

Antidiabetic herbal plants: A review

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Abstract

Diabetes is a metabolic disorder where in human body does not produce or properly uses insulin, a hormone that is required to convert sugar, starches and other food into energy. Diabetes results in abnormal levels of glucose in the bloodstream. Herbal plants are very common in use in our day to day life. Either as a nutrient or as a source of food these herbs are being consumed by the patient as well as healthy person. Easy availability, raw consumption, least side effects and low cost makes the herbal preparations the king of all available therapies. Diabetes and herbs have got a long relation from the past. Thus, plants are a potential source of anti-diabetic drugs which can be proved by the ethnobotanical information reports about 800 plants that may possess anti-diabetic potential. Hyperglycemia-mediated oxidative stress plays a major role in the development of diabetic complications. Medicinal plants with their plant parts reported to possess antidiabetic activity. This study evaluated the beneficial effects over the diabetes mellitus.

Keywords: diabetes mellitus, herbal plant, insulin, ethnobotanical

Introduction

Diabetes mellitus is one of the common metabolic disorders acquiring around 2.8% of the world's population and is anticipated to cross 5.4% by the year 2025. Since long back herbal medicines have been the highly esteemed source of medicine therefore, they have become a growing part of modern, high-tech medicine. In view of the above aspects the present review provides profiles of plants with hypoglycemic properties available through literature source from various database with proper categorization according to the parts used, mode of reduction in blood glucose and active phytoconstituents having insulin mimetics activity. Management of diabetes without side effects remains a challenge. Many synthetic drugs are used in the treatment of diabetes; however, plant-based drugs are often considered less toxic and free of side effects. Indian traditional medicines belong to one of the richest medicinal systems in the world. Therefore, there is a need to search for phytoconstituents that normalize hyperglycemia and ameliorate oxidative stress for the prevention or minimization of diabetes-associated complications. In India, indigenous remedies have been used in the treatment of diabetes mellitus since the time of Charaka and Sushruta. Plants have always been an exemplary source of drugs and many of the currently available drugs have been derived directly or indirectly from them. The ethnobotanical information reports that about 800 plants may possess anti-diabetic potential. Several such herbs have shown anti-diabetic activity.

Plant Name: *Averrhoa bilimbi* ^[2]

Synonyms: Bilimbi, Cucumber tree, Tree sorrel.

Scientific name: *Averrhoa bilimbi*

Biological source: *Averrhoa bilimbi* is a fruit-bearing tree of the genus *Averrhoa*, family Oxalidaceae. It is a small tropical tree native to Malaysia and Indonesia, reaching up to 15m in height. It is often multitrunked, quickly dividing into ramifications. Possibly originated in Moluccas, Indonesia the species is now cultivated and found throughout Indonesia, the Philippines, Sri Lanka, Bangladesh, Maldives, Myanmar and Malaysia. It is also

common in other Southeast Asian countries. In India, where it is usually found in gardens, the bilimbi has gone wild in the warmest regions of the country. It is also seen in coastal regions of South India.

Plant Part: Fruit.

Morphology: Small purplish-red flowers borne in a pendulous panicle inflorescence, 5-petaled and fragrant, each inflorescence has about 60 flowers. Fruit is ellipsoid to obovoid in shape, turns from light green to yellowish-green when ripen, measuring about 4-10 cm long. Bilimbi leaves are alternate, pinnate, measuring approximately 30-60 cm in length. Each leaf contains 11-37 leaflets; ovate to oblong, 2-10 cm long and 1-2 cm wide and cluster at branch extremities. The leaves are quite similar to those of the Otaheite gooseberry. The tree is cauliflorous with 18-68 flowers in panicles that form on the trunk and other branches. The flowers are heterotristylous, borne in a pendulous panicle inflorescence. There flower is fragrant, corolla of 5 petals 10-30 mm long, yellowish green to reddish purple. The fruit is ellipsoidal, elongated, measuring about 4-10 cm and sometimes faintly 5-angled. The skin, smooth to slightly bumpy, thin and waxy turning from light green to yellowish-green when ripe.



Fig 1

Chemical Constituents: The chemical constituents of *Averrhoa bilimbi* include amino acids, citric acids, cyanidin-3-o-h-glucoside, phenolics, potassium ion and sugars. *Averrhoa bilimbi* is a nutrition-packed, starchy fruit that grows mostly on the trunk of tall trees. It is a rich source of vitamin C.

