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Review Article

Traditional Medicinal Plants Used for the Treatment of Diabetes

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Abstract

This review focuses on Indian Herbal drugs and plants used in the treatment of diabetes, especially in India. Diabetes is an important human ailment afflicting many from various walks of life in different countries. In India it is proving to be a major health problem, especially in the urban areas. Though there are various approaches to reduce the ill effects of diabetes and its secondary complications, herbal formulations are preferred due to lesser side effects and low cost. These are the some herbal drug used in the treatment of diabetes mellitus are *Emblica officinalis*, Gaertn Garlic (*Allium sativum*), Ginger (*Zingiber officinale*), *Tinospora cordifolia*, banana flower, *Abroma Augusta*, *Butea monosperma*, *Catharanthus roseus*, Allium Cepa (onion), *Azadirachta indica*, Mangifera Indica (Mango), *Aegle Marmelos* (bel), *Caesalpinia bonducella, Eugenia jambolana, Abelmoschus esculentus, Curcuma longa, Coriandrum Sativum, Berberis aristata, Helicteres isora* roots, Murrayc koenigii, Momordica charantia etc.

1. INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder resulting from a defect in insulin secretion, insulin action, or both. Insulin deficiency in turn leads to chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism[1].

Diabetes mellitus may be categorized into several types but the two major types are type 1 and type 2. On the basis of aetiology, the term type 1 and type 2 were widely used to describe IDDM (insulin dependent diabetes mellitus) and NIDDM (Non insulin dependent diabetes mellitus) , respectively; other specific types of diabetes and gestational diabetes are given in the term juvenile -onset diabetes has sometimes been used for IDDM and maturity-onset for NIDDM[2].

1.1 Definition According to WHO

The term diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both. The effects of diabetes mellitus include long–term damage, dysfunction and failure of various organs. Diabetes mellitus may present with characteristic symptoms such as thirst, polyuria, blurring of vision, and weight loss[3].

1.2 Classification of Diabetes

Type 1 (IDDM) insulin dependent diabetes mellitus: ß-cell destruction with little or no endogenous insulin secretory capacity Autoimmune Idiopathic.[1]

Type 2 (NIDDM**)** Non insulin dependent diabetes mellitus ranges from relative insulin deficiency to disorders of insulin secretion and insulin resistance[1].

Type 3 (Gestational Diabetes): Mellitus refers to the onset or initial recognition of glucose intolerance during pregnancy, usually in the second or third trimester. It occurs in about 4% of all pregnancies. Patients with GD have a 30% to 50% chance of developing DM, usually type 2 DM[1].

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2. EPIDEMIOLOGY OF DIABETES

According to recent estimates, approximately 285 million people worldwide (6.6%) in the 20–79 year age group will have diabetes in 2010 and by 2030, 438 million people (7.8%) of the adult population, is expected to have diabetes. The largest increases will take place in the regions dominated by developing economies. [4]

The WHO reports suggests that the prevalence of diabetes in adults worldwide would increase to 300 million in years 2025. It is the one of the main threats to human health in the 21st century and is the fifth leading cause of deaths in most developed countries. There are an estimated 86 million person with diabetes in Asia out of which around 25-30 millions are in India. High prevalence is increasing all over the world. By the 2025, more than 75% of individuals with diabetes will reside in developing countries[5].

3. SOME MEDICINAL PLANT USED TO TREAT DIABETES MELLITUS

3.1 *Emblica officinalis* Gaertn

Commonly known as amla or Indian gooseberry is known for its medicinal and therapeutic properties from ancient time in India and considered as a wonder fruit for health conscious population. It is extensively found throughout India and some other Asian countries[6].

3.1.1. Chemical Constituents

Tannins 30%, phyllembin (2.4%), phyllemblic acid (6.3%), gallic acid (1.32%), ellagic acid in natural form and cytokine like substances identified as Zeatin, Z riboside, Z nucleotide etc[7].

