



## Review Article

# Diabetes Mellitus Treatment Using Herbal Drugs

Sonia Verma<sup>1</sup>, Madhu Gupta<sup>1</sup>, Harvinder Popli<sup>1</sup> and Geeta Aggarwal<sup>1\*</sup>**Abstract**

Diabetes mellitus is becoming a common metabolic disorder which has serious threat to public health in the world. There are chemicals and biochemical agent that helps in controlling diabetes but there is no permanent remedy available which helps to get recovered completely from this disorder. By conducting large number of research work, numerous traditional medicines have been found for diabetes. Substances and extracts isolated from different natural resources especially plants have always been a rich arsenal for controlling and treating diabetes problem and complication arising due to it. So this review helps the reader to understand the importance of various types of herbal and poly herbal formulations present traditionally which can be used to treat diabetes mellitus.

**Keywords:** Diabetes mellitus; Herbal drugs; extract; traditional medicine; polyherbal

## Introduction

Diabetes mellitus is a non-infectious endocrine disorder which is characterized by the disturbance in metabolism of carbohydrate and associated with hypoglycemia [1] [2]. It is linked with developing of various serious diseases like micro vascular (nephropathy, retinopathy, nephropathy) and macro vascular (peripheral vascular disease and coronary heart diseases) [3]. Diabetes mellitus also known as diabetes which was observed as diseases related with “sweet urine” and muscle loss. Glucose blood levels are maintained by insulin which is a hormone released from the pancreas. When these level increases, insulin is produced from the pancreas and maintained the level of glucose. In diabetic patients, the production of insulin is absent or less which causes hyperglycemia [4]. Diabetes mellitus are three types Type 1, Type 2 and gestational diabetes mellitus. Type 1 Diabetes mellitus is known as insulin dependent diabetes mellitus which is due to total loss of function of  $\beta$  cell of islets of

Langerhans which are present in pancreas. Type 2 Diabetes mellitus is known as insulin non dependent diabetes mellitus which is temporary loss of  $\beta$  cell mass and it is due to genetic predisposition and mostly occur in obese persons and associated with high blood pressure and high cholesterol levels. The aim of treatment of type 2 diabetes mellitus is decreases the insulin resistance and increases insulin secretion. Gestational diabetes is a type of diabetes which present with hyperglycemia in pregnant women. It usually appears in 2-4% pregnancies in 2<sup>nd</sup> or 3<sup>rd</sup> trimester [5]. The symptoms of diabetes mellitus are polydipsia, polyuria, polyphagia, fatigue, nausea, vomiting, impotence in men, slow healing wound and blurred vision [6].

According to International Diabetes Federation (IDF) survey in 2016 diabetes is a disorder which affects 415 million people in the world and it may increase to 642 million by the year 2040 [7]. According to Aroma world reports 61.3 million people have diabetes in INDIA and consist of 20-79 age group in the population. It may approx. doubled by the year 2030. INDIA is also known as diabetes capital of the world and affects mainly rural and urban people [8]. The frequency of diabetes is progressively increases in urban India. The frequency of diabetes in urban area

Correspondence: [geetaaggarwal17@gmail.com](mailto:geetaaggarwal17@gmail.com)

<sup>1</sup>Delhi Pharmaceutical Science and Research University, Pushp Vihar, Sector-3 MB Road, New Delhi, New Delhi, India

Full list of author information is available at the end of the article.

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is approx. 6 times more than compared to rural population. Decreased exercise, increasing weight and tension, change in diet, malnutrition, alcohol consumption, viral infection are the major causes of diabetes mellitus in last 20 years [1, 9]. Female diabetic patients are more than compared to male diabetic patients because hormone and inflammation act differently in women. The people who are less educated have diabetes disorder more than compared to more educated people [10]. The utmost percentages of people having diabetes are lives in developing countries [11].

### Diagnosis of diabetes mellitus

The diabetes can be measured by analyzing the blood sugar levels. The blood sugar level in healthy man on fasting are 80 mg/dl and in postprandial state is up to 160 mg/dl. Different test for diagnosed of diabetes in laboratory are finger prick blood sugar test, fasting blood sugar, glucose tolerance diagnostic test, glycohemoglobin [6].