Uses: Antidiabetic. A leaf infusion is used as an after-birth tonic, while the flower infusion is used for thrush, cold, and cough. Malaysians use fermented or fresh bilimbi leaves to treat venereal diseases. In French Guiana, syrup made from the fruit is used to treat inflammatory conditions.

Plant Name: *Bixa Orellana* [3]

Synonym: Orellana, Annatto, Achiote, Lipstick tree

Scientific name: *Bixa orellana*

Biological Source: *Bixa orellana* is a shrub native to a region between northern South America and Mexico. It is grown in many countries worldwide. The tree is best known as the source of annatto, a natural orange-red condiment obtained from the waxy arils that cover its seeds belonging to family Bixaceae. *Bixa orellana* grows easily in subtropical to tropical climates, in frost-free regions sheltered from cool winds. It prefers year-round moisture, good drainage and moderately fertile soil in full sun or partial shade. It can be propagated from seed and cuttings. Cutting-grown plants flower at a younger age than seedlings.

Plant Part: Whole Plant

Morphology: *Bixa orellana* is a perennial, tall shrub that can reach 6–10 m (20–33 ft) high. It bears clusters of 5 cm (2 in) bright white or pink flowers, resembling single wild roses that appear at the tips of the branches. The fruits of the *Bixa orellana* are globular, ovoid capsules arranged in clusters resembling spiky looking red-brown seed pods covered in soft spines. Each capsule, or pod, contains 30–45 cone-shaped seeds covered in a thin waxy blood-red aril. When fully mature, the pod dries, hardens, and splits open, exposing the seeds. Flowers pedicelate terminal branched panicles with 8 to 50 flowered, fragrant, 4-6 cm across; pedicel scaly, thickened at the apex, bearing 5-6 large glands; having 4 to 5 free and obovate sepals, caduceus and covered with scales; petals are 4 to 7, obovate with scaly stalks; stamens infinite; 1.6 cm long pistil.



Fig 2

Chemical Constituents: 2-butanamine, acetic acid, pentanoic acid, phenol, pantolactone benzoic, bixin, 40 to 45% cellulose, 3.5 to 5.5% sugars, 0.3 to 0.9% essential oils, 3% fixed oils, 1.0 to 4.5% pigments, and 13 to 16 % proteins and *alpha* and *beta*-carotene, as well as tannins and saponins, methyl-6,8

diapocaroten-6-8dioate, 6-geranylgeranyl-6-methyl-(9Z)-6,6-diapocaroten-6-6-dioate and 6-geranylgeranyl-6-methyl-6-6-diapocaroten-6-6-dioate.

Uses: Antidiabetic. *Bixa orellana* plant was for body, face, and hair paint among various tribes and ancient civilizations either for decorative purposes or as omens to ward off evil spirits and illnesses. The tree has been used in Ayurveda, the folk medicine practices of India, where different parts of the plant are thought to be useful as therapy. The Annatto pulp and other parts that contain astringent properties are used to cure cases of dysentery, jaundice and other kidney diseases.

Plant Name: *Camellia sinensis* [5]

Synonym: Tea plant, Tea shrub and Tea tree.

Scientific name: *Camellia sinensis*

Biological Source: *Camellia sinensis* is a species of evergreen shrubs or small trees in the flowering plant family Theaceae. Leaves and leaf buds are used to produce tea. *C. sinensis* is mainly cultivated in tropical and subtropical climates in areas with at least 127 cm (50 in) of rainfall a year. Tea plants prefer a rich and moist growing location in full to part sun and can be grown in hardiness zones 7-9. However, the clonal one is commercially cultivated from the equator to as far north as Cornwall and Scotland on the UK mainland. Many high-quality teas are grown at high elevations, up to 1,500 m (4,900 ft) as the plants grow more slowly and acquire more flavor.

Plant Part: Leaves.

Morphology: The leaves are 4-15 cm (1.6-5.9 in) long and 2-5 cm (0.79-1.97 in) broad. Fresh leaves contain about 4% caffeine, as well as related compounds including theobromine. The young, light-green leaves are preferably harvested for tea production; they have short, white hairs on the underside. Older leaves are deeper green. 1-2 m tall with many virgate (straight or slender) stems arising from the base of the plant near the ground. Leaf is hard, thick and leathery; surface matt, marginal veins indistinct and appear sunken in lamina.



Fig 3

Chemical Constituents: Fresh green tea leaves contain five major catechins: catechin (C), (–)-epicatechin (EC), (–)-epicatechin 3-gallate (ECG), (–)-epigallocatechin (EGC) and (–)-epigallocatechin gallate (EGCG), caffeine and catechins, procyanidins, flavan-3-ols.

