

REVIEW ARTICLE

A Review on Antidiabetic Medicinal Plants and Marketed Herbal Formulations

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ABSTRACT

Diabetes mellitus is a major problem of today's world and leading cause of death. The number of people suffering from diabetes is increasing due to population growth, aging, urbanization, and increasing prevalence of obesity and physical inactivity. Indians are genetically more susceptible to diabetes, for which World Health Organization predicts the number of diabetic persons in India may rise up to 74 million by 2025. The increasing worldwide incidence of diabetes mellitus in adults constitutes a global public health burden. It is predicted that by 2030, India, China and the United States will have largest number of people with diabetes. So the need arises to cure this disease with potent drug causing fewer side effects. The plant based medicinal system is very useful since a long time for treatment of diabetes. It is necessary to emphasize plant based study because allopathic system has more side effects; however they are potent antidiabetic agents. Many of the herbs are available having antidiabetic activity and shows their action by different mechanism like stimulating or regenerating the effect on β cell or extra pancreatic effect for hypoglycemic activity. The 60% of the patient uses traditional system of medicine in India for treatment of diabetes. This article presents a review on some reported antidiabetic medicinal plants (with their botanical name, common name, constituent and mechanism of action for antidiabetic action) and plant based marketed herbal formulations.

Key words: Diabetes, Antidiabetic herbs, Medicinal plants, Hypoglycemic medicinal plants.

INTRODUCTION

Diabetes mellitus (DM) is the most common endocrine disorder which currently affects more than 100 million people worldwide and the number of people with diabetes is increasing due to population growth, aging and increasing prevalence of obesity and physical inactivity^[1, 2]. India is the world's second most populous country, having more people with type 2 diabetes than in any other nation as the disease prevails in both genders and all age groups^[3,4]. According to recent estimates, approximately by the year 2030, 438 million people (7.8%) of the adult population, is expected to have diabetes^[5]. Some reasons like stress, rapid development of cities, substantial increase in purchase power, lifestyle ease and metro life have lead to health issues and higher number of people suffering from these diseases^[6]. The cost of treating diabetes and associated complications exceeds \$100 billion per year and complications are far less common and less severe in people who have well controlled blood sugar levels^[7]. The treatment of diabetes with synthetic

drugs is generally not preferred because of its high cost and side effects for this reason, it is necessary to develop traditional and alternative medicine. Herbal drugs constitute an important part of traditional medicine and literature shows that there are more than 400 plant species showing antidiabetic activity^[8]. In the present review, an attempt has been made to summarize the various medicinal plants having antidiabetic activity which can be beneficial for the mankind.

Various medicinal plants have been reported for their antidiabetic action which is categorized on the basis of plant's part as follows.

Leaves:

Aframomum melegueta

Crude leaf extract of *Aframomum melegueta* (Zingiberaceae) are used in West Africa, as an antidiabetic drug. The hypoglycaemic effects of crude leaf extract were evaluated on the alloxan induced diabetic male and non diabetic rats (control). Oral administration of leaf extract in dose of 50, 100 and 200 mg/kg significantly reduce blood glucose level^[9].

***Aloe barbidensis* (Southakathalai, Ghikanvar)**

Aloe vera (Liliaceae) is a cactus like plant with green dagger shaped leaves that are fleshy tapering, spiny and filled with clearly viscous gel. The aqueous extract of *Aloe vera* has the hypoglycemic property which was given orally at a dose of 150mg/kg of body weight. Whole study was performed on the alloxan induced male albino rats [10, 11].

Azadirachta indica

Azadirachta indica (Meliaceae) is an indigenous plant widely available in India and Burma. Effect of *Azadirachta indica* leaf extract on serotonin inhibition in glucose mediated insulin release in rat pancreas was studied in vitro to elucidate the possible mechanism of antihyperglycemic effect [12]. In another study it was shown that hydro alcoholic extracts of this plant has antihyperglycemic activity in streptozotocin treated rats and this effect is because of increase in glucose uptake and glycogen deposition in isolated rat hemidiaphragm. This plant also has anti-bacterial, antimalarials, antifertility, hepatoprotective and antioxidant effects [13].

***Aegle marmelos* (Bael leaves)**

Beal is the medium sized, armed, deciduous tree, belongs to the family Rutaceae. It showed the antidiabetic effect which was more effective along with the oral hypoglycemic therapy. Beal leaves can be combined in high dose with oral hypoglycemic agents to bring the blood glucose to normal levels in patients whose diabetes is not in control with these agents or in those patients in whom these drugs produce adverse effects on dose increments [14].