### Pathophysiology of diabetes mellitus

The main role in pathophysiology of diabetes is oxidative stress. The imbalance between production of reactive oxygen species (ROS) and capacity of enzymatic or non enzymatic antioxidant are known as oxidative stress. Reactive oxygen species contains free radicals such as super oxide, hydroxyl, peroxy, hydroperoxy and non radical species such as hydrogen peroxide. Antioxidant contains super oxide dismutase, glutathione reductase, vitamins A, C and E, carotenoid, glutathione and trace elements. Low density lipoprotein cholesterol are oxidized in the presence of reactive oxygen species which taken up by hunter receptor in scavenger cell and cause formation of foam cells and arterial sclerosis plaques. These ROS can Stimulate various damaging pathway which have important role in growth of diabetes disease. Some important pathways are glucosamine pathway, sorbitol aldose reductase pathway, electron transport chain, protein kinase C stimulation. Stimulation of these pathways and mode of action can lead to atherosclerosis, programmed cell death, lipid per oxidation, advanced glycation end product (Ages) formation, amylin and failure of pancreatic  $\beta$  cell function. It is proven that sequence specific DNA binding factor (nuclear factor erythroid derived 2 like 2) along with their negative regulator ( kelch like ECH associated protein 1) have important cell protection mode of action against oxidative stress [12].

### Antidiabetic drugs

Diabetes mellitus disease can be prevented by regulating the blood sugar level with various types of medicines, acquiring

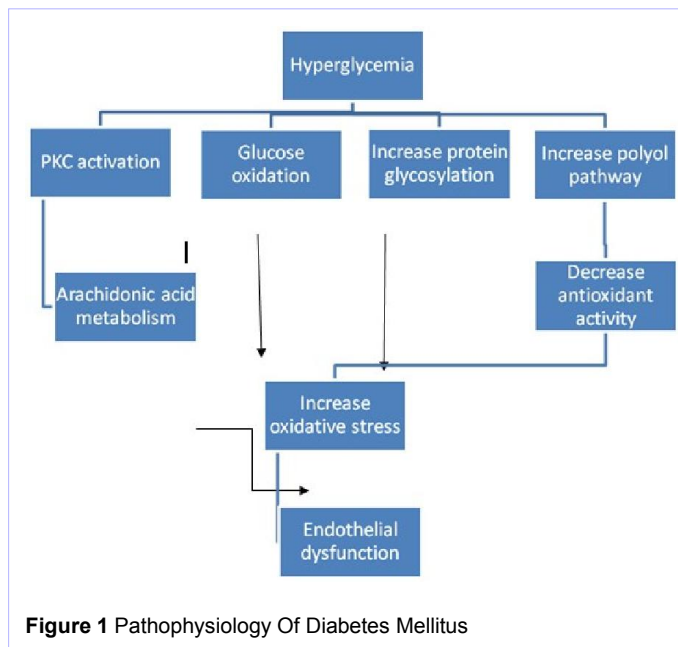


Figure 1 Pathophysiology Of Diabetes Mellitus

to different exercise or yoga therapy or diet plan [9]. Currently available therapies of diabetes mellitus are insulin treatment for type 1 diabetes mellitus and other oral hypoglycemic drugs such as sulphonylureas, thiazolidinediones, peptide analogs for treatment of type 2 diabetes mellitus [4] [13].

### Herbal Remedy

Treatment of Diabetes mellitus without any adverse effects is still the biggest question to medical practioners. According to world ethanobotanical 800 medicinal plants are used for the prevention of diabetes mellitus. Clinically proven that only 450 medicinal plants possess anti diabetic properties from which 109 medicinal plants have complete mode of action. In ancient time doctor and lay person used traditional medicinal plants with their active constituents and properties for the treatment of various diseases such as heart diseases, cancer and diabetes. There is a long history of traditional plants used for the control of diabetes in India and China. There are various books available such as Charaka Samhita and Susruta Samhita which explains phytopharmacology features of diabetes and its adverse effect [14]. Synthetic drugs which are used for treatment of diabetes are associated with various adverse effect such as sickness, vomiting, dysentery, alcohol flush, migraine, swelling, malignant anemia and faintness. Herbal drugs are proved to be a better choice over synthetic drugs because of less side effects and adverse effects. Herbal formulations are easily available without prescription. These herbal drugs are used for life threatening disease. These drugs are also used when chemical drugs are ineffective in treatment of disease. These are natural and safe drugs i.e. there is

