main chemical constituents of *tulasi* are: oleanolic acid, ursolic acid, rosmarinic acid, eugenol, carvacrol, linalool, β -caryophyllene (about 8%), β -elemene (11.0%), and germacrene D (about 2%). Isolated *O. sanctum* extracts have some Antibacterial activity against *E. coli*, *S. aureus* and *P. aeruginosa*. The aqueous extract of leaves of *Ocimum sanctum* showed the significant reduction in blood sugar level in both normal and alloxan induced diabetic rats. Significant reduction in fasting blood glucose, uronic acid, total amino acid, total cholesterol, triglyceride and total lipid indicated the hypoglycemic and hypolipidemic effects of *Tulasi* in diabetic rats. Oral administration of plant extract (200 mg/kg) for 30 days led to decrease in the plasma glucose level by approximately 9.06 and 26.4% on 15 and 30 days of the experiment respectively. Renal glycogen content increased 10 fold while skeletal muscle and hepatic glycogen levels decreased by 68 and 75% respectively in diabetic rats as compared to control. This plant also showed antiasthmatic, antistress, antibacterial, antifungal, antiviral, antitumor, gastric antiulcer activity, antioxidant, antimutagenic and immunostimulant activities. [18]

11. *Phyllanthus amarus* (Bhuiawala)



Figure 11: Leaves of *phyllanthus amarus*

It is herb of height up to 60 cm, from family *Euphorbiaceae*. It is commonly known as Bhuiamala. Its leaves are shown in figure 11. It is scattered throughout the hotter parts of India, mainly Deccan, Konkan and south Indian states. Traditionally it is used in diabetes therapeutics.

The phytochemical constituents of *phyllanthus amrus* are Alkaloids like Isobubbialine and Epibubbialine, Tannins: Geraniin, corilagin, 1,6-digalloylglucopyranoside rutin, quercetin-3-O-glucopyranoside, Amarulone, Phyllanthus iin D & Amariin. Lignans: Niranthin, Nirtetralin, Phyltetralin, Hypophyllanthin, Phyllanthin, demethylenedioxy-niranthin, 5-demethoxy-niranthin, Isolintetralin, Ellagitannins: Amariin, 1-galloyl-2,3-dehydrohexahydroxydiphenyl (DHHDP)-glucose, Repandusinic acid, Geraniin, Corilagin, Phyllanthusiin D, and flavonoids namely rutin, and quercetin 3-O-glucoside, 1-Ogalloyl-2,4-dehydrohexahydroxydiphenoyl-glucopyranose, elaeocarpusin, repandusinic acid A and geraniinic acid. Volatile oil: Linalool and Phytol and Triterpene (2Z, 6Z, 10Z, 14E 18E, 22E-farnesil farnesol).

Methanolic extract of *Phyllanthus amarus* was found to have potent antioxidant activity. This extract also reduced the blood sugar in alloxanized diabetic rats. The plant also shows anti-inflammatory, antimutagenic, anticarcinogenic, antidiarrhoeal activity.

The antidiabetic potential of *Phyllanthus amarus* investigated in an experiment model where fasted rats were made diabetic by single intraperitoneal injection of 120 mg/kg of alloxan monohydrates and then two doses of the aqueous and hydroalcoholic extract of *Phyllanthus amarus* administered orally which were then compared with the normal control group that received distilled water only. After 15 days treatment the result demonstrates aqueous and hydroalcoholic extract of *Phyllanthus amarus* decrease the blood glucose level significantly. Serum analysis of the treated

experimental animals showed an increase in insulin and reduction in the malondialdehyde concentration, therefore demonstrated the potential antidiabetic property of aqueous and hydroalcoholic extract of *Phyllanthus amarus*.^[19]

12. *Caesalpinia bonducella* (Kuberakshi)



