PHCOG MAG.: Short Review
Potential of Ayurvedic Herbs in the Treatment of Diabetes Mellitus

A.S.Sandhu,
Dept of Natural Products,
National Institute of Pharmaceutical Education and Research (NIPER), Mohali

Amrit Pal Singh,
Medical Advisor, Tas-Med India Pvt. Ltd, Chandigarh (India).
E.mail : amritpal2101@yahoo.com

Diabetes mellitus in Ayurveda is known as Madhu-meha. Several Ayurvedic formulations have been used in the treatment of Diabetes mellitus for centuries. In addition to herbs, minerals find wide application in Ayurvedic prescriptions for diabetes. Medicinal herbs like *Momordica charntia, Gymnema sylvestre, Enicostemma littorale, Pterocarpus marsupium, Salacia reticulata, Coccinia gluaca* and *Trigonella foneum graceum* are prescribed as single powder drugs (SPD) 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 antidiabetic potential.

Keywords: Diabetes mellitus/ Medicinal Plants/ Ayurveda

Diabetes and Ayurveda

Ayurveda is an ancient medicine system, which treats what is advantageous and what is harmful for the body and stresses on happy and unhappy states of life. Ayurveda was derived from Artharva Veda and Vedic era is considered to be the time, when Ayurveda flourished as a science. Tridosha (vata, pitta and kapha) are considered to be the root cause of all diseases. The aim of the treatment is in correcting the imbalance of the biological humors.

Diabetes mellitus is a metabolic disorder characterized by excess levels of glucose in the blood (hyperglycemia) and appearance of glucose in the urine (glycosuria).Pancreas is a glandular organ having dual function of exocrine as well as endocrine (for position of the pancreas. The endocrinal part of the pancreas consists of group of cells known as islet of Langerhans. The islets contain α and ß cells, which secrete glucagon and insulin respectively. Diabetes mellitus may be encountered in obese as well as non obese patients.

Glucose consumed in the diet after absorption reaches the liver and insulin from the pancreas converts it into glycogen. If insulin is absent, glucose escapes in the blood circulation and the condition is known as hyperglycemia. Normal value of blood glucose on empty stomach is 80-120 mg/100 ml of blood (fasting) and after consuming meals 120-180 mg/100 ml of blood (postprandial).

Diabetes mellitus is of two types: Insulin-dependent diabetes mellitus (juvenile or type-1) and non-insulin dependent diabetes mellitus (maturity onset or type-2). Clinical features of diabetes mellitus may be present with excess of thirst, excess of appetite, excess of urination, weight gain or loss and ulcers that refuse to heal. If not cured properly diabetes can affect eyes, kidneys and nerves.

Treatment of diabetes mellitus requires rational approach. Synthetic drugs like glibenclamide, metformin and pioglitazone have brought revolution in the field of diabetology. Although results are encouraging but side-effects associated with oral hypoglycemic agents cannot be over looked. Hypoglycemia and liver toxicity are common with oral hypoglycemic agents. Researchers have shifted focus to natural remedies to find a suitable anti-diabetic compound.

Medicinal herbs like *Momordica charntia, Gymnema syslvestre, Aegle marmelos* and mineral preparations like *Asphaltum punjabianum* have been tried for keeping symptoms of diabetes under control. Recent research has shown anti-diabetic potential of above mentioned drugs.

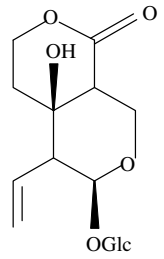
Caesalpinia bonducella F., (Karanja)

Family**:** Leguminosae
Habitat: *Caesalpinia bonducella* is found in tropical parts of Asia and Africa.
Common name: Nicker tree.
Botany: Leaves are pinnatae, prickly and of dark-green colour. Seeds are globular, shining and of dull grey colour. Kernel is dull-white, bitter and mucilaginous. The oil is obtained from seeds.
Chemistry: Bitter principle (bonducin) [1].
Study: Biswas and workers (1997) studied the hypoglycemic activity of aqueous extract of *Caesaplinia bonducella*. The drug was tested in fasted, fed, glucose loaded, streptozocin induced diabetes and alloxan induced diabetic rats. The dose of the 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 agent [2].
Parts used: Seeds, leaves and oil expressed from kernel of seeds.
Preparation: Powder.
Dose: 0.3-2 G.