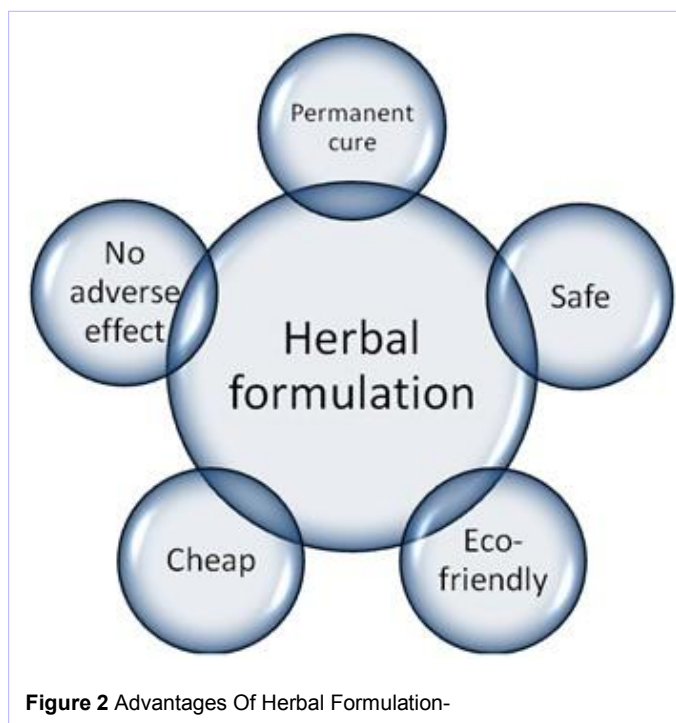
**Table 1** Antidiabetic drugs (5,14,16)

S.no.	Category	Name of Drugs	Brand Name	Mode of action
1	Insulin Rapid acting insulin  Intermediate acting Insulin  Long acting Insulin	Regular Insulin, Insulin glulisine, Isophane Insulin Neutual protamine Hagedorn Extended insulin zinc insulin	Humulin R Apidra Humulin N Novolin N Ultralente	Decrease glucose production and Increase peripheral glucose uptake.
2	Alpha glycosidase inhibitors	Acarbose Miglitol	Precose Glyset	Decrease glucose absorption from intestine.
3	Biguanides	Metformin, Phenformin	Glucophage DBI	Decrease insulin resistance.
4	Meglitinide	Repaglinide Nateglinide	Prandin Starlix	Insulin secretagogues.
5	Sulfonylurea First generation agents  Second generation agent	Tolbutamide Chlorpropamide Glipizide Glimepiride	Orinase Diabinese Glucotrol Amaryl	Block the ATP sensitive potassium channels.
6	Thiazolidinediones	Rosiglitazone Pioglitazone	Avandia Actos	Increases the insulin sensitivity.
7	Peptide analogs Injectable incretin mimetics Glucagon like peptide -1 (GLP-1) Gastric inhibitory peptide analogs Injectable Amylin analogues	Exenatide Sitagliptin Saxagliptin linagliptin Pramlintide	Byetta Januvia Onglyza Tradjenta Symlin	Increase incretin levels which inhibit glucagon release and increases insulin secretion.
8	Glycosurics	Canagliflozin	Sulisent, Invokana	Inhibit reabsorption of glucose in the kidney and lower blood sugar level.

no toxic effects. Herbal drugs permanently cure person and treat the disease while synthetic drugs are not permanently cured the diseases. Herbal formulations contain natural herbs and fruits and vegetables extract which are beneficial in treatment of various diseases without any adverse effects. On the other hand chemical drugs are prepared synthetically and have side effect also. Herbal formulations are cheap as compared to all opathic medicines. Herbal formulations are Eco friendly. Herbal formulations are produced from natural products while all opathic medicines are produced from chemical and chemically modified natural products. Herbal formulations are available without prescription while all opathic medicines are available with prescription [15] [16].