***Anacardium occidentale* (Cashew plant)**

Methanolic leaf extract of *Anacardium occidentale* (Anacardiaceae) was investigated in streptozotocin induced diabetic rats. Oral administration of methanolic extracts at doses of 35, 175 and 250 mg/kg significantly reduce blood glucose levels in diabetic rats. Hexane and ethyl acetate fractions showed the most prominent actions suggesting the presence of non polar and polar hypoglycemic compounds in the plant [15]. In another study it was investigated that methanolic stem bark extract of cashew plant shows antidiabetic activity in fructose-fed (diabetic) rats [16].

Basella rubra

Basella rubra (Basellaceae) is known as Malabar spinach or cyclone spinach. The leaf pulp has antihyperglycemic effect which was studied on STZ induced diabetic rats. It was found that after ingestion, fasting blood glucose levels were

remarkably reduced to normal and liver glycogen content was remarkably increased [17].

***Bougainvillea glabra* (B.G.)**

Bougainvillea glabra is also called Glorey of the garden which belongs to family Nyctaginaceae. It has originated from South America and is a popular plant in California and Florida. Aqueous and methanolic leaf extract has antidiabetic potential studied on alloxan induced diabetes mellitus in male albino rats. The phytochemical screening shows the presence of alkaloids, flavonoids, saponin, and cardiac glycoside. 100 mg/kg and 400 mg/kg extract of B.G. has significantly reduced the blood glucose level in diabetic animals [18].

Cajanus cajan

Cajanus cajan is commonly known as pigeon pea which belongs to family Fabaceae. Findings showed that methanolic leaves extract of *Cajanus cajan* has antidiabetic activity which was studied in alloxan induced diabetic and oral glucose loaded rats. It was investigated that the extract (400 and 600 mg/kg) significantly reduced fasting blood sugar of alloxan induced diabetic rats in a dose-related manner, with maximum hypoglycemic effect at 4-6 hr. The extract also significantly suppressed the peak postprandial rise in blood glucose of normal rats by 101.8 and 57.40% respectively [19].

Coccinia indica

Coccinia indica (Cucurbitaceae) is a creeper that grows wild and is found in abundance in Bengal. The plant has been used since ancient time for treating diabetes mellitus in the Indian system of medicine known as ayurveda. It was shown that oral administration of an aqueous suspension of ethanolic extract of leaves to 18 hr-fasted rats, lowered the blood glucose level of both normal and streptozotocin-diabetic rats and depressed the activity of the liver gluconeogenic enzyme glucose-6-phosphatase [20].

Cassia occidentalis

Cassia occidentalis (Caesalpinaceae) is extensively used in the indigenous and folklore medicine systems to treat several illnesses. Methanolic fraction of leaves was tested against streptozotocin induced diabetic rats. Treatment with this plant extracts at different doses and times following in normal and diabetic rats significantly reduced blood glucose level to normal in diabetic rats. Histopathological examination showed that methanolic extract protects the pancreatic tissue from STZ induced damage [21].

Camellia sinensis

Camellia sinensis or green tea belongs to family Theaceae. Tea is known in folk medicine as a medicinal plant that used as a hypotensive and antidiabetic. Its antidiabetic action is due to reduction of intestinal glucose absorption. The aqueous leaf extract (450 mg/kg) shows a strong glucose lowering effect after oral administration in alloxan induced diabetic rats. The fall of glycemia was approximately 30 % as compared to control [22].

***Gymnema sylvestre* (Gurmar)**

Gymnema sylvestre (Asclepiadaceae) is distributed throughout India. The leaves are known for its antidiabetic activity which is rich in phytochemicals such as alkaloids, flavonoids, saponins, carbohydrates, and phenols with highest concentration of saponins being 5.5%. It helps the pancreas with insulin production in type 2 diabetes and increases the sensitivity to insulin in type 1 diabetics. Reports showed the ability of gymnemic acids to delay the glucose absorption in the blood due to the atomic arrangement of gymnemic acid molecules which is similar to that of glucose molecules. These molecules fill the receptor locations on the taste buds thereby preventing its activation by sugar molecules present in the food, thereby curbing the sugar craving. Similarly Gymnemic acid molecules fill the receptor location in the absorptive external layers of the intestine thereby preventing the sugar molecules absorption by the intestine, which results in low blood sugar level [23, 24].

