



Review Article

ANTIDIABETIC PLANTS IN TRADITIONAL MEDICINES: A REVIEW

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Article Received on: 25/05/17 Approved for publication: 23/06/17

DOI: 10.7897/2230-8407.08690

ABSTRACT

Plant extracts and their constituents are one of the potential approaches those are used for the prevention and treatment of a huge number of disorders. Herbal products and food supplements are the chief components of plant extracts, those are helpful in retaining healthiness, performing against a range of diseases and they support the quality of being. Diabetes mellitus is, a multi-factorial chronic metabolic ailment causes high blood glucose level, one of them. The systematic researches of traditional herbal therapies for diabetes give precious leads for the progress of alternative medicines and therapeutic approaches. Alternatives are evidently required due to the incapability of modern approaches to organize all of the pathological aspects of diabetes, and the poor availability and high cost of existing therapies for several country population. This review summarizes traditional plants with verified antidiabetic potential in pre-clinical and clinical studies for synergistic management of diabetes.

KEY WORDS: Antidiabetic drugs, diabetes mellitus, herbal, natural products.

INTRODUCTION

Diabetes mellitus is a disease characterized by improper metabolism of altered carbohydrate, protein and lipid metabolism. Diabetes can be regulated by insulin causes a rise of fasting and postprandial blood glucose levels or the disorder. That can be characterized by an increased concentration of blood glucose level due to derangement in carbohydrates metabolism and improper secretion of insulin. That metabolic disorder results in severe and long-term diabetic problem, which are responsible for early death and disability.¹ Diabetes leads to decompose body proteins that cause secondary complications such as affecting eyes, kidneys, nerves and arteries. Diabetes is an important multi-factorial chronic metabolic disorder, which has widespread complications; it associated with a lifetime damage, dysfunction and failure of various organs. It is the world's major endocrine disease linked by increased morbidity and mortality rates. Although it is a non-communicable disease, it is considered one of the five primary causes of death worldwide.

As per WHO, about 100 million persons were suffering from diabetes globally in 2006, it is estimated that, this number will be doubled until 2030. Diabetes mellitus occurs throughout the world, but most cases are found in developed nations. A large increase in occurrence is estimated mainly in Asia and Africa by 2030. The increased prevalence of diabetes in developing nations those follows the style of changes in daily life and urbanization. Diabetes is considered in the peak i.e., rank five of the mainly significant disorders in the urbanized world. Although extensive armamentarium has been developed to combat this ancient disease but these days, focus has been

shifted to identify effective agents that can be used along with developed drug to treat this disease synergistically.²

The occurrence and consequences associated with diabetes are found to be maximizing in countries like India (32.7%), China (21.8%) and USA (19.7%). The rate is expected to rise by 2030 in the above countries. In World Health Organization (WHO) survey on diabetes, it reveals that among the entire diabetes cases more than 95% are account to type-II (National Diabetes Fact sheet, 2005). The death rate in people with diabetes is almost twice that of people without diabetes.³ The WHO estimated that 85% of the population of developing countries depends on production and utilization of traditional medicine. A large number of people are suffering of diabetes, since insulin may be not available or is unaffordable by them. Many herbal products claim to have the anti-diabetic effect. Ayurveda has been the first to provide an elaborative explanation of diabetes. Plant drugs are frequently considered least toxic and free from side effects than synthetic drugs.⁴ The significant advantages of natural products are that, they are non-necrotic, effective, preventive and curative agents for many diseases. Plants are efficient producers of a wide range of chemical compounds called photochemicals. Two types of metabolites are produced from plants i.e. primary metabolites and secondary metabolites. Primary Metabolites are mainly used as industrial raw materials, food or food additives, like carbohydrates, proteins, phenols, lipids etc. while secondary metabolites are alkaloids, flavonoids, sterols etc. Research on these metabolites provides evidences for producing commercially and medicinally useful plant extracts.⁵ Many plants such as *Momordica charantia*, *Pterocarpus marsupium*, *Zingiber officinale*, *Cyamospsis tetragonolobus*,