Enicostemma littorale Blume (Majmakbooti)

Family: Gentiaceae
Habitat: It is found throughout India up to height of 1500 feet.
Botany: *Enicostemma littorale* is a perennial herb attaining height of 5-20 inches. It produces yellow or

white coloured flowers, which are arranged in clusters.
Chemistry: Bitter principle (swertimarine; see structure), two alkaloids (one gentianine and other's name not confirmed), ophelic acid and tannins.



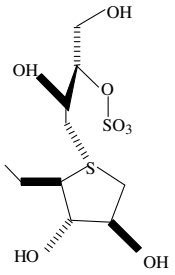
Structure of Swertimarin

Study 1: In a study, Maroo and workers have shown hypoglycemic and antioxidant activity of methanol extract of *Enicostema littorale*. Administration of methanol extracts (2.5 g/kg body weight/day) to diabetic rats for 20 days reduced blood glucose levels from 466.50+ 37.07 to 237.20+ 28.22. The extract not only raised the serum insulin levels but improved the antioxidant status of the rats also[3].

Study 2: In another study, Maroo and workers studied the dose dependent blood glucose lowering effect of aqueous extract of *Enicostemma littorale* in alloxan diabetic rats. 1.5 G of dry plant caused significant decrease in glycosylated hemoglobin, liver glucose-6-phosphatase activity and significant increase in serum insulin levels of the diabetic rats[4].
Parts used: Whole plant.
Dose: Powder (1-3G); Decoction 50-100 ml.

***Salacia reticulata and Salacia oblonga Wall* (Saptachakra)**

Family: Hippocrateaceae.
Habitat: Salacia is found in Malabar and Bombay
Botany: *Salacia reticulata* is an evergreen small tree or shrub. Leaves are 3-6 inches long, ¾-2 inches broad and dentate. Flowers are yellow colored and in a group of three to six. The plant, flowers in December and fruits in April.
Chemistry: Flavonoids (Salacinol and kotalanol)



Structure of Salacinol.

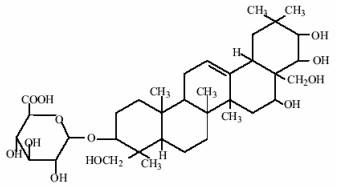
Study 1: Augusti, Joseph and Bapu (1995) studied the hypoglycemic activity of chloroform eluted fraction of the petroleum ether extract of the root bark of *Salacia oblanga*. They separated a compound, which demonstrated potent hypoglycemic activity in rats when compared to tolbutamide (synthetic oral hypoglycemic agent)[5].
Study 2: Hisashi and workers (2002) studied the antidiabetogenic constituents from several natural medicines including drugs used in Ayurveda. They isolated salacinol and kotalanol from *Salacia reticulata and Salacia oblonga*. Both the compounds showed potent inhibitory activity against intestinal α-glucosidase and also inhibitory effects of salacinol on the increase in serum glucose levels in maltose and sucrose loaded rats were found to be more potent than those of acrabose (synthetic oral hypoglycemic agent) [6].
Parts used: Roots.
Dose: Decoction 50-100 ml.

***Gymnema sylvestre R. Br* (Gurmar booti)**

In Ayurveda, *Gymnema sylvestre* is commonly known as Gurmarbooti (killing the sweet taste) or Mesharingi (sheep or ram's horn). Sushruta, the great Indian surgeon, has described the medicinal herb as one of best Antidiabetic option available in Ayurvedic system of medicine. The drug is considered to be diuretic, digestive and emetic. The leaves and roots are used in medicine.
Family: Asclepiadacea
Habitat: India.
Botany: *Gymnema sylvestre* is a large, milky, twinning, much branched climber. Leaves are dark green color, ovate and elliptic; small flowers, yellow in nearly sessile cymes; root about size of little finger; seeds 1.3 cm long and brown.

Chemistry:

1.Dried leaves: Resin, pararabin, triterpene glycoside (gymnemic acid 6 per cent), peptide (gurmarin), alkaloid (gymnamine), bitter principle (having sialagouge activity), lupeol, quercitol, coloring matter and anthraquinones.
2. Bark: Calcium and starch.
3. Alcoholic extract: Saponin.
4. Ash: Alkali, phosphoric acid and manganese.



Structure of Gymnemic acid.

Study1: Shanmugasundaram and workers (1990) tested the hypoglycemic activity of water-soluble acidic fraction of the *Gymnema sylvestre* leaves in rats. The drug was tested in streptozotocin induced diabetic rats. It was concluded that *G. sylvestre* raises levels of insulin. Mechanism of action however remains unclear and gymnemic acid is an active constituent of *Gymnema sylvestre* [7].