Justicia beddomei

Justicia beddomei is a shrub, grows in shadow and moist area which belongs to family Acanthaceae. The leaves of the plant are reported to be useful in the treatment of diabetes. The ethanolic extract of leaves (100 mg/kg) reduced the serum glucose level in alloxan induced diabetic rats after intraperitoneal administration (i.p) of the extract. Plant also has other effects like astringent, expectorant, anti-inflammatory, antispasmodic, antibacterial, diuretic, anthelmintic etc [25].

Morinda lucida

Methanolic extract and aqueous extract of *Morinda lucida* (Rubiaceae) has been found to have hypoglycemic activity in alloxan induced diabetic rats [26].

***Murraya koenigii* Leaves (Curry leaf tree, Metha neem)**

Murraya koenigii (Rutaceae) is an ingredient of Indian diet since several centuries. Daily oral administration of aqueous extract (600 mg/kg B.W.) and methanol extract (200 mg/kg B.W.) of

Murraya koenigii spreng leaves for a period of eight weeks lowers the blood glucose level and plasma insulin level in alloxan induced diabetic rats. In another study leaves showed hypoglycemic activity when given with different dose in normal and alloxan induced diabetic rats [27, 28].

Ossimum gratissium

The hypoglycemic effects of aqueous leaves extract of *Opium gratisimum* (Labiatae) was investigated in streptozotocin induced diabetic rats. The aqueous extract at the dose of 500 mg/kg significantly lowered blood glucose level of the diabetic rats by 81.3% after 24 hr of extract administration [29].

Peperomia pellucida

Antidiabetic activity of ethanolic extract of *Peperomia pellucida* (Piperaceae) was investigated in alloxan induced diabetic Albino male rats. The extracts were given in dose of 500 mg/kg BW and 1000 mg/kg BW. Ethanolic extract at dose 1000 mg/kg BW showed better antidiabetic activity than dose 500 mg/kg BW [30].

Vernonia amygdalina

The antidiabetic activity of *Vernonia amygdalina* (Asteraceae) has been investigated on postprandial blood glucose concentration of healthy human subjects. This investigation was compared with that of another indigenous vegetable which was identified to be taken by diabetic patients [31].

Bark:***Alstonia scholaris***

Aqueous extract of bark of *Alstonia scholaris* (Apocynaceae) has found to have antidiabetic and antihyperlipidemic activity in streptozotocin (STZ) induced diabetes in rats. Four week treatment with aqueous extract of bark (150 mg/kg and 300 mg/kg) significantly ameliorated the alterations in fasting blood glucose, serum triglyceride, serum cholesterol, liver glycogen, glycosylated hemoglobin and body weight in diabetic rats [32].

Bauchinia variagata

Ethanolic and aqueous leaves extracts of *Bauchinia variagata* (Caesalpiniaceae) have shown the hypoglycemic effect in normal and streptozotocin (STZ) induced diabetic rats. The extract with dose 200mg/kg shows significant reduction in Total cholesterol, LDL cholesterol, VLDL cholesterol and improvement in HDL cholesterol in diabetic rats [33].

Diospyros melanoxylon

The Ethanolic extract of *Diospyros melanoxylon* (Ebenaceae) bark was found to have antidiabetic activity in alloxan-induced diabetic rats. Unlike

antidiabetic activity it has other activities like acute oral toxicity studies and its effect on different biochemical parameters. It is also beneficial in hyperlipidemia [34].

Ficus racemosa

Ficus racemosa (Moraceae) is used in traditional system of medicine for the treatment of several disorders including diabetes mellitus. Ethanolic extract of bark showed antihyperglycemic and hypolipidemic activities in alloxan induced diabetic rats. The dose of 100-500 mg/kg of extract showed significantly lowered blood glucose level [35].

Adansonia digitata

Antidiabetic potential of methanolic stem bark extract of *Adansonia digitata* (Bombacaceae) was carried out in streptozotocin induced diabetic wistar rats. Dose of the plant extract was given as 100, 200 and 400 mg/kg intraperitoneally to the rats. Results shows that bark extract reduced the hyperglycemia with a great extent [36].