Grewia asiatica, Aegle marmelos, Aloe vera, Artemisia pallens, Annona squamosa, Andrographis paniculata, Azadirachta indica, Biophytum sensitivum, Boerhavia diffusa, Cassia auriculata, Coccinia indica, Casearia esculenta, Catharanthus roseus have been evaluated for their composition of primary metabolites. Recently the search for appropriate antihyperglycemic agents has been focused on plants because there are a number advantages associated with using herbal medicines as opposed to pharmaceutical products, such as, reduced risk of side effects, effectiveness in chronic conditions, lower cost and widespread availability. Treatment with sulphonylureas and biguanides are also associated with side effects.⁶ However, many reasons, complementary medicine has developed in popularity in current years. Several native medicinal plants have been found to be helpful to deal with diabetes, some of them have been tested, and their active ingredients isolated. The beneficial uses of medicinal plants in traditional system of medicine of many cultures are extensively documented. Numerous plants have been used as nutritional adjuvant and in treating the number of diseases even without any knowledge on their proper functions and constituents. Many recent scientific investigations have also confirmed the efficacy of plant preparations, only some of these are extremely efficient.⁷

Types of diabetes mellitus: The World Health Organisation (WHO) distinguishes three main forms of diabetes mellitus: IDDM, NIDDM and gestational diabetes (occurring during pregnancy); all have similar symptoms, signs, and consequences, but different reasons and population distributions. Eventually, all occurs due to the β -cells of the pancreas being incapable to generate adequate amount of insulin to prevent hyperglycaemia.⁸

IDDM is generally occurs due to autoimmune damage of the pancreatic β -cells, those produce insulin. It is caused by an auto-immune reaction where the body's defense system destroys the insulin-producing β -cells. Population with type 1 diabetes produce very little or no insulin. The disease usually occurs at younger age. Patients totally depend on the exogenous insulin to manage the levels of glucose in their blood. Genetic factors are supposed to be the major cause of it.

NIDDM is illustrated by tissue-wide insulin resistance, but destruction of β cell function is essential for its growth. About

90% of all cases of diabetes mainly belong to this category. It is characterized by insulin resistance and deficiency. This happens because of loss of functional β -cells. Type 2 diabetes is related with very serious life ceasing complications.⁹

Gestational diabetes (GDM) is similar to Type 2 diabetes (T2D), in that it involves insulin resistance due to predisposal of pregnancy hormones, i.e., the diabetes consisting of high blood glucose levels during pregnancy. It occurs in 2-4% of pregnancies normally in 2nd or 3rd trimester.¹⁰

World Health Organization has stated that about 80% of citizens around the earth use herbal medicines at early level of health remedy in the same way and they need to be evaluated scientifically for their efficacies. The plants as a major source of food supplements are effective in controlling blood glucose and preventing long term complications in type II diabetes. The positive effects of many herbal medicines in reducing blood glucose and its complications have been already recognized (Table 1).

ANTIDIABETIC PLANTS IN TRADITIONAL MEDICINES

The aim of this review is to collect the data available on medicinal plants showing hypoglycemic activity either via increasing secretion of insulin from pancreas or by acting similarly. According to research, various Traditional Medicines are used as antidiabetics, and some 50% of these traditional remedies have been studied experimentally, as shown in Figure 1.¹¹ In India, plants like *Abroma augusta, Abutilum indicum, Aconitum palmatum, Aloe barbadensis, Asparagus racemosus, Berberis aristata, Calamus rotang, Cannabis sativa, Catharanthus roseus, Cinnamomum tamala, Coccinea grandis, Costus speciosus, Ficus racemosa, Ipomoea batatas, Momordica charantia, Nardostachys jatamansi, Picrorhiza kurroo, Quercus lanata, Swertia chirayita, Syzygium cuminii, Trigonella foenumgraecum, Urtica dioica, Zingiber officinale, Allium cepa, Allium sativum, Aloe vera, Cajanus cajan, Coccinia indica, Caesalpinia bonducella, Ficus bengalensis, Gymnema sylvestre, Momordica charantia, Ocimum sanctum, Pterocarpus marsupium, Tinospora cordifolia* etc., are most commonly used species in traditional medicine as antidiabetic agents, as shown in Figure 2.¹²