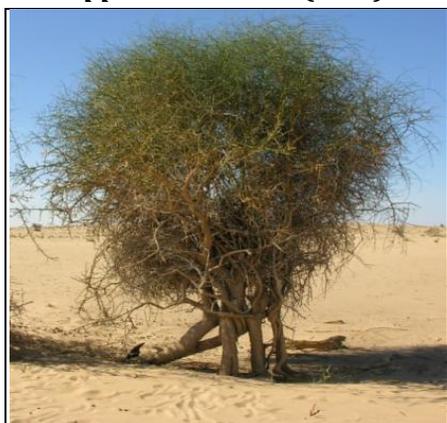
Fig 12: flowers and leaves of *Caesalpinia Bonducella*

The common names of *Caesalpinia Bonducella* are fever nut, Bonduc nut. In Hindi it is known with the names Kankarej, Katikaranjana, and the Sanskrit name is Kuberakshi, Its flowers and leaves are shown in figure 12. *Caesalpinia bonducella* belonging to Family *Caesalpinaceae*. The plant *Caesalpinia bonducella* (syn: *Caesalpinia Crista* Linn.) has been used in different system of traditional medication for the treatment of diseases and ailments of human beings. It is reported to contain various Alkaloids, Glycosides, Terpenoids and Saponins. It has been reported as anti-asthmatic, antidiabetic, anti-inflammatory, anti-oxidant, anti-bacterial, anti-filarial, anti-tumor, anxiolytic, immunomodulatory, hypoglycemic activity.

Caesalpinia Bonducella is seen in hotter places in India, Sri Lanka and Burma. These trees grow on waste grounds and on coastal areas. Its seeds contain stearic, palmitic, octadeca-4, octadeca-2, ligoceric, linolenic and oleic acids. They also contain bonducellin, arginine, citrulline and aspartic acid. *Caesalpinia bonducella* is widely distributed throughout the coastal region of India and used ethnically by the tribal people of India for controlling blood sugar. Both the aqueous and ethanolic extracts showed potent hypoglycemic activity in chronic type II diabetic models. These extracts also increased glycogenesis thereby increasing liver glycogen content.^[20]

13. *Acacia arabica* (Babul)**Figure 13: Flowers and leaves of Babul**

The local name of the plant is bahul also commonly named as acacia from family Leguminosae, Its flowers and leaves are shown in figure 13. The different plant parts are used for therapeutic purpose as leaves, Seed, Bark and gum. Acacia gum contains chiefly arabin which is the mixture of calcium, magnesium and potassium salts of arabic acid. On hydrolysis arabic acid yields L-rhamnopyranose, galactopyranose, L-arabofuranose and the aldobionic acid, 6-d-glucuronosido-d-galactose. Further hydrolysis yields L-arabinose, D-galactose, d-glucuronic acid and rhamnose. The gum also possesses enzymes like oxidases, peroxidases and pectinases. It is found all over India mainly in the wild habitat. The plant extract acts as an antidiabetic agent by acting as secretagogue to release insulin. It induces hypoglycemia in control rats but not in alloxanized animals. Powdered seeds of *Acacia arabica* when administered (2,3 and 4 g/kg bodyweight) to normal rabbits induced hypoglycemic effect by initiating release of insulin from pancreatic beta cells. [21]

14. *Capparis deciduas* (Kair)**Figure 14: Plant and seed of *Capparis deciduas***