Azelia Africana

The antidiabetic properties of aqueous extract of stem bark of *Azelia africana* (leguminosae) and its beneficial effect on hematological parameters reported on streptozotocin induced diabetic rats. The extract was given at a dose of 200 mg/kg that significantly reduced blood glucose level. In addition of hyperglycemia, it also prevents various complication of diabetes [37].

Berberis aristata

Berberis aristata (Berberidaceae) is used in Indian traditional medicine for treating diabetes mellitus. Antidiabetic activity of methanolic extract of this plant has been observed in streptozotocin induced diabetes in adult male wistar rats. Unlike antidiabetic it is also used in antibacterial, antiperiodic, antiarrhoeal, ophthalmic, skin diseases etc [38].

Elaeodendron glaucum

Elaeodendron glaucum (Celastraceae) is a medium sized tree which is distributed throughout India, Australia America, South Africa & Tropical Asia. Methanolic extract of this plant shows antidiabetic activity in normal and alloxan induced Inbred adult male Charles-Foster (CF) albino rats [39].

Terminalia arjuna

Stem bark of *Terminalia arjuna* (Combretaceae) has the antidiabetic activity which was studied on alloxan induced diabetic rats. Ethanolic extract of bark was given at a dose of 250 and 500mg/kg which significantly decrease the blood glucose and decrease in the activities of glucose-6-phosphatase, fructose-1, 6-disphosphatase,

aldolase and an increase in the activity of phosphoglucoisomerase and hexokinase in tissues [40].

Ougeinia oojeinensis

Ougeinia oojeinensis (Leguminosae) bark has been found to have hypoglycemic and hypolipidemic property which was evaluated on alloxan induced diabetic rats. Bark extract was given orally at a dose of 200mg/kg for the hypoglycemic activity. Extract also reduce the elevated biochemical parameters like triglyceride, low density lipoprotein, total cholesterol etc [41].

Thespesia populnea

Thespesia populnea (Malvaceae) is a reputed ever green tree, commonly known as Indian tulip tree. The plant is distributed in tropical regions and coastal forest in India. The ethanolic extract of the plant bark and leaf shows hypoglycemic activity which was evaluated against the streptozotocin (STZ) induced diabetic rats and compared it with standard drug glibenclamide. It was supposed that free radical generation is inhibited by the extract [42].

Root:

Ipomoia digitata

The antidiabetic effect of various fractions of *Ipomoia digitata* was studied on alloxan induced diabetic rats. Extract was used in the dose of 100 mg/kg, medium dose 200 mg/kg, high dose 400 mg/kg of body weight. Glibenclamide (10mg/kg body weight) was used as a standard reference [43].

Tectona grandis

Methanolic extract of *Tectona grandis* (Verbenaceae) roots has antidiabetic activity which was performed on alloxan induced diabetic albino rats. Its hypoglycemic action was compared with glibenclamide and hypoglycemic activity has been reported at the dose of 500mg/kg [44].

Pseudarthria viscida

Ethanolic extract of the roots of *Pseudarthria viscida* (Fabaceae) was evaluated for anti diabetic activity against alloxan induced diabetes in albino rats. The ethanolic extracts showed significant activity as compare to standard glibenclamide [45].

Nyctanthes arbortristis

Methanol extract of root of *Nyctanthes arbortristis* (Oleaceae) possess safe and strong antidiabetic activity which was investigated in alloxan induced diabetic rat. The antidiabetic activity was compared with the standard drug as glibenclamide. It was found that the methanolic extract at 500 mg/kg dose level exhibited significant hypoglycemic activity [46].

Bauhinia tomentosa

The ethanolic extract of the roots of *Bauhinia tomentosa* (Fabaceae) has been found to have antidiabetic potential. It was checked by glucose tolerance test in normal rats and alloxan induced diabetic rat. Extract was administered daily for 14 days at doses of 250 and 500 mg/kg. i.p. Both of doses extract showed significant antidiabetic activity and was compared with glibenclamide (10 mg/kg)^[47].

Ginseng

Ginseng (Araliaceae) is a well known medicinal plant used in traditional oriental medicine. In recent decades, Ginseng root has gained popularity as a dietary supplement in the United States. It has also been commonly used in medicine to treat diabetes like conditions. The mechanism behind this action is reported as Ginseng increased insulin release from pancreatic β -cells, which is probably caused by increased β -cell stimulation and increased insulin synthesis^[48].