**Traditional herbal Anti diabetic drugs**

Currently the medicinal plants and herbs are being used in extract forms for their anti diabetic activity. Various clinical studies confirmed that medicinal plants extracts shows anti diabetic activity and restoring the action of pancreatic  $\beta$ - cells[17].



**Figure 2** Advantages Of Herbal Formulation-

### ***Allium sativum***

It is locally name as garlic belongs to Liliaceae, a family of *Allium sativum* [18]. Ethanolic extract of garlic (10 ml/kg/day) frequently shows hypoglycemic activity [2]. Extract of garlic was more efficient than anti diabetic drug glibenclamide [19]. Ethyl acetate, ethanol and petroleum ether extract was observed to show an anti diabetic activity in STZ induced rats. Garlic shows various therapeutic effect such as anti platelet, antibacterial, lowering the blood pressure and lowering the cholesterol level in the body [20].

### ***Aloe borbadensis***

It is known as Ghikanvar which belongs to Liliaceae family. It looks like a cactus plant with green blade shaped leaves that are heavy narrowing, hairy and filled with clear viscid gel. Oral administration of aqueous extract of aloe Vera in a dose of 150mg/kg of body weight significantly lowering the blood glucose level [18]. Aloe Vera gel consist various therapeutic effects such as anti diabetic, antioxidant, increases the decrease level of glutathione by four times in diabetic rats [4].

### ***Azadirachta indica***

It is locally name as neem which belongs to family Meliaceae. It is available in India and Burma [18]. Ethanolic and aqueous extract of *Azadirachta indica* shows reduction in blood glucose level in high dose. It can be combined with allopathic drugs in type 2 diabetic patients whose diabetes is not maintained by allopathic drugs only [2]. Worldwide large numbers of patients are treated by natural neem tablets. Its extract improves the blood circulation by enlarging the blood vessels and useful in reducing the blood glucose level in the body [21].

### ***Brassica juncea***

It is known as Rai which belongs to family cruciferae. It is widely used as spice in various food items. Aqueous seed extract has blood sugar lowering activity which was observed in alloxan induced diabetic rats. 250, 350, 450 mg/kg doses of extract shows hypoglycemic activity [22].

### ***Carica papaya***

It is known as papaya which belongs to family caricaceae. Seed and leaves extract shows lowering of blood sugar level, lowering of lipid in the body and healing of wound activities in alloxan induced diabetic rats [23].

### ***Catharanthus roseus***

It is known as *Vinca roseus* which belongs to family Apocynaceae. Methanolic extract of leaves and twigs shows decrease

in blood sugar level in the alloxan induced diabetic rats. Oral administration of 500 mg/kg dose of leaves and twigs extract was beneficial in animals for lowering in blood sugar level [18]. The mechanism of action of *Catharanthus roseus* is increases the synthesis of insulin from  $\beta$  cells of Langerhans [2].

### ***Coriandrum sativum***

It is mainly known as coriander which belongs to family Apiaceae. It is widely used as spice in various food items. 200 mg/kg seed extract frequently increases the action of the  $\beta$  cells of Langerhans and decreases serum sugar in alloxan induced diabetic rats and synthesis insulin from  $\beta$  cells of the pancreas. Extract of *coriandrum sativum* shows blood sugar lowering property and insulin synthesizer [2].

### ***Eugenia jambolana***

It is known as jamun belongs to Myretaceae family. It contains dried seeds and mature fruits of *Eugenia jambolana*. It contains malvidin 3-laminaribiosidea and ferulic acid as active constituents. Extract of dried seeds (200 mg/kg) used for treatment of diabetic patients [21].

### ***Gymnema sylvestre***

It is commonly known as Gudmar which means "sugar destroying" and consists of Asclepidaceae family. Leaf extract of *G. sylvestre* (3.4/13.4 mg/kg) showed significant reduction of blood sugar level in streptozotocin induced rats. It is mostly used in Indian ayurvedic medicines for treatment of diabetes. The active constituents in *G. Sylvester* are alkaloids, flavonoids, saponins and carbohydrates. It is also used for treatment of cancer, treatment of inflammation and treatment of various microbial diseases [20].