Capparis deciduas is commonly known as *kair*, *kerda*, *karir*, *kirir*, *karril*, etc. The plant and its seed are shown in figure 14. This is a useful plant in its marginal habitat. Its spicy fruits are used for preparing vegetables, curry and fine pickles and can attract helpful insectivores; the plant also is used in folk medicine and herbalism. *Capparis deciduas* can be used in landscape gardening, afforestation and reforestation in semi desert and desert areas; it provides assistance against soil erosion. *Capparis deciduas* is belonging to family Capparidaceae, yet important medicinal plant of Indian Medicinal Plants. In the traditional system of medicine, the bark has been shown to be useful in the treatment of coughs, asthma and inflammation; roots used in fever and buds in the treatment of boils. In Unani, leaves act as appetizer, helps in cardiac troubles, fruits used in biliousness. The plant is reported to contain Phytochemicals including alkaloids, terpenoids, glycosides and some fatty acids. Root bark is used as anthelmintic and purgative. The plant have significant pharmacological activities like hypercholesterolemic, anti-inflammatory and analgesic, antidiabetic, antimicrobial, antiplaque, antihypertensive, antihelmintic & purgative activities.

The plant is found to reveal the presence of a number of alkaloids, terpenoids, glycosides and some fatty acids. This is found throughout India, especially in dry areas. Hypoglycemic effect was seen in alloxanized rats when the rats were fed with 30% extracts of *Capparis deciduas* (*C. deciduas*) fruit powder for 3 weeks. This extract also reduced alloxan induced lipid peroxidation significantly in erythrocytes, kidney and heart. *C. deciduas* was also found to alter superoxidodis mutase and catalase enzyme levels to reduce oxidative stress. This plant additionally showed hypolipidaemic activity. [22]

15. *Coccinia indica*: (Kandutiki bel)**Figure 15: Fruits of *Coccinia indica***

Coccinia indica (Synonym: *Coccinia grandis*, *Coccinia cordifolia*) family Cucurbitaceae Commonly called little gourd or Rantondli in Marathi, Bimba in Sanskrit and *Kandutiki bel* in Hindi, fruit is shown in figure 15. It is indigenous to Bengal and other parts of India. *C. indica* grows abundantly all over India, Tropical Africa, Australia, Fiji and throughout the oriental countries. The plant has also been used extensively in Ayurvedic and Unani practice in the Indian subcontinent. It has long tuberous fleshy roots, smooth and green fruits. Microscopy of root shows parenchyma, phelloderm, pericyclic fibers, stone cells, starch grains. Transverse Section of leaves has shown upper and lower epidermis, ranunculaceae stomata, uniseriate multicellular trichomes. Fresh juice of roots is used to treat diabetes; tincture of leaves is used to treat gonorrhoea, paste of leaves is applied to the skin diseases. Dried bark is a good cathartic. Leaves and stem are anti-spasmodic and expectorant. The fleshy green fruit is very bitter. Green fruit is chewed to cure sores on the tongue. *C.indica* leaves showed that it depressed the activity of the enzyme glucose-6-phosphatase and possesses an antioxidant activity, which may be attributed to its protective action on lipid peroxidation and to the enhancing effect on cellular antioxidant defense contributing to the protection against oxidative damage in streptozotocin diabetes. Hypolipidemic activity was also studied but that was also in diabetic rats. Many clinical trial studies has also proven effectiveness and safety of this plant parts and derived formulations for antidiabetic effect. Anti-inflammatory, analgesic and antipyretic activity of fruit and leaves were studied and found to be significant. Plant contains saponins, flavonoids, sterols and alkaloids. The 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. [23]

CONCLUSION

The next few years promise to be an exciting time in diabetes care. Many agents for the treatment of type 2 diabetes are under development and the options, method and delivery for insulin therapy continue to grow. It will be going to be more refined in near future. Achieving the best blood sugar control possible remains the ultimate goal in type 1 and type 2 diabetes. We know beyond a doubt, that good blood sugar control minimizes the long term complications of diabetes, including blindness, nerve damage. Finally a healthy lifestyle can do nothing bad. It should remain the cornerstone for current treatment of diabetes mellitus. These Indian herbs are around us and can be used as an adjuvant or supplementary medicine to control diabetes. Some patients definitely will get benefited by the uses of these specific plants in near future and from that time an alternative system of medicine for Ayurvedic traditional herbs will come into play important and useful supplementary and alternative herbs for diabetes Mellitus.

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