Anthocephalus indicus

It has been reported that root extract of *Anthocephalus indicus* (Rubiaceae) has hypoglycemic, lipid lowering and antioxidant activities in alloxan induced diabetic rats. Oral administration of ethanol extract of root (500mg/kg body weight) for 21 days significantly decreased the levels of blood glucose, triglycerides, total cholesterol, phospholipids and free fatty acids^[49].

Ceiba pentandra

Hypoglycemic effect of the root and bark extract of *Ceiba pentandra* (Bombacaceae) has been reported in normal and streptozotocin induced diabetic rats. Doses were selected as 40,75,150 and 300 mg/kg of the extract in fasted normal and diabetic groups. It was reported that the dose at lower level produce hypoglycemic effect rather than with the high dose^[50].

Annona squamosa

The aqueous extract of roots of *Annona squamosa* (Annonaceae) at a dose of 250 mg/kg and 500 mg/kg body weight respectively was reported for antidiabetic activity in Streptozotocin (STZ) induced hyperglycemic rats. It reduces the blood glucose level and effects were compared with the glibenclamide^[51].

Calotropis procera

The root extracts of *Calotropis procera* (Apocynaceae) were investigated for its anti-diabetic effect in streptozotocin induced diabetic male wistar albino rats. The different extracts like

ether, methanolic and aqueous extracts of roots were tested for antidiabetic activity on rats^[52].

Seed:***Abrus precatorius***

The antidiabetic effect of chloroform methanol extract of *Abrus precatorious* (Leguminosae) seed was studied in alloxan induced diabetic rabbits. Its antidiabetic property was found to be similar to that of chlpropamide^[53].

***Eugenia jambolana* (EJ)**

Ethanolic extract of dried seed of *Eugenia jambolana* (Myrtaceae) has been reported to have antidiabetic effects on streptozotocin induced diabetes. Extract was given orally in the doses of 100–400 mg/kg and it showed dose dependent decrease in blood glucose level in diabetic rats. Apart from hypoglycemic effect, seed has been reported to have anti-inflammatory, neuropsychopharmacological, antibacterial, anti-HIV and anti-diarrhoeal effects^[54].

Caesalpinia bonducella

Caesalpinia bonducella belongs to family Caesalpiniaceae commonly known as Nata Karanja. The aqueous and ethanolic extracts of the seeds of this plant significantly lowered the blood sugar level in streptozotocin (65 mg/kg b.w. /i.p. in citrate buffer) and alloxan (150 mg/kg b.w. /i.p. in normal saline) induced diabetic rat's models^[55].

Brassica juncea

Brassica juncea is a traditional medicinal plant which belongs to family Cruciferae. Its aqueous seed extract has a potent hypoglycemic activity which was investigated in STZ induced diabetic male albino rat. Doses which have hypoglycemic activity was reported as 250, 350, 450 mg/kg^[56].

Fruit:***Carica papaya***

Hypoglycemic activity was seen in aqueous seed extract of *Carica papaya* (Caricaceae) in normal male wistar rats. It was found that crude extract significantly and progressively lowered fasting blood sugar (FBS), triglyceride (TG), total cholesterol (TC), LDL-c, and VLDL-c dose-dependently. In addition to hypoglycemic effect it also has cardio protective and hypolipidemic^[57].

Opuntia dillenii

Opuntia dillenii (Cactaceae) is a Haw fruit which has been used in folk medicine as an antidiabetic agent in STZ induced diabetic rats. It is a rich source of fiber, carbohydrates, and vitamins B1, B2 and C, in addition to the minerals. Oral administration of *O. dillenii* juice to diabetic rats reduced blood glucose level and MDA levels. It

may also improve the insulin receptors of β -cells [58].

Phyllanthus emblica

Phyllanthus emblica (Euphorbiaceae), commonly known as Amla is widely distributed in Asia and Africa. The aqueous fruit extract of *Phyllanthus emblica* showed effect on type-II diabetes, triglycerides (TG) and liver specific enzyme, alanine transaminase (ALT). It was shown that aqueous fruit extract in a dose of 200mg/kg body weight, significantly decreased the blood glucose level after it's intraperitoneally administration in alloxan induced diabetic rats. The aqueous extract also induced hypotriglyceridemia by decreasing TG levels in diabetic rats. In addition, the extract was also found to improve liver function by normalizing the activity of liver specific enzyme alanine transaminase (ALT) [59].