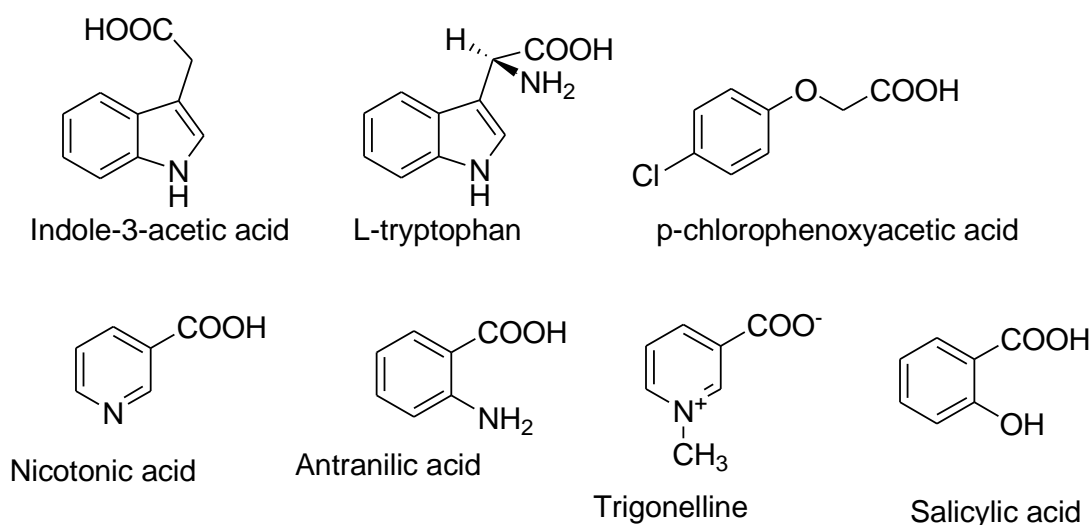


Figure 1: Plant growth regulators with hypoglycemic activity

Among various traditional plants used for the treatment of diabetes, only a small number of drugs have received scientific and medical evaluation as described below (Table 2)

Aegle marmelos

The leaf extract of *Aegle marmelose* (L.) was found to be as effective as insulin in the restoration of blood glucose and body weight to normal levels. *A.marmelose* can be used as potential hypoglycaemic agent.¹³

Anthemis nobilis

Anthemis nobilis Linn.is a 3 hydroxy-3-methylglutaric acid (HMG) containing flavonoids, glucoside hamaemeloside which has been shown to have *in vivo* hypoglycaemic activity comparable to that of free HMG.¹⁴

Artemisia pallens

Oral administration of an extract of the aerial parts of *Artemisia pallens* Wall. reduce hypoglycaemia at a higher dose. Only the methanol extract was active whereas the water extract was inactive.¹⁵

Asteracantha longifolia

Oral administration of the extract of *Asteracantha longifolia* Nees. (20 g/kg of starting material) can significantly improve glucose tolerance in healthy human subjects and diabetic patients.¹⁶

Azadirachta indica

An *Azadirachta indica* leaf extract significantly blocked the inhibitory effect of serotonin on insulin secretion mediated by glucose.¹⁷

Bauhinia forficata

The fresh leaves of *Bauhinia forficata* are the essential part of this plant, which shows the hypoglycemic activity and the genus *Bauhinia* belongs to the family Caesalpinaceae.¹⁸

Combretum micranthum

Combretum Micranthum, commonly known as ‘geza’ in Hausa is an anti diabetic medicinal plant used in Northwestern Nigeria. It belongs to the family of Combretaceae. The plant apart from anti diabetic properties has also been documented to show properties of being antioxidant, antimicrobial and anti inflammatory.¹⁹