2.1.2. Mechanism of Action

Amla contains highest amount of Vitamin C (ascorbic acid), low and high molecular weight tannins 30%, phyllembin (2.4%), phyllemblic acid (6.3%), gallic acid (1.32%), ellagic acid in natural form and

cytokine like substances identified as Zeatin, Z riboside, Z nucleotide. Amla fruit ash contains chromium, 2.5; zinc, 4; and copper, 3 ppm. Presence of chromium is of therapeutic value in diabetes[8]. The fruit contains 482.14 units of superoxide dismutase/g fresh weight, and exhibited anti senescent activity. Chromium, a trace element possesses significant anti diabetic activity in various experimental models of diabetic mellitus. Chromium compounds also improved deranged lipid metabolism of both type 1 and type 2 diabetic rats. It has been reported that insulin derived with chromium is capable of reversing blood sugar, serum cholesterol and phospholipids levels to those of normal rats[6].

3.1.3 Uses
The fruits are sour, astringent, bitter, acrid, sweet, cooling, anodyne, ophthalmic, carminative, digestive, stomachic, laxative, alterant, aphrodisiac, rejuvenative, diuretic, antipyretic and tonic. They are useful in vitiated conditions of tridosha, diabetes, cough, asthma, bronchitis,[7] cephalalgia, ophthalmopathy, dyspepsia, colic, flatulence, hyperacidity, peptic ulcer, erysipelas, skin diseases, leprosy, haematogenesis, inflammations, anemia, emaciation, hepatopathy, jaundice, strangury, diarrhoea, dysentery, hemorrhages, leucorrhoea, menorrhagia, cardiac disorders, intermittent fevers and grayness of hair [8].

3.2 Garlic (*Allium sativum*)
Garlic (Allium sativum) is one of the most popular herbs Used worldwide to reduce various risk factors associated with cardiovascular diseases[9].

3.2.1 Chemical constituents
Sulphur-containing compounds (e.g. S-allylcysteine sulphoxide) etc[10].

3.2.2 Mechanism of Action
Most of the studies showed that garlic can reduce blood glucose levels in diabetic mice, rats and rabbits.9 Augusti and Sheela consistently showed that S-allyl cysteine sulphoxide, (allicin), a sulphur-containing amino acid in garlic (200 mg/kg body weight), had a potential to reduce the diabetic condition in rats almost to the same extent as did glibenclamide and insulin[9].

3.2.3 Uses
Anticoagulant (anti-thrombotic), antioxidant, antibiotic, hypocholesterolaemic, hypoglycemic, as well as hypertensive activity[9, 10].

3.3 Ginger (*Zingiber officinale*)
The *Zingiber officinale* is a hypoglycemic drug that has less or no side effects at all. Ginger exhibits hypoglycemic activity in both normal and diabetic rats. They further reported that ginger contains magnesium, calcium and phosphorus which play important roles in bone formation, curbing muscle spasm, depression, hypertension, convulsion, nausea, gastrointestinal disorders, paralysis, kidney damage and several other bio-functions necessary for keeping body in homeostatic condition .[11]

3.3.1 Chemical Constituents
6-Gingerol, tannins, polyphenolic compounds, flavonoids and triterpenoids etc[11, 12].

3.3.2 Mechanism of Action
It has been demonstrated that flavonoid compound act against diabetes mellitus either through their capacity to avoid glucose absorption or improve glucose tolerance. In vitro studies have shown that a soyabean extract containing the isoflavones genistein daidzein inhibits glucose absorption into the intestinal brush border membrane vesicles of rat or mice. So it has demonstrated that flavonoids can act per as insulin secretagogues or insulin mimetics[12].

3.3.3 Uses
Ginger contains magnesium, calcium and phosphorus which play important roles in bone formation, curbing muscle spasm, depression, hypertension, convulsion, nausea, gastrointestinal disorders, paralysis, kidney damage and several other bio-functions necessary for keeping body in homeostatic condition [11,12].

3.4 *Tinospora cordifolia* (TC)
Tinospora cordifolia (wild) Miers Ex Hook F. and Thoms.TC belong to the family Menispermaceae and is known as Gulancha in English, Guduchi in Sanskrit ,and Giloya in hindi[13].

3.4.1 Chemical Constituents
Flavonoids, tannins etc[13].

3.4.2 Mechanism of Action
Mechanism of action of *Tinospora cardifolia* is same as mentioned under 3.3.2.

3.4.3 Uses
As tonic and vitalizer and as remedy for diabetes and other metabolic disorder[12,13].

3.5 Banana Flower (*Musa sapientum*)
Commonly known as 'banana' is widely used in Indian folk medicine for the treatment of diabetes mellitus. The available literature confirms that flavonoids are present in banana flowers. The chloroform, water and ethanol extract of Musa sapientum flowers were found to exhibit hypoglycemic activity in alloxan diabetic rat[14].