### ***Mangifera indica***

It is commonly known as mango and consists of family Anacardiaceae. Anti diabetic activity shows by leaves extract (250 mg/kg) but oral administration of aqueous extract did not change the blood glucose level in alloxan induced diabetic rats [24].

### ***Momordica charantia***

It is commonly known as bitter melon (karela) and belongs to Cucurbitaceae family. The active constituents of *Momordica charantia* are momordic I and momordic II, cucurbitacin B. It is used in the treatment of diabetes. It consist lectin which has insulin like activity. Lectin is non protein which is linked to insulin receptors. This lectin decreases the blood sugar level by acting on peripheral tissues [25]. Fruit extract of *M. charantia* (200 mg/kg) shows hypoglycemic activity.



### ***Ocimum sanctum***

It is known as tulsi and belongs to Labiateae family. It is widely found all over India. It is used in Indian ayurvedic medicines for treatment of various diseases. Various animal studies proved that aqueous extract of *Ocimum sanctum* leaves (200 mg/kg) showed the hypoglycemic activity in streptozotocin induced rats. It is also used for treatment of viral infection, treatment of fungal infection, reduces stress, treatment of tumor and treatment of gastric ulcer [26].

### ***Tinospora cardifolia***

It is well-known as guduchi and consists of the Menispermaceae family. The active constituents of *T. cardifolia* are diterpene compounds which consists tinosporone, tinosporic acid, Syringen, berberine and giloin [27]. Root extract of *T. cardifolia* (50-200mg/kg) shows decrease in blood and urine sugar in streptozotocin induced diabetic rats during oral administration for 6weeks. It is mostly used in Indian ayurvedic medicines for treatment of diabetes. Root extract also forbid the reduction of body weight [24] [28-37].

Various plant parts such as roots, stem, leaves and fruits are extracted by maceration, infusion, percolation, decoction and soxhlet extraction generally. Mostly various solvents are used such as ethanol, methanol and petroleum ether.

### ***Herbal marketed formulations of diabetes mellitus***

Currently there are many poly herbal formulations in Indian market are used in different form such as Vati, Churna, Arkh, Quath etc for the treatment of diabetes [9]. These formulations may consist aqueous extract or powders of the various plants part which are used for the treatment of diabetes. These formulations are called as poly herbal formulation because they contain 3 to 25 herbs in the formula [38-43].

### ***Aegle marmelos***

It is known as Bael and belongs to Rutaceae family. It is inherited to India and parts of plant such as leaves, barks, roots and fruits are used in the ayurveda and in various medicines which is used for cure of various diseases. Leaves of neem and tulsi in combination with leaves of *A. marmelos* are dried, powdered and administered three times a day for 15 days. Animal studies proved that *Aegle marmelos* (100,200 and 500 mg/kg) are used for treatment of various diseases such as treatment of cancer, treatment of various viral diseases, treatment of various microbial diseases [24].

### ***Allium cepa***

It is locally known as onion or pyaz belongs to Liliaceae, a family of *Allium cepa*. Antihyperglycemic activity shown by ether soluble part and ether insoluble part of dried onion powder. It contains chemical ingredient allyl propyl disulphide which is known as APDS and it inhibits the insulin destruction by the liver and provoke the production of insulin by the pancreas which enhances the concentration of insulin and decreases the glucose levels in the blood. Crucial oil (100mg/kg) collected from red onion frequently shows antihyperglycemic activity, antistatin and antioxidant effects in alloxan induced diabetic rats. 300 mg/kg are most useful percentage in treatment of hyperglycemia and hyperlipidemia. Various clinical trails and animal research provided information that onion are used for treatment of asthma, treatment of diabetes, treatment of cancer and treatment of various viral diseases.

### ***The Challenges of herbal medicines in India***

Although the medicinal value of herbs, there are some levelled against it; such as need of consistency, specific amount of medicine is not prescribed to patients, dose not strictly given on time, since the manufacturing method is not standardized, varying amounts of the active ingredient are present. Now the problem is "how to prepare these herbal drugs to clear the above criticisms to struggle with pharmaceutical medicines. It will involve thorough research involving separation and categorization of active constituents of medicinal plants. Also, the herbal drugs and even the conventional medicine currently in use essentially not resulted to cure many diseases. There is need to investigate the alternative therapeutic treatment through study of the plant kingdom and rationale of their potentials through relative studies [44, 45].