Table 1: Antidiabetic Polyherbal Products Marketed in India

Brand name	Manufacturer	Ingredients
Diabecon	Himalaya	<i>Balsamodendron mukul</i> , <i>Pterocarpus marsupium</i> , <i>Casearia esculenta</i> , <i>Gymnema sylvestre</i> , <i>Glycyrrhiza glabra</i> , <i>Tinospora cordifolia</i> , <i>Swertia chirata</i> , <i>Tribulus terrestris</i> , <i>Phyllanthus amarus</i> , <i>Gmelina arborea</i> , <i>Berberis aristata</i> , <i>Aloe vera</i> , <i>Eugenia jambolana</i> , <i>Asparagus racemosus</i> , <i>Boerhaavia diffusa</i> , <i>Sphaeranthus indicus</i> , <i>Gossypium herbaceum</i> , <i>Shilajeet</i> and powders of <i>Momordica charantia</i> , <i>Piper nigrum</i> , <i>Ocimum sanctum</i> , <i>Abutilon indicum</i> <i>Curcuma longa</i> , <i>Rumex maritimus</i> and <i>Trikatu</i> .
Pancreatic tonic 180 cp	Ayurvedic supplement herbal	<i>Pterocarpus marsupium</i> , <i>Cinnamomum tamala</i> , <i>Gymnema sylvestre</i> , <i>Azadirachta indica</i> , <i>Ficus racemosa</i> , <i>Aegle marmelos</i> , <i>Trigonella foenum graecum</i> , <i>Momordica charantia</i> , <i>Syzygium cumini</i>
Diasulin	Tobbest Busindo	<i>Cassia auriculata</i> , <i>Coccinia indica</i> , <i>Momordica charantia</i> , <i>Syzygium cumini</i> , <i>Emblica officinalis</i> , <i>Trigonella foenum graecum</i> , <i>Curcuma longa</i> , <i>Gymnema sylvestre</i> , <i>Tinospora cordifolia</i> , <i>Scoparia dulcis</i>
Bitter gourd Powder	Garry and Sun natural Remedies	Bitter gourd (<i>Momordica charantia</i>)
Diabetes-Daily Care	Nature's Health Supply	Alpha Lipoic Acid, Chromax, Vanadium, Cinnamon Extract, Fenugreek extract, <i>Gymnema sylvestre</i> extract, <i>Momordica</i> extract, Licorice Root extract
Ayurveda alternative herbal formula to Diabetes	Chakrapani Ayurveda	Gurmar (<i>Gymnema sylvestre</i>), Jamun Gutli (<i>Syzygium cumini</i>), Neem (<i>Azadirachta indica</i>), Methika (<i>Trigonella foenum graecum</i>), Guduchi (<i>Tinospora cordifolia</i>), Pushkarmool (<i>Inula racemosa</i>), Karela (<i>Momordica charantia</i>).
Dia-care	Admark Herbals Limited	Sanjeevan Mool, Jambu beej, Kadu, Neem chal, Himej, Namejav
Gurmar powder	Garry and Sun natural Remedies	Gurmar (<i>Gymnema sylvestre</i>)
Syndrex	Plethico Laboratories	Germinated Fenugreek seed extract
Diabecure	Nature beaute sante	<i>Berberis vulgaris</i> , <i>Millefolium</i> , <i>Juglans regia</i> , <i>Erythrea centaurium</i> , <i>Taraxacum</i>
Epinsulin	Swastik Formulations	vijaysar (<i>Pterocarpus marsupium</i>)
Diabeta Ayurvedic cure	Ayurvedic Herbal Health Products	<i>Momordica charantia</i> (Bitter Gourd), <i>Zingiber officinale</i> (Ginger), <i>Gymnema sylvestre</i> , <i>Curcuma longa</i> (Turmeric), <i>Pterocarpus marsupium</i> (Kino Tree), <i>Vinca rosea</i> (Periwinkle), <i>Azadirachta indica</i> (Neem), <i>Tinospora cordifolia</i> , <i>Acacia arabica</i> (Black Babhul), <i>Syzygium cumini</i> (Black Plum).

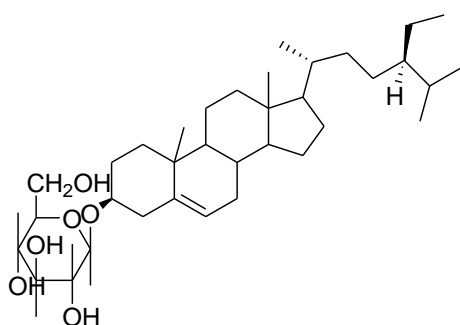
Table 2: Anti-diabetic Plants with Active constituents

Family	Botanical Name	Common Name	Part Used	Active Constituents
Apiaceae	<i>Coriandrum sativum</i>	Coriander	Leaf	Alanine
	<i>Cuminum cyminum</i>	Cumin	seed	Aldehyde
Acanthaceae	<i>Hygrophila auriculata</i>	Talmakhana	Whole plant	
	<i>Strobilanthes crispus</i>		Leaf	
Asteraceae	<i>Chamaemelum nobile</i>		Leaf	
	<i>Eugenia jambolana</i>		Fruit pulp, Seed	Pandanus odoris