3.5.1 Chemical Constituents
Bio flavonoids (e.g. epicatechin and gallocatechin), are present in banana flower etc[15].

3.5.2 Mechanism of Action
The chloroform, water and ethanol extract of Musa sapientum flowers were found to exhibit hypoglycemic activity in alloxan diabetic rat intraperitoneal administration of prunin produces a significant hypoglycemic effect in diabetic rats. Bio-flavonoids are well-known for their multi-directional biological activities including anti-diabetic efficacy[14].

3.5.3 Use:
As an anti diabetes agent and as insulin secretagogues, insulin mimetics[14,15].

3.6 *Augusta abroma*
Abrinoma Augusta have hypoglycemic effect on alloxan induced diabetic rats.Syzygium cumi have alpha glycosidase inhibitory activity .In folk medicine Syzygium cumini were used in treating diabetes diarrhoea and ringworm And the leaves of Syzygium cumini are antibacterial and are used for strengthening the teeth and gums[16].

3.6.1 Chemical Constituents
Syzygium cumini is the active constituents in abroma augusta etc[17].

3.6.2 Mechanism of Action
Syzygium cumini have alpha glycosidase inhibitory activity. In folk medicine *Syzygium cumini* were used in treating diabetes diarrhea and ringworm And the leaves of *Syzygium cumini* are antibacterial and are used for strengthening the teeth and gums[17].

3.6.3 Use
Treating diabetes, diarrhea, ringworm, antibacterial and used as strengthening the teeth and gums[16,17].

3.7 *Butea monosperma*
Butea monosperma belongs to family Fabaceae. In English name is bastard teak. Its vernacular name is parasa and it is commonly known as palaspara[18].

3.7.1 Chemical Constituents
Butrin, butein, 7 trihydroxy flavones, palasonin etc[18,19].

3.7.2 Mechanism of Action
Because the presence of butrin, butein,7 trihydroxy flavones butea monosperma shown antidiabetic activity[19].

3.7.3 Use
It is use as antidiabetic agent[20].

3.*8 Catharanthus roseus*
There are a number of plants to control the blood glucose level one of them is Nayantara (*Catharanthus roseus*) [21].

3.8.1 Chemical Constituents
Catharanthin, catharanthus, catharin etc[21,22].

3.8.2 Mechanism of Action
Due to the presence of cataranthin or catharin it show anti diabetes activity because catharathin reduse blood glucose level in the albino wister rat and swiss albino mice[22].

3.8.3 Use:
It is use as an anti-diarrheal, anti-diabetes agent[21].

3.9 *Allium Cepa* (Onion)
Allium cepa belongs to the family Liliaceae and is probably native of south west Asia and is widely cultivated throughout the world, [24]. Allium cepa (onion) dried powder shown anti hyperglycemic activity in diabetic rat. *Allium cepa* is also know to have antioxidant and hypolipidaemic activity[23].

3.9.1 Chemical Constituents
Sulfar containing amino acid s methyl cysteine sulphoxide etc. [23, 24]

3.9.2 Mechanism of Action
Due to the presence of sulfar containing amino acid s methyl cysteine sulphoxide it control blood glucose as well as lipids in serum and tissues and normalized the activity of liver hexokinase glucose6 phosphate[24].

3.9.3 Use
It is use as anti diabetic, antioxidant, hypolipidaemic. Modern uses is to lower Blood pressure, antiseptic, hypoglycaemic and hypocholesterlemic properties[23, 24].

3.10 *Azadirachta indica* (Neem)
Hydro alcoholic extracts of this plant showed anti-hyperglycemic activity[25].

3.10.1 Chemical Constituents
Azadiracthin is the main active chemical constituents in the neem due to the presence of azadiracthin[25,26].

3.10.2 Mechanism of Action
Hydroalcoholic extracts of this plant showed anti-hyperglycemic activity in streptozotocin treated rats and this effect is because of increase in glucose uptake and glycogen deposition in isolated rat hemidiaphragm.[26]

Use
Anti-bacterial, antimalarial, antifertility, hepatoprotective and antioxidant, anti diabetes[26].

