

A Review on Medicinal Plants used in Diabetes in Uttar Pradesh

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ABSTRACT

Plants have always been a source of drugs for humans since time immemorial. The Indian traditional system of medicine is replete with the use of plants for the management of diabetic conditions. According to the World Health Organization, up to 90% of population in developing countries use plants and its products as traditional medicine for primary health care. There are about 800 plants which have been reported to show antidiabetic potential. The present review is aimed at providing in-depth information about the antidiabetic potential and bioactive compounds present in *Ficus religiosa*, *Pterocarpus marsupium*, *Gymnema sylvestre*, *Allium sativum*, *Eugenia jambolana*, *Momordica charantia*, and *Trigonella foenum-graecum*.

KEYWORDS: diabetes, medicinal, plants, Uttar Pradesh, traditional

INTRODUCTION

Diabetes is a chronic disorder of carbohydrate, fat and protein metabolism characterized by increased fasting and post prandial blood sugar levels. The global prevalence of diabetes is estimated to increase, from 4% in 1995 to 5.4%

by the year 2025. WHO has predicted that the major burden will occur in developing countries. Studies conducted in India in the last decade have highlighted that not only is the prevalence of diabetes high but also that it is increasing rapidly in the urban population [4]. It is estimated that there are approximately 33 million adults with diabetes in India. This number is likely to increase to 57.2 million by the year 2025.[1,2,3]

Diabetes mellitus is a complex metabolic disorder resulting from either insulin insufficiency or insulin dysfunction. Type I diabetes (insulin dependent) is caused due to insulin insufficiency because of lack of functional beta cells. Patients suffering from this are therefore totally dependent on exogenous source of insulin while patients suffering from Type II diabetes (insulin independent) are unable to respond to insulin and can be treated with dietary changes, exercise and medication. Type II diabetes is the more common form of diabetes constituting 90% of the diabetic population. Symptoms for both diabetic conditions may include: (i) high levels of sugar in the blood; (ii) unusual thirst; (iii) frequent urination; (iv) extreme hunger and loss of weight; (v) blurred vision; (vi) nausea and vomiting; (vii) extreme weakness and tiredness; (viii) irritability, mood changes etc.

Table 1 Indian medicinal plants used in Uttar Pradesh with antidiabetic and related beneficial properties

Plant Name	Ayurvedic/common name/herbal formulation	Antidiabetic and other beneficial effects in traditional medicine
<i>Annona squamosa</i>	Sugar apple	Hypoglycemic and antihyperglycemic activities of ethanolic leaf-extract, Increased plasma insulin level
<i>Artemisia pallens</i>	Davana	Hypoglycemic, increases peripheral glucose utilization or inhibits glucose reabsorption
<i>Areca catechu</i>	Supari	Hypoglycemic
<i>Beta vulgaris</i>	Chukkander	Increases glucose tolerance in OGTT
<i>Boerhavia diffusa</i>	punarnava	Increase in hexokinase activity, decrease in glucose-6-phosphatase and fructose bis-phosphatase activity, increase plasma insulin level, antioxidant
<i>Bombax ceiba</i>	Semul	Hypoglycemic
<i>Butea monosperma</i>	palasa	Antihyperglycemic
<i>Camellia sinensis</i>	Tea	Anti-hyperglycemic activity, antioxidant
<i>Capparis decidua</i>	Karir or Pinju	Hypoglycemic, antioxidant, hypolipidaemic
<i>Caesalpinia bonducella</i>	Sagarghota, Fevernut	Hypoglycemic, insulin secretagogue, hypolipidemic
<i>Coccinia indica</i>	Bimb or Kanturi	Hypoglycemic
<i>Emblica officinalis</i>	Amla, Dhatriphala, a constituent of herbal formulation, "Triphala"	Decreases lipid peroxidation, antioxidant, hypoglycemic
<i>Eugenia uniflora</i>	Pitanga	Hypoglycemic, inhibits lipase activity
<i>Enicostema littorale</i>	krimihrita	Increase hexokinase activity, Decrease glucose 6-phosphatase and fructose 1,6 bisphosphatase activity. Dose dependent hypoglycemic activity
<i>Ficus bengalensis</i>	Bur	Hypoglycemic, antioxidant
<i>Gymnema sylvestre</i>	Gudmar or Merasingi	Anti-hyperglycemic effect, hypolipidemic
<i>Hemidesmus indicus</i>	Anantamul	Anti snake venom activity, anti-inflammatory