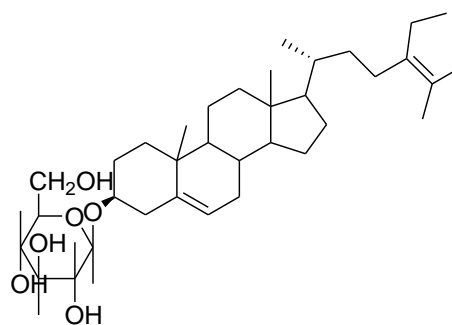
	<i>Smallanthus sonchifolius</i>		Leaves	Sonchifolin, uvedalin, enhydrin, fluctuanin
	<i>Vernonia anthelmintica</i>		Seed	Epoxy acid or vernolic acid
	<i>Artemisia sphaerocephala</i>	Worm wood		Polysaccharide
	<i>Taraxacum officinale</i>	Dandelion	Fruit	Terpen
	<i>Eleocharis scaber</i>		Whole plant	Terpenoid and 2.6.2-trienolide
Araliaceae	<i>Panax ginseng</i>	Ginseng Fruit	Berry extract	Saponin
	<i>Panax quinquefolius</i>		Root	Ginsenosides, protopanaxadiol
Amaranthaceae	<i>Amaranthus esculentus</i>		Whole plant	
	<i>Beta vulgaris</i>		Root	Phenolics, betacyanins
Annonaceae	<i>Annona squamosa</i>		Leaf, Fruit Pulp	
Arecaceae	<i>Areca catechu</i>		Seed	Arecaine, Arecoline
Alliaceae	<i>Allium cepa</i>	Onion	Bulb	Allyl propyl disulphide, S - methyl cysteine sulphoxide
	<i>Allium sativum</i>	Garlic	Root	Ethanollic Diallyl disulphide oxide, Ajoene, Allyl propyl disulfide, S -allyl cysteine, S -allyl mercaptocysteine
Asphodelaceae	<i>Aloe barbadensis</i>	Barbados aloe	Leaf	Lophenol, 24 -methyl -lophenol, 24 -ethyllophenol
Apocynaceae	<i>Catharanthus roseus</i>	Red periwinkle	Whole Plant	Vinculin, Alkaloid
Anacardiaceae	<i>Mangifera indica</i>	Mango tree	Leaf, Stem Bark, Fruit	Mangiferin, Phenolics, Flavonoid
	<i>Rhus coriaria</i>	Sicilian Sumac	Fruit	Ethanollic Limonene, Nonanal, Dec -2 (Z) -enal
Asclepiadaceae	<i>Gymnema sylvestre</i>	Sugar destroyer	Leaf	Gymnemic acid, Gymnema, Saponin
Brassicaceae	<i>Brassica juncea</i>	Mustard	Seed, Leaf	Isorhamnetin diglucoside
	<i>Lepidium sativum</i>		Leaf	
	<i>Raphanus sativus</i>		Whole plant	
Chenopodiaceae	<i>Beta vulgaris</i>	Beetroot	Whole Plant	Sugar beet pectin, Polydextrose
Chrysobalanaceae	<i>Parinari excelsa</i>		Bark	Quercetin, Myricetin
Cucurbitaceae	<i>Ibervillea sonorae</i>	Huereque	Root	Monoglyceride (MG), Fatty acid
	<i>Momordica charantia</i>	Bitter melon	Whole plant	Charantin, Momordicin, Galactosebinding Lectin Non-bitter, Diosgenin, Cholesterol, lanosterol, β -sitosterol, Cucurbitacin glycoside
	<i>Coccinia indica</i>	Ivy-gourd	Fruit	B-amyirin, Lupeol, Cucurbitacin
	<i>Cucumis metuliferus</i>	Jelly melon Fruit	Fruit extract	B-carotene and fatty acids
	<i>Momordica Kaarali</i>	Kanda	Fruit	Steroidal glycoside or phenolics
	<i>Cymbalaria Momordica balsamina</i>	Balsam apple	Fruit	Momordicin, Vitamin C, Resin acid, Fixed oil, Carotene, Aromatic volatile oil, Alkaloid, Cucurbitacin, Saponin
Crassulaceae	<i>Bryophyllum pinnatum</i>		Leaf	
Combretaceae	<i>Combretum micranthum</i>		Leaves	Polyphenols
	<i>Terminalia chebula</i>	Chebolic myrobalan	Seed, Fruit	Shikimic, Gallic, Triacotanoic, Palmitic acid, β -sitosterol, Daucosterol
	<i>Terminalia superba</i>		Stem, bark	
	<i>Terminalia catappa</i>	Indian almond	Fruit	Phenolics
	<i>Tremella mesenterica</i>		Fruit	
Cactaceae	<i>Opuntia dillenii</i>	Prickly pear	Fruit	Polysaccharide
Capparidaceae	<i>Gynandropsis gynandra</i>		Root	N,N-diethyltoluamide
	<i>Capparis decidua</i>		Fruit	Spermidine Isocodonocarpine
Celastraceae	<i>Salacia oblonga wall</i>		Root, bark	Salacinol
Caprifoliaceae	<i>Viburnum opulus</i>	Cranberry bush	Fruit	Tannin
Caricaceae	<i>Carica papaya</i>	Papaya	Fruit	Saponin, Tannin, Alkaloid, Flavonoid
Euphorbiaceae	<i>Jatropha curcas</i>	Barbados nut	Whole plant	Diterpene
	<i>Phyllanthus emblica;</i> <i>P. Acidus</i>	Indian Gooseberry	Fruit	Tannin
	<i>Ricinus communis</i>		Root	Ricinolic acid
	<i>Emblica officinalis</i>	Amla	Fruit	Tannoid
Ericaceae	<i>Vaccinium myrtillus</i>	Bilberry	Leaf, Fruit	Anthocyanoside
	<i>Vaccinium angustifolium</i>	Wild blueberry	Fruit	Phenolic
Ebenaceae	<i>Diospyros peregrine</i>	Gaub persimmon	Fruit	Lupeol, Betulin, Gallic acid, Betulinic acid, Hexacosane, Hexacosanol, Sitosterol
	<i>Diospyros lotus</i>	Date plum	Fruit	Phenolics
Fabaceae	<i>Acacia arabica</i>	Indian gum Arabic	Seed, Bark	Polyphenol, Tannin
	<i>Cassia auriculata</i>	Tanner's cassia	Flower	Sterol, Triterpenoid, Flavonoid, Tannin
	<i>Glycine max</i>	Soya beans	Seed	3-O-methyl-D-chiro- inositol
	<i>Trigonella foenum graecum</i>		Leaves and seeds	4-hydroxy isoleucine
	<i>Tamarindus indica</i>	Tatul tree	Seed, Fruit	Flavonoid, Polysaccharide
	<i>Xanthocercis zambesiaca</i>	Nyala tree	Leaf	Fagomine, 4-O-beta-Dglucopyranosylfagomine, Castanospermine