### ***The Future aspects of herbal remedies for diabetes mellitus***

Many herbal drugs are used by people and various native drugs are regularly being introduced into current therapeutics. About 80% of the people, in developing countries particularly the rural people, rely on the conventional medical remedies for health care requirements. There has been a revival of interest in herbal drugs in developed countries due to a huge amount on the preference of products from natural sources. Therefore, there's a need to differentiate between herbal drugs supplied by a medical practitioner and those herbal remedies easily accessible to the people for self medication. The rapidly growing occurrence of diabetes mellitus is a Seriousness to human physical condition in all over the world. Recently, new active medicines have been extracted from plants and possess anti-diabetic activity with more effectiveness than oral hypoglycemic agents used in proven therapy. In recent years, awareness has been drawn towards discovery of

**Table 2** Herbal used for treatment of diabetes mellitus

S.no.	Plant species	Family	Common name	Part used	Active constituents	Mode of action	References
1	<i>Aegle marmelos</i>	Rutaceae	Bael	Leaves extracts	Aegle marmelosine	Improve functional state of pancreatic $\beta$ -cells	[21]
2	<i>Allium cepa</i>	Liliaceae	Onion	Dried powder	Dipropyl disulphide oxide	Stimulating the effects on glucose utilization and antioxidant enzyme	[32]
3	<i>Allium sativum</i>	Liliaceae	Garlic	Petroleum ether extract of bulbs	Allylpropyl disulphide oxide, Allicin	Improve plasma lipid metabolism and plasma antioxidant activity	[25]
4	<i>Aloe borborensis</i>	Asphodelaceae	Ghikanwar	Leaf pulp extract	$\beta$ -sitosterol, Campesterol	Improvement in impaired glucose tolerance	[23]
5	<i>Andrographis paniculata</i>	Acanthaceae	Kalmegh	Ethanollic extract of plant	Kalmeghin	Increases the glucose utilization and lower plasma glucose	[33]
6	<i>Annona squamosa</i>	Annonaceae	Sharifa	Leaf extract	Liriodenin, moupinamide	Improve glucose tolerance	[22]
7	<i>Azadirachta indica</i>	Meliaceae	Neem	Leaf extracts	Azadirachitin nimbin	Glycogenolytic effect due to epinephrine action was blocked	[26]
8	<i>Brassica juncea</i>	Brassicaceae	Mustard	Aqueous extract	Sulforaphane	Increase activity of glycogen synthetase	[34]
9	<i>Cajanus cajan</i>	Fabaceae	Arhar	Seed	2'-2'methyl cajanone, isoflavones, cajanin, cahanones	Significant reduction in serum glucose level	[8]
10	<i>Carica papaya</i>	Cariaceae	Papaya	Aqueous seed extract	Papain, chymopapain	Lowered fasting blood sugar, triglyceride, total cholesterol	[28]
11	<i>Carum carvi</i>	Apiaceae	Caraway	Aqueous extract of seed	Furfurol carvone	Significant decrease in blood glucose level.	[2]
12	<i>Cassia auriculata</i>	Leguminosae	Tanner's cassia	Aqueous extract of Seed	Limonene, terpinol	Enhances the activity of hepatic hexokinase, phospho fructokinase	[35]
13	<i>Catharanthus roseus</i>	Apocynaceae	Vinca	Hot water decoction of leaves	Catharanthaine, vincristine, vinblastine	Lowering of glycemia	[22]
14	<i>Coccinia indica</i>	Cucurbitaceae	Baby-watermelon	Ethanollic extract of whole plant	Glutamic acid, Asparagine	Lower blood glucose level due to suppressed glucose synthesis.	[36]
15	<i>Coriandrum sativum</i>	Apiaceae	Coriander	Seed extract	p-cymene linalool	Increases the activity of $\beta$ -cells and decrease serum glucose.	[2]
16	<i>Cinnamomum cassia</i>	Lauraceae	Cinnamon	Bark	Cinnamaldehyde eugenol	Increases the sensitivity of insulin receptor.	[34]
17	<i>Cinnamomum tamala</i>	Lauraceae	Tejpat	Leaf extract	Linalool, $\beta$ -caryophyllene	Insulin release from pancreatic $\beta$ - cells.	[19]
18	<i>Curcuma longa</i>	Zingiberaceae	Turmeric	Powdered form	$\alpha$ -phellantrene, tripinolene	Lowers blood sugar, increases glucose metabolism and potentiates insulin activity	[37]
19	<i>Eugenia jambolana</i>	Myrtaceae	Jamun	Pulp of fruit	Oleanolic acid, ellagic acid	Inhibited insulinase activity from liver and kidney.	[38]
20	<i>Ficus bengalensis</i>	Moraceae	Bargad	Alcoholic extract of stem bark	Leucodelphinidin	Enhanced insulin secretion from $\beta$ -cells.	[22]
21	<i>Ficus hispida</i>	Moraceae	Daduri	Alcoholic extract of leaves	Ficustriol, O-methyltylophorinidine	Reduce the blood glucose level and increased the serum insulin level	[39]
22	<i>Gymnena sylvestre</i>	Asclepiadaceae	Gudmar	Dried leaves	Dihydroxy gymnemic triacetate	Increase the serum G peptide level which monitor the release of endogenous insulin	[26]
23	<i>Mangifera indica</i>	Anacardiaceae	Mango	Leaves extract	$\beta$ -carotene $\alpha$ - carotene	Reduction in the intestinal absorption of glucose	[4]
24	<i>Momordica charantia</i>	Cucurbitaceae	Bitter gourd	Fresh green leaves	Charantin, sterol	Activates PPARs $\alpha$ and $\gamma$ and lower the plasma apo $\beta$ -100 in mice fed with high fat diet	[19]