***Syzygium cumini* (SC)**

Syzygium cumini (Myrtaceae) has been widely used as a traditional system of medicine to treat diabetes in India. Seed extract of SC has shown the antidiabetic activity against streptozotocin (STZ) induced diabetic rats. The compound 'Mycaminose' and ethyl acetate and methanol extract was found to reduce the blood glucose level [60].

Blighia sapadia

The fruit of *Blighia sapida* (Sapindaceae) have been shown to induce hypoglycemia in rabbits, monkeys, rats and mice upon intravenous venous injection. The two chemical compounds as hypoglycin A and hypoglycin B among which A is more potent than compound B. It was found that hypoglycin A is effective by mouth in rats. The blood sugar of alloxanized rats also falls after intake of hypoglycin A [61].

Lycium barbarum

Fruit of *Lycium barbarum* of family Solanaceae is well known in traditional Chinese herbal medicine and now a days has been widely used as a popular functional food, with a large variety of beneficial effects, such as reducing blood glucose and serum lipids, anti-aging, immuno-modulating, anticancer, anti-fatigue, and male fertility-facilitating. The hypoglycemic effects of *Lycium barbarum* fruit, crude polysaccharide extracts and purified polysaccharide fractions was investigated in alloxan induced diabetic rabbits through designed sequential trials and by measuring blood glucose level [62].

Whole Plant /Bulb/ Aerial Part:

Catharanthus roseus

Catharanthus roseus belongs to family Apocynaceae which is known with various names

in India and all over the world. Dichloromethane: methanol extract (1:1) of leaves and twigs shows hypoglycemic effect on streptozotocin (STZ) induced diabetic rats. The dose of this extract (500 mg/kg) was given orally to the animal for its hypoglycemic activity. Enzymic activities of glycogen synthase, glucose 6-phosphate-dehydrogenase, succinate dehydrogenase and malate dehydrogenase were decreased in liver of diabetic animals in comparison to normal [63].

Allium cepa

Allium cepa belongs to family Liliaceae and probably native of South West Asia which is widely cultivated throughout the world. It is commonly known as onion, pyaz etc. It is an herbaceous biennial plant having an edible bulb. Bulb or whole plant is used for its therapeutic effect. Its ethenolic extract show hypoglycemic effect which was carried on alloxan induced male albino rats. The most effective percentage reduction in blood glucose level, total serum lipids and cholesterol is observed at 300 mg/kg [64].

Abutilon indicum

It is also called Indian mallow which belongs to family Malvaceae. It is an Asian phytomedicine traditionally used to treat several disorders, including diabetes mellitus. The aqueous extract of entire plant has been used to treat STZ induced diabetes in rats. The mechanism behind this is that it regulates the adipocyte differentiation through PPAR γ agonist activity and increasing glucose utilization via GLUT1. It was reported to be beneficial in reducing the insulin resistance [65].

Allium sativum

Allium sativum commonly known as garlic is a species of the onion, family Liliaceae. Hypoglycemic study was performed on the STZ induced diabetic rats. Simple garlic extract and ethanolic extract shows significantly antidiabetic activity. Raw garlic possesses a beneficial potential in reversing proteinuria in addition to reducing blood sugar, cholesterol and triglycerides in diabetic rats [66]. In another study petroleum ether, ethyl acetate, chloroform portion of methanolic extract was also reported to show anti hyperglycemic effect on alloxan induced diabetic rats [67].

Olea europea

Olea europea belongs to family Oleaceae which is a small evergreen tree from 12 to 20 feet high, with hoary, rigid branches, and a grayish bark. *Olea europea* is traditionally used in Indian system of medicine for the treatment of diabetes beside the diabetes extract of *Olea europea* was used in the treatment, migraine, insomnia,

diarrhea, dysentery, fever, piles and fistula. Its aqueous/ethanolic extract has been reported for the treatment of hyperglycemia in alloxan (150mg/kg) treated wister strain of rats [68].

Phyllanthus niruri

Methanol extract (ME) of aerial parts of *Phyllanthus niruri* (Euphorbiaceae) has antidiabetic activity. It was evaluated in normal and alloxan diabetic rats. It is shown that ME significantly reduced the fasting blood sugar in a dose-related manner and suppressed the postprandial rise in blood glucose after a heavy glucose meal in normoglycaemic rats. Chronic oral administration of ME caused a significant dose related reduction in blood glucose levels as well as total cholesterol and triglycerides levels in diabetic and normoglycaemic rats [69].

