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A Review on Scientific Validation of Medicinal Plants with Potential Anti-Diabetic Activity

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ABSTRACT

In the last few years, there has been an exponential growth in the field of herbal medicine and gaining popularity both in developing and developed countries because of their natural origin and less side effects. A review was conducted to pile up information about medicinal plants used for the treatment of diabetes mellitus. Diabetes is a metabolic disorder of the endocrine system and affecting nearly 10% of the population all over the world also the number of those affected is increasing day by day. The profiles presented include information about the scientific and family name, plant parts and test model used, the degree of hypoglycemic activity, and the active chemical agents. The large number of plants described in this review (103 plant species belonging to different families). A number of scientific investigations have highlighted the importance and the contribution of many plant families i.e. Asteraceae, Liliaceae, Apocynaceae, Solanaceae, Caesalpinaceae, Rutaceae, Piperaceae, Sapotaceae used as medicinal plants clearly demonstrated the importance of herbal plants in the treatment of diabetes. The effects of these plants may delay the development of diabetic complications and correct metabolic abnormalities. This work stimulates the researchers for further research on the potential use of medicinal plants having antidiabetic potential.

INTRODUCTION

Herbal medicine sometimes referred to as Herbalism or Botanical Medicine, is the use of herbs for their therapeutic or medicinal value. An herb is a plant or plant part valued for its medicinal, aromatic or savory qualities. Herb plants produce and contain a variety of chemical substances that act upon the body. Herbal system and greater parts of its medicaments are based on indigenous herbals. Knowledge about the medicinal plant is mandatory for all who is working in the field of Ayurveda, in order to identify and select the appropriate plant for a specific disease. In recent years, the interest in medicinal plants has increased in a great deal. According to an all India Ethno Biological Survey carried out by the Ministry of Environment and Forests, Government of India, there are over 8000 species of plants being used by the people of India. A WHO consultation had drafted "Guidelines for the Assessment of Herbal Medicines" in 1991[1]. Diabetes mellitus is a widespread disorder, which has been long recognized in the history of medicine. Before the advent of insulin and oral hypoglycemic drugs, the major form of treatment involved the use of plants. More than 400 plants are known to have been recommended, and recent investigations have affirmed the potential value of some of them treatment. The hypoglycemic and anti-hypoglycemic effect of several plants used as anti-diabetic studied[2]. Diabetes is also the most common endocrine disorder, affecting 16 million individuals in the United States and also estimated that there are 30 to 33 million diabetic patients in India now and every fourth diabetes patient in the world today is an Indian. India has today become the diabetic capital of the world with over 20 million diabetics and this number is set to increase to 57 million by 2025 (Sridhar 2003)[3]. Diabetes was estimated to affect 177 million people worldwide in 2000 and this figure is projected to increase to 300 million by 2025. Diabetes is not a single disease rather it is a heterogeneous group of syndromes characterized by an elevation of blood glucose caused by relative or absolute deficiency of insulin[4]. Diabetes is a disorder of carbohydrate metabolism wherein there is abnormal rise in blood glucose due to lack of insulin or lack of insulin resistance or a combination of both factors. Impaired glucose tolerance, formerly known, as “borderline diabetes” is a degree of hyperglycemia that may precede type 2 diabetes[5]. Plant drugs that demonstrate hypoglycemic effect within the body play a major role in folk medicine, since the plant drugs are frequently considered to be less toxic and free from side effects than synthetic agents.

Though different types of oral hypoglycemic agents are available along with insulin for the treatment of diabetes mellitus, there is an increasing demand by patients to use natural products with anti-diabetic activity. Insulin cannot be used orally and continuous use of synthetic drugs causes side effect and toxicity.

Table No. 1: Epidemiological data for distribution of diabetes (in millions)

Country	Year 2010	Year 2018	% Increase
World	15.1	22.1	46
North America	14.2	17.5	23
South America	15.6	22.5	44
Africa	9.4	14.1	50
Europe	26.5	32.9	24
Asia	84.5	132.3	57
Australia	1.0	1.3	33