3.11 *Mangifera Indica* (Mango)
The leaves of this plant are used as an antidiabetic agent in Nigerian folk medicine, although when aqueous extract given orally did not alter blood glucose level in either normoglycemic or streptozotocin induced diabetic rats[27, 28].

3.11.1 Chemical Constituents
Mangiferin, mangifera etc[27].

3.11.2 Mechanism of Action
Anti diabetic activity was seen when the extract and glucose were administered simultaneously and also when the extract was given to the rats 60 min before the glucose. The results indicate that aqueous extract of Mangifera indicia possess hypoglycemic activity[28].

3.11.3 Use
Anti-diabetic agent[27].

3.12 *Aegle Marmelos* (Bel)
Administration of aqueous extract of aegle marmelos (bel) leaves improves digestion and reduces blood sugar and urea, serum cholesterol in alloxanized rats as compared to control.[29]

3.12.1 Chemical Constituents
Flavonoids, tannins etc[30].

3.12.2 Mechanism of Action
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 1h in oral glucose tolerance test[29,30].

3.12.3 Use
As anti-oxidant and anti-diabetic agent[30].

3.13 *Caesalpinia bonducella*
Caesalpinia bonducella is widely distributed throughout the coastal region of India and used e thnically 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. Two fractions BM 169 and BM 170 B could increase secretion of insulin from isolated islets.[31]

3.13.1 Chemical Constituents
Flavonoids, is the active chemical constituents in the *Caesalpinia bonducella* etc[31,32].

3.13.2 Mechanism of Action
Due to the presence of flavonoid it shown anti diabetes activity by decresing glucose absorption[32].

3.13.3 Use
Antidiabetic as well as antihyperlipidemic[31].

3.14 *Eugenia jambolana* (Indian gooseberry jamun)
In India decoction of kernels of *Eugenia jambolana* is used as household remedy for diabetes. This also forms a major constituent of many herbal formulations for diabetes[33].

3.14.1Chemical Constituents
Tri-terpenoids, tannins, gallic acid, and oxalic acid were the chemical constituents detected in Eugenia jambolana seed etc[34].

3.14.2 Mechanism of Action
In India decoction of kernels of Eugenia jambolana is used as household remedy for diabetes. This also forms a major constituent of many herbal formulations for diabetes. Antihyperglycemic effect of aqueous and alcoholic extract as well as lyophilized powder shows reduction in blood glucose level. The extract of jamun pulp showed the hypoglycemic activity in streptozotocin induced diabetic mice within 30 min of administration while the seed of the same fruit required 24 h. The oral administration of the extract resulted in increase in serum insulin levels in diabetic rats.[33,34]

3.13.3 Use
These extracts also inhibited insulinase activity from liver and kidney[33].

3.15 *Abelmoschus esculentus*
Abelmoschus esculentus Linn. is a plant of family Mallow (Malvaceae). It is Naturalized in all tropical countries and grown abundantly throughout India. The plant prefers acid, neutral and basic (alkaline) soils and can grow in very alkaline soil. Stem is erect, aerial, herbaceous or woody, usually solid, cylindrical and branched. Herbaceous portion of stem is covered with scaly hairs, woody part is fibrous. Leaves are Alternate and stipulate and its fruit is loculicidal Capsule[35].

3.15.1 Chemical Constituents
Carbohydrate, gums and mucilages, proteins, phytosterols, flavonoids, tannins, phenolic compounds and volatile oil etc[36].

3.15.2 Mechanism of Action
Due to the presence of flavonoids and phenolic compound it show anti diabetes activity by lowering blood glucose level[35,36].

3.15.3 Uses
Used traditionally as emollient, demulcent, diuretic, cooling, aphrodisiac, Antiseptic and in gonorrhea[37].

3.16 *Curcuma longa*
Curcumin (diferuloylmethane) is a naturally occurring yellow pigment isolated from the rhizomes of the plant Curcuma longa (Linn) found in south Asia and is a potent antioxidant agent and free radical scavenger[38].

3.16.1 Chemical Constituents
Curcumin, bio flavonoid etc[38].

3.16.2 Mechanism of Action
Due to the presence of curcumin and flavonoid it show anti diabetes activity by lowering the blood glucose level[39].