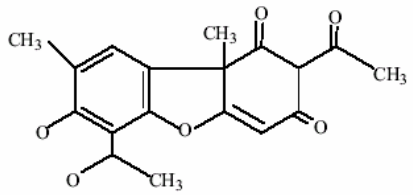
Study 2: Sugihara, Nojima, Matsuda, Murakami, Yoshikawa and Kimura (2000) investigated the antihyperglycemic action of a crude saponin fraction and five triterpene glycosides (gymnemic acids I-IV and gymnemasaponin V) derived from the methanol extract of leaves of *Gymnema sylvestre* in streptozotocin (STZ)-diabetic mice. The saponin fraction (60mg/kg) reduced blood glucose levels 24h after the intraperitoneal administration. Gymnemic acid IV, not the other 4 glycosides at doses of 3.4-13.4mg/kg reduced the blood glucose levels by 13.5-

60.0%, 6h after the administration comparable to the potency of glibenclamide, and did not change the blood glucose levels of normal mice. Gymnemic acid IV at 13.4 mg/kg increased plasma insulin levels in STZ-diabetic mice[8].

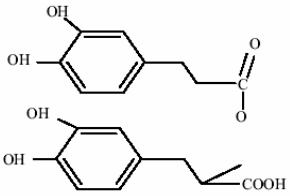
Parts used: Leaves.
Dose: Powder (3-6 G); decoction (50-100 ml).

***Ocimum sanctum Linn*. (Tulsi)**

Family: Labiatae
Common name: Sacred basil.
Habitat: India.
Botany: *Ocimum sanctum* is an upright, 30-60 cm tall plant covered with soft hairs. The stems are square in transection, and the leaves are opposite, elliptical-oblong with relatively long petioles and serrated leaf margins. The flowers appear in racemes arising in whorls on the terminal part of the stems and are labiate, bilaterally symmetrical and purplish in colour.
Chemistry: Volatile oil (containing eugenol and caryophyllene), triterpenoids (rosmarinic acid and ursolic acid), flavonoids and saponins.



Structure of Ursolic acid

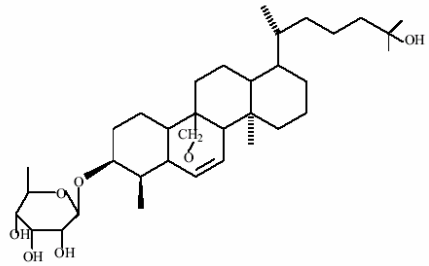


Structure of Rosmarinic acid

Study: Agrawal, Rai and Singh (1996) in a randomized, placebo-controlled, single-blind, crossover trial studied the effects of *Ocimum sanctum* (dried leaf 2.5 g daily) on fasting and postprandial blood glucose and serum cholesterol levels in patients diagnosed with non insulin-dependent diabetes mellitus.
Forty patients, twenty 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. Following a 5-day run-in period, subjects were randomized to take sacred basil or placebo for four weeks, 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 the authors conclude that *Ocimum sanctum* like Gymnema sylvestre raises levels of insulin [9].
Parts used: Leaves, Roots and seeds.
Dose: Expressed juice 10-20 ml; Decoction of the root (50-100 ml) and seed powder (3-6 G).

***Momordica charantia* (Karvellaka)**

Family: Cucurbitaceae.
Common name: Bitter gourd.
Habitat: *Momordica charantia* is cultivated throughout India.
Botany: Leaves palmately five lobed, sinuate, toothed and villous on the under surface. Fruit, spindle-shaped, 10-15 cms long, green when raw and reddish-yellow on ripening, ribbed with watery swelling, bitter when uncooked.
Chemistry: Alkaloid (Momordicine), ascorbic acid, glucoside, saponin and anthelmentic principle.



Structure of Momordicine

Study: Ahmed, Chandranath, Sharma, Adeghate, Pallot and Singh (1999) studied the mechanism of action of hypoglycemic activity of *Momordica charnatia* fruit juice in rats. Rats were rendered diabetic by single injection (60 mg/kg body weight^{-1}) of streptozocin. One week after injection, treated animals were fed with juice of *M. charantia* (10 ml kg^{-1}) daily for three months. The juice elicited a dose dependent decrease in glucose uptake and it attenuated the insulin induced increase in glucose uptake [10].
Parts used: Whole plant, fruit.
Preparation: Expressed juice.
Dose: 10-20 ml.