Diabetes mellitus is a group of metabolic alterations characterized by hyperglycemia resulting from defects in insulin secretion, action or both. It is made up of two types: Type I and Type II. Type I diabetes often referred to as juvenile diabetes, is insulin dependent and known to affect only 5% of the diabetic population. The Type II, which is non-insulin dependent, usually develops in adults over the age of 40. It has already been established that chronic hyperglycemia of diabetes is associated with long term damage, dysfunction and eventually the failure of organs, especially the eyes, kidneys, nerves, heart and blood vessels. It has an adverse effect on carbohydrate, lipid and protein metabolism resulting in chronic hyperglycemia and abnormality of lipid profile. These lead to series of secondary complications including polyurea, polyphasia, ketosis, retinopathy as well as cardiovascular disorder[6]. In spite of the introduction and extensive utilization of hypoglycemic agents, diabetes and the related complications continue to be a major health problem worldwide, which is affecting nearly 10% of the population all over the world and considered as a major cause of high economic loss which can in turn impede the development of nations[7]. It is projected to become one of the world's main disablers and killers within the next 25 years. Many factors contribute to the onset of diabetes and these are termed as predisposing or risk factors. Environmental factors such as diet, obesity and sedentary lifestyle increase the risk of diabetes. Other important risk factors include high family aggregation, insulin resistance,

nutritional status, age and lifestyle change due to urbanization. The management of diabetes is a global problem until now and successful treatment is not yet discovered[8].

Currently, available therapy for diabetes includes insulin and various oral hypoglycemic agents such as sulfonylureas, metformin, glucosidase inhibitors, troglitazone, etc. But these are reported to produce serious adverse side effects such as liver problems, lactic acidosis and diarrhea[9]. It is currently affecting around 143 million people and the number of those affected is increasing day by day, by 2030 it is predicted to reach 366 million populations worldwide. About 800 plant species have been reported to possess anti-diabetic properties. Several plant species have been used for prevention or management of diabetes by the Native Americans, Chinese, South Americans and Asian Indians[10]. The study showed that Asian and African continents have 56% and 17% share of the worldwide distribution of therapeutic herbal plants, respectively. Biological actions of the plants are related to chemical composition that are rich in phenolics, alkaloids, flavonoids, terpenoids, coumarins, and glycosides usually show positive effects. On the other hand, many conventional drugs for treatment of diabetes, such as metformin are secretagogues which have a plant origin[11].

The conventional drugs are used to treat diabetes by improving insulin sensitivity, increasing insulin production and decreasing the amount of glucose in blood. The adverse effect of drug treatment are not always satisfactory in maintaining normal levels of blood glucose and this view many medicinal plants have been provided a potential source of antidiabetic principle which are widely used for the treatment of diabetes mellitus in various traditional system of medicine worldwide and many of them are known to be effective against diabetes. The hypoglycemic effect of pharmacologically active component of plant decrease the effect on α-amylase and various direct and indirect effects of different blood parameters responsible for development of diabetes[12]. A large number of antidiabetic medicines are available in the pharmaceutical market for diabetes and its related complications; however, currently, no effective therapy is available to cure the disease. However, due to unwanted side effects the efficacies of these compounds are debatable and there is a demand for new compounds for the treatment of diabetes[13 14]. In the last few years, there has been a growing interest in the herbal medicine in care and management of diabetes both in developing and developed countries, due to their natural origin and less side effects[15].

In this review article, an attempt has been made to compile the reported hypoglycemic plants available in different scientific journals and may be useful to the health professionals,

scientists and scholars working in the field of pharmacology and therapeutics to develop evidence based alternative medicine to cure different kinds of diabetes in humans and animals. This review shows the importance and the interest placed on medicinal plants in the drive to demonstrate their antidiabetic effects and the responsible bioactive agents. This review also covers the common name of a plant, the parts that are commonly used as a remedy sources, extracts, doses, and a test model.

Table No. 2: Analysis of remedies obtained from different plant parts for diabetes mellitus

S.No	Name of Medicinal Plant	Common Name	Parts Used	Solvent for Extraction	Active Chemical Constituents	Dose Mg/kg	Test Model	Ref.
1	*Acacia arabica*	Indian gum arabic	Seed, Bark	NA	Polyphenol, Tannin	100	NA	16
2	*Tamarindus indica*	Tatul tree	Seed, Fruit	Methanolic	Flavonoid, Polysaccharide	200	STZ rat	17
3	*Butea monosperma*	Bastard teak	Fruit	Aqueous	Butein, Palasonin, Stigmasterol-3 β-D-glucopyranoside	1 or 2g	Type II diabetic patient	18
4	*Cassia auriculata*	Tanner's cassia	Flower	NA	Sterol, Triterpenoid, Flavonoid, Tannin	NA	NA	19
5	*Glycine max*	Soya beans	Seed	NA	3-O-methyl-D-chiro-inositol	NA	NA	20
6	*Retama raetam*	NA	whole plant	Aqueous	NA	NA	STZ rat	21
7	*Aegle marmelos*	Golden apple	Leaf, Seed, Fruit	Ethanolic, Aqueous	Aegeline2Coumarin, Flavonoid, Alkaloid	1.0g/kg 14D	STZ rat	22, 26
8	*Citrus reticulate*	Mandarin	Fruit	Essential oil	Essential oil	500-2000	Alloxan rat	23
9	*Feronia elephantum*	Wood apple	Fruit	Aqueous	Bioflavonoid, Triterpenoid, Stigma sterol, Bergapten	500	Alloxan rat	24
10	*Murraya*	Curry-leaf	Leaf,	Fruit juice	Carbazole,	2.5-5.0	Alloxan	25