3.16.3 Use
As anti-diabetic and antioxidants[38,39].

3.17 *Coriandrum Sativum*
Coriander is an important culinary herb. The fruits and the fresh leaves are widely used for flavouring food and the root can be cooked and eaten as a vegetable[40].

3.17.1 Chemical constituents:
Coriander, sataverin, tannins, flavonoid etc[41].

3.17.2 Mechanism of Action
The present study was designed to investigate clinically the hypoglycemic effect of Coriandrum sativum in Type-2 diabetes mellitus[40]. After assaying fasting plasma and urinary glucose, 10 patients of type-2 diabetes mellitus with no previous medication, 10 patients of type-2 diabetes mellitus taking oral hypoglycemic agents with history of inadequate control and six control subjects were given low (2.5 g tid) and high (4.5 g tid) doses of powdered part, aqueous extract and alcoholic extract of Coriandrum sativum for 14 days. On 15th day blood and urine samples for glucose were taken. Based on results obtained it was found that Coriandrum sativum has significant hypoglycemic activity in high dose and can be successfully combined with oral hypoglycemic agents in type-2 Diabetic patients whose diabetes is not controlled by these agents[41].

3.17.3 Use
As anti-diabetic agent[40].

3.18. *Berberis aristata*
Berberis aristata DC, known as 'Daruharidra' in Ayurvedic system of medicine, is extensively used in various systems of indigenous medicine for treating a variety of ailments such as eye and ear diseases, rheumatism, jaundice, diabetes, stomach disorders, skin disease, malarial fever and as tonic etc[42].

3.18.1 Chemical Constituents
Berberine, berbamine, aromoline, karachine, palmatine, oxyacanthine and oxyberberine etc[43].

3.18.2 Mechanism of Action
Due to the presence of berberine and aromoline it show anti-diabetic activity[42].

3.18.3 Use
AS an antioxidant and anti-diabetic agent[42,43].

3.19. *Helicteres isora* root
The root of *helicteres isora* root used in the treatment of diabetes aqueous ethanol and butanol extracts had shown significant protection and lowered the blood glucose levels[44].

3.19.1 Chemical Constituents
Tannins, flavonoid, helicterin etc[45].

3.19.2 Mechanism of Action
It has been demonstrated that flavonoid compound act against diabetes mellitus either through their capacity to avoid glucose absorption or improve glucose tolerance. [13]

3.19.3 Use
Used in the treatment of type2 diabetes.[46]

3.20. *Murraya koenigii*
Leaves of *Murraya koenigii* (Rutaceae) are used traditionally in Indian Ayurvedic system to treat diabetes. The purpose of the study is to investigate the effect of mahanimbine carbazole alkaloid from Murraya koenigii leaves on blood glucose and serum lipid profiles on streptozotocin-induced diabetic rats.[47]

3.20.1 Chemical Constituents
Mahanimbine, flavonoid, alkaloids[48,49].

3.20.2 Use
Used as anti-diabetic agent[48].

3.21 *Momordica charantia*
M. Charantia bitter Mellon, Better gourd is a flowering vine in the family of cucurbitaceae[50]. It is tropical plant that is widely cultivated in asia in India east Africa and south America. Used for the treatment of diabetes and used in cooking[51].

3.21.1. Chemical Constituents
Saponins, glycosides, alkaloids, reducing sugar resins, fixed oil. [52]

3.21.2. Uses
Antidiabetic, anticancer, anti inflammation, antivirus, antioxidants and cholesterol lowering effect.[53]

4. CONCLUSION
The present study revealed that the administration of these plants *Emblica officinalis, Gaertn Garlic (Allium sativum), Ginger (Zingiber officinale), Tinospora cordifolia, banana flower, Abroma Augusta, Butea monosperma, Catharanthus roseus, Allium Cepa (onion), Azadirachta indica, Mangifera Indica (Mango), Aegle Marmelos (bel), Caesalpinia bonducella, Eugenia jambolana ,Abelmoschus esculentus,Curcuma longa, Coriandrum Sativum, Berberis aristata ,Helicteres isora roots, Murrayc koenigii, Momordica charantia etc*. Extract showed antidiabetes effects in alloxan and streptozotocin (stz) induced diabetes rats, therefore it was concluded that these plant extract is helpful to lower glucose level in treatment of diabetes patients.

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