**Table 3** Continued

S.no.	Plant species	Family	Common name	Part used	Active constituents	Mode of action	References
25	<i>Musa paradisiacal</i>	Musaceae	Banana	Flower	$\beta$ -Sitosterol, Leucocyanidin, Syringin	Decrease the blood glucose and glycosylated hemoglobin levels and increase in total hemoglobin	[8]
26	<i>Ocimum sanctum</i>	Labiataeae	Tulsi	Entire herbs	Eugenol	Increased insulin release	[17]
27	<i>Panax ginseng</i>	Araliaceae	Ginseng	Root extract	Ginsenosidespro-topanaxadiol	Inhibit $\alpha$ - glycosidase activity and decrease glucose absorption	[40]
28	<i>Phyllanthus emblica</i>	Euphorbiaceae	Amla	Methanolic extract of leaf	Phyllanthin	Reduction of glycemia	[23]
29	<i>Punica grantum</i>	Puniaceae	Pomegranate	Methanolic seed extract	Punicalagin, punicalin	Decrease of glycemia	[41]
30	<i>Swertia chirata</i>	Gentianaceae	Chirata	Entire herbs	Methyl swertianin	Lower blood glucose level	[24]
31	<i>Terminalia arjuna</i>	Combrataceae	Arjuna	Dried stem	Arjunic acid, arjunolic acid	Decrease the blood glucose level and decrease the activities of G6P	[23]
32	<i>Terminalia catappa</i>	Combrataceae	Almond	Petroleum ether fruit extract	Omega-9 fatty acid		[42]
33	<i>Tinospora cardifolia</i>	Menispermaceae	Gulvel	Aqueous extract of root	Tinosporone, tinosporic acid	Decrease of glycemia and brain lipids	[37]
34	<i>Trigonella foenum graecum</i>	Fabaceae	Methi	Ethanolic extract of leaves	4- hydroxy isoleucine	Stimulate the secretion of insulin, reduce insulin resistance and decrease blood sugar levels	[22]
35	<i>Zingiber officinalis</i>	Zingiberaceae	Sunth	Rhizome	Gingerol, shogaol	Increases insulin level	[5]