<i>Hibiscus rosa-sinensis</i>	Gudhal or Jasson	Initiates insulin release from pancreatic beta cells
<i>Ipomoea batatas</i>	Sakkargand	Reduces insulin resistance
<i>Momordica cymbalaria</i>	Kadavanchi	Hypoglycemic, hypolipidemic
<i>Murraya koenigii</i>	Curry patta	Hypoglycemic, increases glycogenesis and decreases gluconeogenesis and glycogenolysis
<i>Musa sapientum</i>	Banana	Antihyperglycemic, antioxidant
<i>Phaseolus vulgaris</i>	Hulga, white kidney bean	Hypoglycemic, hypolipidemic, inhibit alpha amylase activity, antioxidant. Altered level of insulin receptor and GLUT-4 mRNA in skeletal muscle
<i>Punica granatum</i>	Anar	Antioxidant, anti-hyperglycemic effect
<i>Salacia reticulata</i>	Vairi	inhibitory activity against sucrase, α -glucosidase inhibitor
<i>Scoparia dulcis</i>	Sweet broomweed	Insulin-secretagogue activity, antihyperlipidemic, hypoglycemic, antioxidant
<i>Swertia chirayita</i>	Chirata	Stimulates insulin release from islets
<i>Syzygium alternifolium</i>	Shahajire	Hypoglycemic and antihyperglycemic
<i>Terminalia belerica</i>	Behada, a constituent of "Triphala"	Antibacterial, hypoglycemic
<i>Terminalia chebula</i>	Hirda	Antibacterial, hypoglycemic
<i>Tinospora crispa</i>		Anti-hyperglycemic, stimulates insulin release from islets
<i>Vinca rosea</i>	Sadabahar	Anti-hyperglycemic
<i>Withania somnifera</i>	Ashvagandha, winter cherry	Hypoglycemic, diuretic and hypocholesterolemic

DISCUSSION

The various medications in traditional form are taken in Uttar Pradesh to treat diabetes. The anti-hyperglycemic drug called metformin, currently used to treat diabetes, can be traced back to the traditional use of *Galega officinalis* to treat diabetes [26,27]. Most commonly used medicinal plants and vitamins with hypoglycemic activities to improve the immune system and manage blood sugar levels in humans include *Allium sativum* (garlic), *Momordica charantia* (Bitter Melon), *Hibiscus sabdariffa* L. (Roselle Plant), *Zingiber officinale* Rosc (Ginger), and Vitamins C, D, and E. *Allium sativum* is the scientific name for garlic, which is a plant species in the family of Amaryllidaceae. Garlic is known to have various health benefits such as lowering cholesterol, improving blood pressure, and boosting the immune system. Garlic has also been shown to have potential benefits for individuals with diabetes. Research has suggested that garlic may help lower blood sugar levels and improve insulin sensitivity, which can be beneficial for diabetes. *Momordica charantia*, known as bitter melon is used as a complementary or alternative therapy for the treatment of DM in both developing and wealthy countries. It contains compounds that are effective in regulating and lowering blood glucose levels in patients with DM. It regulates and lowers blood glucose in diabetes patients by improving insulin sensitivity and reducing glucose production in the liver. *Hibiscus sabdariffa* L. (roselle) is a plant belonging to the Malvaceae family, growing wild in tropical climates in many countries [4,5,6]. It has been used in traditional medicine for many years due to its high content of pharmacologically active compounds and good healing properties [4]. The most reported health-beneficial effects of *Hibiscus sabdariffa* L. (roselle) include its anti-hypertensive, anti-inflammatory, body fat mass reduction, immunomodulatory, hypoglycemic, antioxidant, lipid-lowering, anticancer, and anti-xerostomic effects [5]. *Zingiber officinale*, known as ginger, is a widely used flavor for various foods and drinks. It has been used as an herbal remedy to treat various ailments worldwide since ancient times. Phytochemicals analysis revealed that *Zingiber officinale* possesses phenolic compounds such as gingerols, shogaols, paradols, and non-volatile compounds, including zingiberone, zingiberole, and zingiberene. Ginger exerts its