	<i>Retama raetam</i>		Whole plant	
	<i>Butea monosperma</i>	Bastard teak	Fruit	Butein, Palasonin, Stigmasterol-3 β-D-glucopyranoside
Ganodermataceae	<i>Ganoderma lucidum</i>	Reishi mushroom	Fruit	Polysaccharide
Gentianaceae	<i>Swertia punicea</i>		Whole plant	Methyl swertianin and bellidifolin
Hypoxidaceae	<i>Hypoxis hemerocallidea</i>		Fruit	
Leguminosae	<i>Cajanus cajan</i>	Pigeon pea	Seed	7-phenyloctahydroquinolizin- 2-one
	<i>Pterocarpus marsupium</i>		Whole plant	Kenotannic acid, pyrocatechin
	<i>Bauhinia forficata</i>		Leaf	Astragalgin, kaempferitrin
Lauraceae	<i>Cinnamomum zeylanicum</i>	Cinnamon	Leaf, Bark	Cinnamaldehyde
	<i>Persea americana</i>	Avocado	Fruit	Fat, Protein, Vitamin, Mineral
Lamiaceae	<i>Mentha piperita</i>	Peppermint	Leaf	Essential oil, Terpen, Flavonoid, Vanadium, Zinc, Chromium, Copper, Iron, Potassium, Sodium, Nickel
	<i>Ocimum sanctum</i>	Holy basil	Leaf	Eugenol (1-hydroxy-2-methoxy-4- 26] allylbenzene)
	<i>Leonotis leonurus</i>		Leaf	
	<i>Salvia officinalis</i>		Leaf	
Liliaceae	<i>Aloe vera</i>	Barbados aloe	Leaf	Pseudo-prototinosaponin, Prototinosaponin
Lythraceae	<i>Punica granatum</i>		Fruit	Punicalagin, punicalm
Lyophyllaceae	<i>Lyophyllum decastes</i>	Fried chicken Mushroom	Fruit	Polysaccharide
Labiatae	<i>Ocimum santum</i>		Whole plant	Eugenol
Meliaceae	<i>Azadirachta indica</i>	Neem	Leaf, Seed	Nimbidin
	<i>Melia dubia</i>	African Mahogany		Liminoid
Myrtaceae	<i>Eucalyptus globules</i>	Blue gum	Leaf	Calytoside
	<i>Psidium guajava</i>	Guava	Leaf, Fruit	Terpen, Flavonoid, Strictinin, Isostrictinin, Pedunculagin, Polysaccharide
	<i>Baccharis trimera</i>		Leaf	
	<i>Syzygium jambolanum</i>	Jambolan	Fruit	Anthocyanin, Citric, Malic, Gallic acid
	<i>Syzygium cordatum</i>		Leaf	
Moraceae	<i>Ficus bengalensis</i>	Banyan tree	Bark	Leucopelargonidin
	<i>Ficus carica</i>	Anjir	Leaf, Fruit	
	<i>Egyptian Morus alba</i>		Stem, bark	
	<i>Artocarpus heterophyllus</i>	Jackfruit	Fruit	Sapogenin
Musaceae	<i>Musa sapientum</i>	Sweet banana	Flower	Flavonoid, Steroid, Glycoside
	<i>Musa paradisiaca</i>	Banana	Fruit	Dietary fibre, Pectin
Moringaceae	<i>Moringa oleifera</i>	Moringa	Whole plant	
	<i>Coscinium fenestratum</i>		Stem, bark	
Menispermaceae	<i>Tinospora cordifolia</i>		Root	Tinosporone, tinosporic acid
	<i>Thespesia populnea</i>	Portia tree	Fruit	Populnetin, Herbacetin, Populneol, Quercetin
	<i>Abelmoschus esculentus</i>	Gumbo	Fruit	Carbohydrate, Gum, Mucilage, Protein, Phytosterol, Flavonoid, Tannin, Phenolics, Volatile oil
Meripilaceae	<i>Grifola frondosa</i>	Maitake	Fruit	Disaccharide
Nymphaeaceae	<i>Nelumbo nucifera</i>	Sacred lotus	Flower	Tolbutamide
Nyctaginaceae	<i>Boerhavia diffusa</i>		Whole plant	Punarnavine, ursolic acid
Oxalidaceae	<i>Biophytum. Sensitivum</i>	Sikerpud	Whole Plant	
	<i>Averrhoa bilimbi</i>		Leaf	
Poaceae	<i>Hordeum vulgare</i>	Barley	Seed	Beta-glucan
	<i>Triticum vulgare</i>	Wheat Whole	plant	Albumin
Piperaceae	<i>Piper betle</i>	Pan	Leaf	
Palmae	<i>Lodoicea sechellarum</i>	Sea coconut Fruit	Fruit extract	Carbohydrate
Punicaceae	<i>Punica granatum</i>	Pomegranate	Fruit	Tannin
Papilionaceae	<i>Butea monosperma</i>	Flame of the forest	Fruit	Flavonoid
Rosaceae	<i>Sarcopoterium spinosum</i>		Root	Catechin, epicatechin
	<i>Prunus amygdalus</i>		Seeds	Amygdalin
Rutaceae	<i>Aegle marmelos</i>	Golden apple	Leaf, Seed, Fruit	Aegeline 2, Coumarin, Flavonoid, Alkaloid
	<i>Citrus reticulate</i>	Mandarin	Fruit	Essential oil
	<i>Feronia elephantum</i>	Wood apple	Fruit	Bioflavonoid, Triterpenoid, Stigma sterol, Bergapten
	<i>Murraya koenigii</i>	Curry-leaf tree	Leaf, Fruit	Carbazole, Alkaloid
	<i>Limonia acidissima</i>	Wood apple	Fruit	Polysaccharide
Ranunculaceae	<i>Nigella sativa</i>	Roman coriander	Whole plant	Thymoquinone
Rubiaceae	<i>Hintonia standleyana</i>		Stem, bark	
	<i>Morinda citrifolia</i>	Indian mulberry Fruit	Fruit	Saponin, Triterpene, Steroid, Flavonoid
Sterculiaceae	<i>East Helicteres isora</i>	Indian	Fruit	Steroid, Terpenoid, Alkaloid,