**Figure 3** pictures of herbal plants used for diabetes mellitus

**Table 4** Antidiabetic marketed polyherbal formulations

S. No	Brand name	Dosage form	Manufacturer	Ingredients	Mode of action	Reference
1	BGR-34	Tablet	Aimil pharmaceutical	<i>Berberis aristata, pterocarpus marsupium, Gymnena sylvestre, rubia cardifolia, Trigonella foenum graecum, Tinospora cardifolia</i>	DPP 4 inhibitor	[44]
2	Dia-becon	Tablet	Himalayan	<i>Gymnena sylvestre, pterocarpus marsupium, glycyrrhiza glabra, syzygium cumini, boerhavia diffusa, phyllanthus amarus, Tinospora cardifolia, piper nigrum, Ocimum sanctum, triphala, Curcuma longa, shilajeet</i>	Insulin secretagogues, alpha glycosidase inhibitors	[30]
3	Dia-sulin	Tablet	Tobbest busindo	<i>Cassia auriculata, Coccinia indica, emblica officinalis, Gymnena sylvestre, Momordica charantia, syzygium cumini, Tinospora cardifolia, Trigonella foenum graecum</i>	Promote the insulin secretion	[30]
4	Bitter gourd	Powder	Garry and sun natural remedy	<i>Momordica charantia</i>	Reduce insulin resistance	[30]
5	Dia-care	Powder	Admark herbals limited	Sanjeevan mool, himej, jambu beej, kadu, namejav, neem chal	Reduce insulin resistance	[30]
6	Gur-mar	Powder	Garry and sun natural remedy	<i>Gymnena sylvestre</i>	Maintain blood glucose level	[30]
7	Dia-beta	Tablet	Ayurvedic cure ayurvedic herbal health products	<i>Gymnena sylvestre, vinca rosea, Curcuma longa, Azadirachta indica, Tinospora cardifolia, Zingiber officinalis</i>	Release of insulin	[30]
8	Pan-creatic tonic	Liquid	Dr. Morse cellular botanical	<i>Tinospora cardifolia, Syzygium cumini, Melia azadirachta, Momordica charantia, Gymnena sylvestre, Aegle marmelos</i>	Regenerating pancreatic $\beta$ -cells	[43]
9	Sha-rang dyab tea	Powder	Plants med laboratorie pvt.ltd	Green coffee beans, cinnamon, <i>Boerhavia diffusa</i>	Stimulate insulin production	[23]
10	Herbal hills jambu	Cap-sule	Isha agro developers	<i>Eugenia jambolana</i>	Reduce blood & urine sugar level	[23]
11	Stevia 33	Cap-sule	Vitalize herbs pvt. Ltd.	Sudh shilajeet, <i>syzygium cumini, Tinospora cardifolia, Margosa indica, Gymnena sylvestre, Momordica charantia, Withania somnifera</i>	Stimulate $\beta$ - cells of pancreas	[23]
12	Spe-nai	Powder	Shriji herbal products	Karela, jamun, chirayata, methi, kalijiri, indrayav, kutki	Antidiabetic	[23]
13	Shila-jeet	Cap-sule	Ayurveda rasashala pune	Shudha shilajeet	Stimulate insulin secretion	[26]
14	Triphala guggul	Tablet	Ayurveda rasashala pune	Triphala guggul	Lower triglyceride level	[26]

plants with anti-diabetic activity that may be useful to people. It may also provide evidence for the improvement of a new oral drug for the treatment of diabetes mellitus [40].

## Conclusions

Diabetes mellitus is a most common endocrine disorder, affecting millions of people worldwide. It is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The increase in resistance and populations of patients at some risk, in conjunction with the restricted number of commercially available drugs for diabetes that still present have many side effects and also problems like unwanted hypoglycemic effect are the cause to shift the research towards traditionally available medicine which have low side effect and wide range of bio activity and do not re-

quire laborious pharmaceutical synthesis seems highly attractive. From this review article, it may be useful to the health professionals, scientists and scholars to develop evidence-based alternative medicine to cure different kinds of diabetes problem using herbal preparation. Substances and extracts isolated from different natural resources play very important role to design medicine and treat hyperglycemic problem in diabetes mellitus.

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