mechanism of action by modulating insulin release, promoting glucose clearances in insulin-responsive peripheral tissues, which is crucial in maintaining blood glucose homeostasis [67]. Furthermore, it has been reported that 6-gingerol increases the glucose uptake at insulin-responsive adipocytes and shows that insulin-responsive glucose uptake has increased and improved diabetes in cells treated with gingerol [60]. A previous study indicated that the administration of 50% ethanolic extract of ginger rhizomes prevents the development of obesity and insulin resistance in rats inter alia by regulating the PPAR receptors [6]. Vitamin E is found mainly in plant-based oils (peanuts, olive, soybean oil), nuts (almonds), seeds (sunflower seeds), fruits (mango, red bell pepper), and vegetables (collard green, spinach, and beets green). It is a collective group of fat-soluble compounds with eight isoforms that can be categorized into tocopherol and tocotrienol isoforms. The tocopherol isoforms can be classified into alpha (α), beta (β), gamma (γ), and delta (δ) categories and have a saturated side and chain on the chromanol ring. Meanwhile, tocotrienol isoforms have an unsaturated side chain, and the two types can be further categorized into α , β , γ , and δ , and the α tocopherol best meets the dietary requirements of humans. Vitamin E is considered a powerful antioxidant that limits the production of ROS formed when fat undergoes oxidation and, therefore, helps prevent or slow chronic conditions associated with free radicals. Research has demonstrated that a high dose of vitamin E reduces oxidative stress biomarkers and increases immune defense. A randomized study in patients with diabetic nephropathy showed that supplementing 800 IU vitamin E for 12 weeks significantly increased the levels of glutathione peroxidase (GPx) compared to the placebo [88]. A similar prospective study on type 2 diabetics with or without complications supplementing 4000 IU of vitamin E along with hypoglycemic drugs daily for 9 months showed a gradual decrease in fasting blood sugar, serum glycosylated hemoglobin (HbA1C), and BMI compared to control [89]. In sum, the antioxidant properties of vitamin E have the potential to delay diabetic complications. Vitamin C, or ascorbic acid, is an antioxidant and plays several functions such as enzyme cofactors, radical scavengers, electron transport donors, or

receptors in the plasma membrane [90]. Deficiency of Vitamin C leads to defective formation of collagen, blood vessels, and connective tissue in the bone, dentine, cartilage, skin, and oxidative stress [7,8,9]. Oxidative stress often leads to glucose metabolism and hyperglycemia. Hyperglycemia promotes the oxidation of glucose to form free radicals. The free radical generation above the scavenging potential of endogenous antioxidants may result in macro- and microvascular dysfunction [7]. Vitamin C biomolecules can protect from oxidation by participating in oxidation-reduction reactions, in which dehydroascorbic acid will be oxidized and reduced back into ascorbate [8]. The main sources of Vitamin C are fresh fruits, vegetables, and aromatic herbs [9]. The vernacular names of fruits with high contents of Vitamin C include the Kakadu plum from Australia, camu-camu from South America, fruit star, guava, kiwi, strawberry, orange, lemon, and pear [10,11,12]. The cruciferous vegetables and aromatic herbs expressing elevated levels of Vitamin C include broccoli, kale, pepper, cabbage, parsley, chives, and coriander [10]. Temperature plays an important role in Vitamin C preservation and stability. The gentle way to preserve Vitamin C content, and avoid possible leaching out into water, degradation, and pH changes, is steaming or boiling in a small quantity of water for very short-time and deep freezing for long-term storage [11]. As many fruits and vegetables contain Vitamin C, a prospective cohort study of 23,953 men who were diabetic-free as a baseline discovered that 1741 men who developed type 2 diabetes increased their vegetable and fruit intake to 1.6 servings per week [12]

RESULTS

The varied plant medications in Uttar Pradesh used against diabetes are as follows: *Syzygium cumini*. Linn. (Myrtaceae) is a large evergreen tree attaining 30 m in height and found throughout India up to an altitude of 1800 m. The seeds are used in the Ayurveda and Unani systems of traditional medicine as an antidiabetic. The seed contains tannins (19%), ellagic acid, gallic acid (1-2%), a glycoside (jamboline), starch, and small quantity of essential oil (Anonymous, Citation1998). Seeds are also reported to contain corilagin, 3,6-hexahydroxydipenoylglucose, 1-galloylglucose, 3-galloylglucose, and quercetin (Rastogi & Mehrotra, Citation1991). Seed extracts showed hypoglycemic activity on oral administration to normal rabbits (Rastogi & Mehrotra, Citation1990). Seed extracts reduced tissue damage in diabetic rat brain on oral administration for 6 weeks (Prince et al., Citation2003). Water-soluble gummy fiber from seeds of *S. cumini*. skeels reduced blood glucose levels and improved oral glucose tolerance (Pandey & Khan, Citation2002).[13,14,15]