Uses: Antidiabetic, Effects on weight loss, stress and anxiety, boosting body's immune system, Anticancer effects, improve heart health, positive effects on skin health, Anti-inflammatory effect, improve bone health, improve liver health.

Plant Name: *Hibiscus rosa-sinensis* [6]

Synonym: Chinese hibiscus, China rose, Hawaiian hibiscus, rose mallow and shoeblack plant.

Scientific name: *Hibiscus rosa-sinensis*

Biological Source: *Hibiscus rosa-sinensis*, known colloquially as Chinese hibiscus, China rose, Hawaiian hibiscus, rose mallow and shoeblack plant is a species of tropical hibiscus, a flowering plant in the Hibisceae tribe of the family Malvaceae. It is widely cultivated in tropical and subtropical regions but is not known in the wild, so that its native distribution is uncertain. An origin in some part of tropical Asia is likely. It is widely grown as an ornamental plant in the tropics and subtropics.

Plant Part: Flower.

Morphology: *Hibiscus rosa-sinensis* is a bushy, evergreen shrub or small tree growing 2.5-5 m (8-16 ft) tall and 1.5-3 m (5-10 ft) wide with glossy leaves and solitary, brilliant red flowers in summer and autumn. The 5-petaled flowers are 10 cm (4 in) in diameter, with prominent orange-tipped red anthers. The flowers are large, conspicuous, trumpet-shaped, with five petals and their colors can be white to pink, red, orange, peach, and yellow or purple that are 4-18 cm broad. The flowers from various cultivars and hybrids can be either a single flower or a double flower. At the bottom of every hibiscus bud is the calyx which is green in color. The pointed ends of the calyx are the sepals. When the hibiscus begins to bloom, the petals begin to grow which contains multiple petals and multiple colors. The ovary and other female parts of the flower lie in the main structure of the hibiscus, the pistil, which is long and tubular. The hibiscus has both male and female parts on the same flower.



Fig 4

Chemical Constituents: The phytochemical analysis showed that *Hibiscus rosa-sinensis* contained tannins, anthraquinones, quinines, phenols, flavonoids, alkaloids, terpenoids, saponins, cardiac glycosides, protein, free amino acids, carbohydrates, reducing sugars, mucilage, essential oils and steroids.

Uses: Antidiabetic. *Hibiscus rosa-sinensis* is considered to have a number of medical uses in Chinese herbology. Traditional uses in China have been to make a black shoe-polish from its flower petals, or to make a woman's black hair dye. The flowers are also used in parts of China to color various intoxicating liquors. The plant may have some potential in cosmetic skin care; for example, an extract from the flowers of *Hibiscus rosa-sinensis* has been shown to function as an anti-solar agent by absorbing ultraviolet radiation.

Plant Name: *Ipomoea batata* [8]

Synonym: Sweet potato, Yam.

Scientific name: *Ipomoea batatas*

Biological Source: The sweet potato or sweet potato is a dicotyledonous plant that belongs to the bindweed or morning glory family is Convolvulaceae. Its large, starchy, sweet-tasting, tuberous roots are a root vegetable. The young shoots and leaves are sometimes eaten as greens.

Plant Part: Fruit.

Morphology: *Ipomoea batatas* is large, starchy, sweet tasting, tuberous roots are a root vegetable. The young shoots and leaves are sometimes eaten as greens. The sweet potato is distantly related to the common potato (*Solanum tuberosum*), both being in the order Solanales. The sweet potato, especially the orange variety, is often called a "yam" in parts of North America, but it is entirely unrelated to true yams. Cultivars of the sweet potato have been bred to bear tubers with flesh and skin of many colors, but white, yellow, and orange flesh is common with a darker skin.

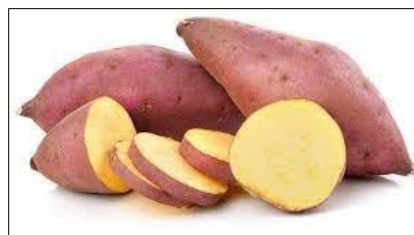


Fig 5

Chemical Constituents: Six compounds were isolated from 90% ethanol extract and identified as Tetracosane, Myristic acid, Beta-sitosterol, Beta-carotene, Daucosterol and Quercetin, Batatinoside I, Citrusin, Octadecyl caffeate, Beta-amyrin acetate, Caffeic acid, Scopoletin.