Salacia oblonga

Salacia oblonga belongs to family Celastraceae having antidiabetic activity, investigated on the L6.C11 rat skeletal muscle myoblast cell culture. Plant extract are mediated not only by inhibiting intestinal α glycosidases but also by enhancing glucose transport in muscle and adipose cells. Extract increased 2-deoxy-D-glucose uptake by 50% in myotubes and adipocytes. Extract and mangiferin (bioactive compound) may exert their antidiabetic effect by increasing GLUT4 expression and translocation in muscle cells. These effects are probably mediated through two independent pathways that are related to 50-AMP-activated protein kinase and PPAR- γ [70].

***Solanum nigrum* (Makoi)**

Solanum nigrum (Solanaceae) is also a medicinal plant. Crude ethanolic extract has shown the antidiabetic potential on blood sugar of albino rat after daily oral administration of dose at the level of 250mg/kg body weight for five and seven days

respectively. It was noticed that the chronic administration for longer duration leads to significant decrease in blood sugar compared to control. Unlike antidiabetic action it is also used for the treatment of cough, cold, asthma, skin disease and liver problem [71].

Lawsonia inermis

Lawsonia inermis (Henna) is a flowering plant of family Lythraceae. Hypoglycemic and antihyperlipidemic activity of ethanolic extract of henna was investigated in streptozotocin induced diabetic rats. Dose selected for extract is 150, 300 and 500 mg/kg of body weight which were given orally. Dose of 500mg/kg was found to be better than glibenclamide (10 mg/kg of body weight) [72].

Fruit Juice:

***Momordica charantia* (Bitter Gourd, Karela)**

Momordica charantia belongs to the family Cucurbitaceae. Plant is widely cultivated in many tropical and subtropical regions of the world and frequently used in South Asia. Extracts from various components of this plant have been reported to possess hypoglycaemic activity on streptozotocin (STZ) induced diabetic rats. It was suggest that oral feeding of fruit juice may have a role in the renewal of β cell in STZ diabetic rats or alternately may permit the recovery of partially destroyed β cell [73].

Ganoderma lucidum

Anti diabetic and some haematological effects of Ethylacetate and n-Butanol fractions of *Ganoderma lucidum* (Ganodermataceae) aqueous extract has been reported in alloxan-induced diabetic wistar rats. A dose of 50 mg/kg of Ethylacetate and n-Butanol fraction of G. lucidum aqueous extract was given intraperitoneally for its activity [74].

Table 1: Marketed herbal Antidiabetic products

SN	Product	Manufacturer	Mechanism	Ref.
1	Sharang Dyab-Tea (Fig. 1)	Plant Med. Lab Pvt. Ltd	Stimulate insulin production	[75]
2	Herbal hills jambu (Fig.2)	Isha Agro Developers	Reduce blood and urine sugar level	[76]
3	Stevia-33 (Fig.3)	Vitalize Herbs Pvt. Ltd.	Stimulate β cells of pancreas	[77]
4	Diab-FIT (Fig. 4)	Herbal FIT	Maintain proper blood sugar level	[78]
5	Madhumar capsule (Fig. 5)	Kangrd Hills Care & Cure Products	Control chronic diabetes mellitus	[79]
6	Daya Stone Powder (Fig. 6)	Jignesh and Co.	Lower the blood glucose level and tone up β Cells of	[80]

7	Diabetone Tablet (Fig. 7)	Shelter Pharma Ltd.	Pancreas Reduce blood glucose [81] level by neutralizing the level of pituitary secretion	
8	Kumari-SAAR (Fig. 8)	Krishna herbal company	Maintain diabetic [82] complication	
9	Spenai (Fig. 9)	Shriji Herbal Products	Antidiabetic [83]	
10	Blue berry (Fig. 10)	Al-Hikma FZCO	Antidiabetic [84]	
11	Episulin (Fig. 11)	Varuna Biocell Pvt. Ltd.	Antidiabetic [85]	



Fig 1: Sharang Dyab-Tea



Fig 2: Herbal Hills Jambu



Fig 3: Stevia-33



Fig 4: Diab-FIT



Fig 5: Madhumar Capsule



Fig 6: Daya Stone powder



Fig 7: Diabetone Tablet



Fig 8: Kumari-SAAR



Fig 9: Spenai

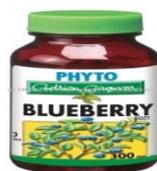


Fig 10: Blue berry



Fig 11: Episulin

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