Gymnema sylvestre. (Retz.) Schult. (Asclepiadaceae) is a large woody climber running over the tops of high trees. It is distributed in Konkan, western ghats, and southern India. It is also found in Sri Lanka and tropical parts of Africa (Kirtikar & Basu, Citation2000a). The plant is used as bitter, and in eye complaints, biliousness, bronchitis, and asthma in the Indian traditional medicine (Ayurveda). The fresh leaves are chewed to reduce glycosuria (Kirtikar & Basu, Citation2000a). The leaves contain gymnemic acids III, IV, V, VIII, and IX. A hypoglycemic component conduritol A was isolated from the leaves (Rastogi & Mehrotra, Citation1995). New flavonol glycosides, namely kaempferol 3-*O*-. β -D-glucopyranosyl-(1,6)- β -D-galactopyranoside was isolated from aerial parts of *G. sylvestre*. (Liu et al., Citation2004). The

ethanol extract of leaves produced antimicrobial activity against *Bacillus pumilis*, *B. subtilis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. (Satdive et al., Citation2003). Extracts of *G. sylvestre*. leaves improved serum cholesterol and triglyceride levels in rats fed on high-fat diet (Shigematsu et al., Citation2001). Three new saponins isolated from ethanol extract of leaves were identified as 21 β -*O*-.benzoylsitakiosogenin 3-*O*-. β -D-glucopyranosyl (1 \rightarrow 3)- β -D-glucuronopyranoside (I), the potassium salt of longispinogenin 3-*O*-. β -D-glucopyranosyl (1 \rightarrow 3)- β -D-glucuronopyranoside (II), and the potassium salt of 29-hydroxylongispinogenin 3-*O*-. β -D-glucuronopyranosyl (1 \rightarrow 3)- β -D-glucuronopyranoside (III). The saponin I exhibited antisweet activity (Ye et al., Citation2001).

Portulaca olearacea. Linn. (Portulacaceae) is an annual succulent prostrate herb. It is distributed all over India and in the Himalayas up to an altitude of 1700 m. It grows in all warm countries. In Ayurveda, its leaves are used to treat tumors, inflammation, asthma, diarrhea, dysentery, and piles. In Unani medicine, it is used to allay thirst, headache, low fevers, stomatitis, piles, and burns (Kirtikar & Basu Citation2000b). The seeds contain noradrenaline, 4-(2-aminoethyl) pyrocatechol, 3-(3,4-dihydroxyphenyl) alanine, and catechol (Rastogi & Mehrotra, Citation1999). [16,17,18,19]

CONCLUSION

Based on the results drawn in this review the plants from Uttar Pradesh, *Urtica*, *Trigonella foenum-graecum*, *Allium sativum*, *Carthamus tinctorius*, *Ferula assa-foetida*, *Bauhinia*, *Gymnema sylvestre*, *Swertia*, *Combretum*, *Sarcopoterium*, *Liriope*, *Caesalpinia bonduc*, *Coccinia grandis*, *Syzygium cumini*, *Mangifera indica*, *Momordica charantia*, *Ocimum tenuiflorum*, *Pterocarpus*, *Tinospora cordifoli*, *Salvia officinalis*, *Panax*, *Cinnamomum verum*, *Abelmoschus moschatus*, *Vachellia nilotica*, *Achyranthes*, *Fabaceae*, *Mentha*, *Asphodelaceae*, *Andrographis paniculata* L, *Artemisia herba-alba*, *Artemisia dracunculul*, *Azadirachta indica*, *Caesalpinioideae*, *Pachira aquatic*, *Gongronema latifolium*, *Nigella Sativa*, *Tinospora cordifolia (guduchi)*, *Chrysanthemum morifolium*, *Zingiber zerumbet*, *Symphytum*, *Cactaceae*, *Symplocos*, *Perilla frutescens*, *Terminalia chebula* and *Aloe vera* are effective to control and treat diabetes.[20]

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