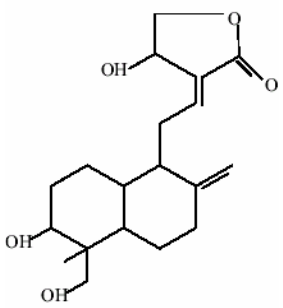
***Asphaltum punjabianum* (Shilajeet)**

Common name: Black bitumen or Mineral Pitch.
Charaka-Samhita has described medicinal uses of *Asphaltum punjabianum*. Sushrita-Samhita indicates the use of purified *Asphaltum punjabianum* in the treatment to diabetes mellitus. *Asphaltum punjabianum* is basically a natural exudate obtained from hilly areas. The exudate contains shilajit up to forty per cent rest being foreign matter.
Chemistry: Fulvic acid and hippuric acid.
Study: Trivedi, Saxena, Mazumdar, Bhatt and Hemavathi (2001) studied the effects of *Asphaltum punjabianum* on blood glucose, lipid profile and vascular preparation in alloxan induced diabetic rats. Diabetes was induced in albino rats by administration of alloxan 5 % (125mg/kg, i.p.). Effects of three different doses of *Asphaltum punjabianum* (50, 100 and 200 mg/kg, p.o., daily) were studied on fasting blood glucose and lipid profile at the end of the 4th week. All three doses of *Asphaltum punjabianum* not only reduced blood glucose level in dose dependent manner, but significant reduction in blood cholesterol and triglycerides was observed. *Asphaltum punjabianum* also prevented diabetes induced vascular dysfunction [11].

Triphala
Triphala is a combination of fruits of three plants; Harade (*Terminalia chebula*), Baheda (*Terminalia belerica*) and Amlaki (*Emblica officinalis*). The poly-herbal drug is a popular remedy for constipation.
Study: Ghosh, Uma, Thejomoorthy and Veluchamy (1990) studied the antidiabetic effect of Triphala in animal models in the dose of 90 mg/kg orally. Triphala was found to be non toxic even administered in high dose [12].

***Andrographis paniculata Nees.l* (Kalmegh)**

Family: Rutaceae.
Common name: Kalmegh.
Habitat: India.
Botany: Andrographis paniculata is an erect, annual herb. It sometimes assumes height of shrub also.
Chemistry: Diterpene lactones (andrographolide, kalmeghin and neoandrographolide).



Structure of Androgrpholide

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 [13].
Parts used: Whole plant.
Preparations: Liquid kalmegh extract.
Dose: Powder (1-3 G), expressed juice (5-10 ml); decoction (20-40 ml) and liquid kalmegh extract (1/2-1 ml).

***Aegle marmelos Corr. ex Roxb.* (Bilva)**

In Ayurveda, fresh leaves of *Aegle marmelos* are recommended on empty stomach for the treatment of diabetes mellitus.
Family: Rutaceae.
Common name: Wood apple.
Habitat: India.
Botany: Aegle marmelos is wild, spinose tree, leaves trifoliate; fruit shell 1-5 cms in diameters and is yellow in colour.
Chemistry: Tannins, active principle (marmelosin), alkaloids (aegelin and aegelinin) and coumarin (marmesin).
Study: Das, Padayatii and Paulose (1996) studied the hypoglycemic activity of leaf extract of *Aegle marmelos* in streptozocin induced diabetes. The extract significantly reversed altered parameters in tissues of the experimental rats. According to authors, the drug seems to repair the injured pancreas [14].
Parts used: Fruit and leaves.
Preparations: Roots, bark, leaves and fruit.
Dose: Powder (3-6 G), expressed juice (10-20 ml) and syrup (20-40 ml).

Conclusion: The medicinal plants find application in pharmaceutical, cosmetic, agricultural and food industry. The efficacy of some herbal products is beyond doubt, the most recent examples being *Silybum marianum* (silymarin), *Artemisia annua* (artemesinin) and *Taxus baccata* (taxol). The incidence of Diabetes mellitus is increasing and researchers are turning back to herbals for effective cures. History of *Vinca rosea* (Madagascar periwinkle) is with us as it was investigated for Anti-diabetic constituent, but it provided us with anticancer drugs like vincristine and vinblastine. The medicinal herbs described in the article have been validated in animal studies. Ancient knowledge coupled with scientific principles can come to the forefront and provide us with powerful remedies to provide potent remedies for diabetes mellitus.

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