		screw tree		Carbohydrate, Phenolics
Scrophulariaceae	<i>Scoparia dulcis</i>		Whole plant	
Solanaceae	<i>Withania somnifera</i>	Winter cherry	Leaf	Withanolide, Alkaloid
	<i>Lycium barbarum</i>	Chirchita	Fruit	Polysaccharide
	<i>Withania coagulans</i>	Vegetable Rennet	Fruit	Milk-coagulating enzyme, Esterase, Fatty oil, Essential oil, Alkaloid
	<i>Physalis alkekengi</i>	Strawberry tomato		Polysaccharide
	<i>Capsicum frutescens</i>	Chilli		Capsaicin
Scrophulariaceae	<i>Scoparia dulcis</i>		Whole plant	
Sterculiaceae	<i>East Helicteres isora</i>	Indian screw tree	Fruit	Steroid, Terpenoid, Alkaloid, Carbohydrate, Phenolics
Theaceae	<i>Camellia sinensis</i>		Leaves	Caffeine, catechins
Turneraceae	<i>Turnera diffusa</i>	Damiana	Leaf	Flavonoid, Terpen
Utricaceae	<i>Urtica dioica</i>	Nettles	Leaf	Flavonoid, Coumarin, Lectin
Verbenaceae	<i>Lantana camara</i>		Leaves	Lantanoside, lantanone
Zingiberaceae	<i>Curcuma longa</i>	Turmeric	Root	Curcuminoid
	<i>Zingiber officinale</i>	Ginger	Bulb	Gingerol, Ethanol