Uses: Antidiabetic. The juice of red sweet potatoes is combined with lime juice to make a dye for cloth. By varying the proportions of the juices, every shade from pink to black can be obtained. Purple sweet potato color is also used as a 'natural' food coloring. Cuttings of sweet potato vine, either edible or ornamental cultivars, will rapidly form roots in water and will grow in it, indefinitely, in good lighting with a steady supply of nutrients. For this reason, sweet potato vine is ideal for use in home aquariums, trailing out of the water with its roots submerged, as its rapid growth is fueled by toxic ammonia and nitrates, a waste product of aquatic life, which it removes from the water.

Plant Name: *Juniperus communis* [10]

Synonym: Juniper

Scientific name: *Juniperus communis*

Biological Source: *Juniperus communis* is a species of small tree or shrub in the genus *Juniperus* in the family Cupressaceae. This evergreen conifer has the largest geographical range of any woody plant, with a circumpolar distribution throughout the cool temperate Northern Hemisphere from the Arctic south in

mountains to around 30°N latitude in North America, Europe and Asia. Relict populations can be found in the Atlas Mountains of Africa.

Plant Part: Whole Plant

Morphology: *Juniperus communis* is very variable in form, ranging from 10 m (33 ft) rarely 16 m (52 ft) tall to a low, often prostrate spreading shrub in exposed locations. It has needle-like leaves in whorls of three; the leaves are green, with a single white stomatal band on the inner surface. It never attains adult foliage. It is dioecious, with male and female cones, which are wind pollinated, on separate plants. The fruit are berry-like cones, initially green, ripening in 18 months to purple-black with a blue waxy coating; they are spherical, 4-12 mm (0.16-0.47 in) diameter, and usually have three fleshy fused scales, each scale with a single seed. The seeds are dispersed when birds eat the cones, digesting the fleshy scales and passing the hard, unwinged seeds in their droppings.



Fig 6

Chemical Constituents: The main compounds in the *Juniperus communis* essential oil are δ -3-carene, α -pinene, β -pinene, sabinene, β -phellandrene, myrcene, limonene and d-germacrene.
Uses: Antidiabetic. These Plant have long been used as medicine by many cultures including the Navajo people. Western American tribes combined the berries of *Juniperus communis* with *Berberis* root bark in an herbal tea. Native Americans also used juniper berries as a female contraceptive. In Norway, the beer is brewed with juniper infusion instead of water, while in the other countries the juniper twigs are mainly used in the mash, as filters to prevent the crushed malts from clogging the outlet of the mashing tun. The use of juniper in farmhouse brewing has been common in much of northern Europe for a very long time.

Plant Name: *Olea europaea*^[11]

Synonym: Wild olive, Brown olive and Indian olive.

Scientific name: *Olea europaea*

Biological Source: The olive tree, *Olea europaea*, is an evergreen tree or shrub native to Mediterranean Europe, Asia, and Africa belonging to Family Oleaceae. It is short and squat, and rarely exceeds 8-15 m (26-49 ft) in height. *Olea europaea* contains a seed commonly referred to in American English as a "pit" and in British English as a "stone".

Plant Part: Leaves and Fruit.

Morphology: The small, white, feathery flowers, with ten-cleft calyx and corolla, two stamens and bifid stigma, are borne generally on the previous year's wood, in racemes springing from

the axils of the leaves. The fruit is small drupe 1-2.5 cm (0.39-0.98 in) long when ripe, thinner-fleshed and smaller in wild plants than in orchard cultivars. The leaves are shortly stalked, lanceolate, sometimes ovate, narrow, oblong, coriaceous, leathery, glabrous, attenuate, apex cuneate to acuminate, margin entire, pale green above with few scales, and silvery-whitish. The flowers are numerous, bisexual or functionally unisexual, small, subsessile, creamy white, and feathery bracted.



Fig 7

Chemical Constituents: Flavonoids, flavone glycosides, flavanones, iridoids, iridane glycosides, secoiridoids, secoiridoid glycosides, triterpenes, biophenols, benzoic acid derivatives, xylitol, sterols, isochromans, sugars, and a few other types of secondary metabolites from its different parts. Phenolic compounds, flavonoids, secoiridoids, and secoiridoid glycosides, β -amyrin, β -sitosterol, oleanolic acid, erythrodiol, betulinic acid, uvaol, ursolic acid and maslinic acid, oleuropein-3-methyl ether, ligstroside-3-O- β -D-glucopyranoside, jaspolyoside, jaspolyanoside and isojaspolyoside.

Uses: Diabetes, Diarrhea, respiratory and urinary tract infections, stomach and intestinal diseases, and as mouth cleanser. Continuous application of olive oil is also useful to prevent hair loss. The infusion prepared from olive leaves is taken orally as a hypotensive while it is administered through rectum for hemorrhoids, olive leaves are taken orally for stomach and intestinal diseases and their essential oil is used orally for constipation and liver pain. Dried leaves are taken orally to treat asthma, hypertension and to induce diuresis. Leaves of *O. europaea* are used in Tunisian folk medicine as a remedy for many inflammation types and bacterial infections such as gingivitis, otitis, icterus, and cough. Fruits and leaves of *O. europaea* are used to treat hemorrhoids and rheumatism, and as vasodilator in vascular disorders. Infusions of leaves are used as ointment to treat eye infections or as mouthwash to relieve sore throat.

Plant Name: *Momordica charantia*^[12]

Synonym: Bitter melon, Bitter apple, Bitter gourd, Bitter squash, Balsam-pear.

Scientific name: *Momordica charantia*

Biological Source: *Momordica charantia* is a tropical and subtropical vine of the family Cucurbitaceae, widely grown in Asia, Africa and the Caribbean for its edible fruit. Its many varieties differ substantially in the shape and bitterness of the fruit. Bitter melon is generally consumed cooked in the green or early yellowing stage. Bitter melon originated in Africa where it was a dry-season staple food of Kung hunter-gatherers. Wild or

semi-domesticated variants spread across Asia in prehistory, and it was likely fully domesticated in Southeast Asia. It is widely used in the cuisines of East Asia, South Asia, and Southeast Asia.

Plant Part: Fruit

Morphology: This herbaceous, tendril-bearing vine grows up to 5 m (16 ft) in length. It bears simple, alternate leaves 4-12 cm (1.6-4.7 in) across, with three to seven deeply separated lobes. The fruit has a distinct warty exterior and an oblong shape. It is hollow in cross-section, with a relatively thin layer of flesh surrounding a central seed cavity filled with large, flat seeds and pith.

The fruit is most often eaten green, or as it is beginning to turn yellow. At this stage, the fruit's flesh is crunchy and watery in texture, similar to cucumber, chayote or green bell pepper, but bitter. The skin is tender and edible. Seeds and pith appear white in unripe fruits; they are not intensely bitter and can be removed before cooking.



Fig 8

Chemical Constituents: Momordicolide(10E)-3-hydroxydodeca-10-en-9-olide, 1), monordicophenoide A, 4-hydroxybenzoic acid 4-O-beta-D-apiofuranosyl 2)-O-beta-D-glucopyranoside, dihydrophaseic acid 3-O-beta-D-glucopyranoside, 6,9-dihydroxy-megastigman-4,7-dien-3-one, blumenol, guanosine, adenosine, uracil and cytosine.

Uses: Antidiabetic. It has been used as a folk remedy for a variety of ailments, particularly stomach complaints. In traditional medicine of India, different parts of the plant are used as claimed treatments for diabetes and as a stomachic, laxative, antibilious, emetic, anthelmintic agent, for the treatment of cough, respiratory diseases, skin diseases, wounds, ulcer, gout, and rheumatism.

Result and Discussion

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. Different parts of the plant contain a profile of important phytochemical constituents that are mostly responsible for its biological action. Different parts of plants (leaf, seed, flower, bark, pod and root) are shows antidiabetic properties. Polar and non-polar solvents are used for extraction of various parts of plants. The result revealed that aqueous and ethanol extract of most of parts contain alkaloids, tannins, flavonoid, anthraquinone, cardiac glycoside, carbohydrate and saponin which were tested in this study. 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.

Conclusion

The current review discussed the chemical constituents, pharmacological effects and therapeutic importance promising medicinal plant with wide range of pharmacological activities which could be utilized in several medical applications because of its effectiveness and safety. Diabetes mellitus a metabolic syndrome characterized by defects in insulin action and insulin secretion is increased rapidly in developing countries like India. The disease related complications were increasing rapidly in spite of treatment with standard drugs. Plant medicines were traditionally used and they were less toxic with no side effects. The ability of the plant extracts was due to the capacity to restore the activity of pancreatic β -cells to secrete the insulin or decrease the intestinal absorption of glucose. Hence, it is required to isolate and characterize the plant mediated compound with novel mode of mechanism to control and manage diabetes as the disease possesses many challenges.

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