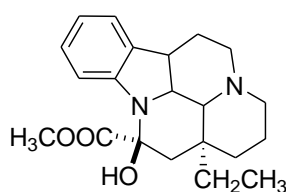


b-sitosterol-D-glucoside

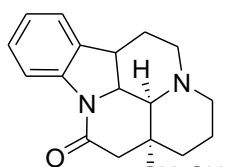


5,25-stigmastadien-3-b-ol-D-glucoside

Steroid glycosides of *Momordica charantia*

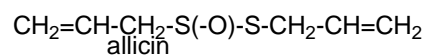
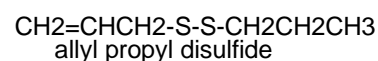


Vincamine

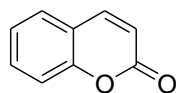


(-)-eburnamonine

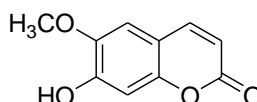
Alkaloids of *Catharanthus roseus*



Sulfur compounds from *Allium sativum*



Coumarin



Scopoletin

Constituents of *Trigonella Foenum graecum*

Figure 2: Chemical Constituents present in plants

Catharanthus roseus

The oral administration of an alcoholic extract of leaves of *Catharanthus roseus* directs to lowering the glycaemia.²⁰

Elephantopus scaber

Elephantopus scaber showed the decrease in blood glucose levels in streptozotocin induced diabetic rats considerably. It is popularly known as Elephant's foot, and it is family of Asteraceae. It is a scabrescent aromatic herb distributed in the moist deciduous forests of the central Western Ghats.²¹

Gymnema sylvestre

Gymnema is a plant used in India and many parts of Asia as a natural treatment for diabetes, the leaves of this plant is used in herbal medicine preparations.²²⁻²³

Liriope spicata

It is a Chinese medicinal plant, which belongs to Liliaceae family and is frequently used as "maidong" in prescriptions of traditional Chinese medicine for the treatment of Diabetes mellitus. It is known for its high availability and safety.²⁴

Parinari excelsa

Senegalese traditional herbals are used for the management of the Diabetes mellitus; of which the decoction of *Parinari excelsa* is the most widely used anti diabetic medicinal plant.²⁵

Ricinus communis

Ricinus communis which belongs to the family Euphorbiaceae, is the traditional Indian medicine which is used for the management of Diabetes mellitus. It is known as Erandah in Sanskrit, Amudam in Telugu and Arandi in Hindi and is known for its castor seed oil.²⁶

Citrullus Colocynthis

Citrullus colocynthis, Cucurbitaceae naturally is a small bitter plant mainly found in the Arabian countries. It is found in warmer climate and tropical areas.²⁷ Initially, from tropical Asia and Africa, it is now generally distributed in the Saharo-Arabian phyto geographic region in Africa and the Mediterranean region.

DISCUSSION

Herbal therapy for diabetes has been pursuing all over the World effectively. Herbs are used to manage different types of diabetes and their complications. These remedies developed all along the ethics of allopathic or modern drug system those are often inadequate in efficiency and bring the threat of side effects, and are usually too expensive, particularly for the developing nations. The aforementioned plants considered for their potential of hypoglycemic behavior. Systematic rationale of various plant species has been proved the efficiency of the botanicals in reduction of the sugar level could be considered as of possible beneficial significance. Thus, various different plants have been used independently or in formulations for healing of diabetes.

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Cite this article as:

Alka Rani et al. Antidiabetic plants in traditional medicines: A review. *Int. Res. J. Pharm.* 2017;8(6):17-24 <http://dx.doi.org/10.7897/2230-8407.08690>

Source of support: Nil, Conflict of interest: None Declared

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