	koenigii	tree	Fruit		Alkaloid	ml/kg	mice	
11	*Limonia acidissima*	Wood apple	Fruit	Methanolic	Polysaccharide	200-400	Alloxan rat	18
12	*Allium sativum*	Garlic	Root	Ethanoic	Diallyl disulphide oxide, Ajoene, Allyl propyl disulfide, S-allyl cysteine, S-allyl mercaptocysteine	P.o., 14d, 21-112 d	STZ rat	27
13	*Aloe barbadensis*	Barbados aloe	Leaf	Aqueous	Lophenol, 24-methyl-lophenol, 24-ethyllophenol	100	Alloxan mice	28
14	*Melia dubia*	African mahogany	Leaf	Alcoholic	Liminoid	300	STZ rat	29
15	*Beta vulgaris*	Beetroot	Whole Plant	Ethanoic	Sugar beet pectin, Polydextrose	200	STZ rat	30
16	*Brassica juncea*	Mustard Seed,	Leaf	Aqueous	Isorhamnetin diglucoside	P.o., 14d	STZ rat	31
17	*Lepidium sativum*		Leaf	Aqueous		p.o., AT, p.o.,15 d	STZ rat	32
18	*Raphanus sativus*	NA	Whole plant	Aqueous	NA	p.o., 21d	STZ rat	33
19	*Cajanus cajan*	Pigeon pea	Seed	NA	(7R*,9as*)-7-phenyloctahydroquinolizin-2-one	NA	NA	34
20	*Withania somnifera*	Winter cherry	Leaf		Withanolide, Alkaloid	NA	NA	35
21	*Lycium barbarum*	Chirchita	Fruit	Crude polysaccharide extract	Polysaccharide	p.o., 21-26d; 10-250 mg/kg	STZ rat, Alloxan rabbit	36
22	*Withania coagulans*	Vegetable rennet	Fruit	Ethanolic	Milk-coagulating enzyme, Esterase, Fatty oil, Essential oil, Alkaloid	750	STZ rat	37

23	*Physalis alkekengi*	Strawberry tomato	Leaf	Aqueous	Polysaccharide	50-100	Alloxan rat	21
24	*Capsicum frutescens*	Chilli	NA	Aqueous	Capsaicin	200	STZ rat	18
25	*Catharanthus roseus*	Red periwinkle	Whole Plant	NA	Vinculin, Alkaloid	100	Alloxan rat	18
26	*Cinnamomum zeylanicum*	Cinnamon	Leaf, Bark	Ethanolic	Cinnamaldehyde	200	STZ rat	38
27	*Persea americana*	Avocado	Fruit	Aqueous	Fat, Protein, Vitamin, Mineral	450-900	Alloxan rat	18
28	*Coriandrum sativum*	Coriander	Leaf	Aqueous	Alanine	200	NA	39
29	*Cuminum cyminum*	Cumin seed	Seed	Aqueous	Aldehyde	100	NA	18
30	*Curcuma longa*	Turmeric	Root	Aqueous	Curcuminoid	NA	NA	40
31	*Zingiber officinale*	Ginger	Bulb	Aqueous	Gingerol, Ethanol	200	NA	41
32	*Eucalyptus globules*	Blue gum	Leaf	Ethanolic	Calytoside	NA	NA	42
33	*Psidium guajava*	Guava	Leaf, Fruit	Aqueous, Methanolic	Terpene, Flavonoid, Strictinin, Isostrictinin, Pedunculagin	P.o., AT; 100-400 mg/kg	STZ rat	43
34	*Syzygium jambolanum*	Jambolan	Fruit	Methanolic	Anthocyanin, Citric, Malic, Gallic acid	100 ng ml-1	STZ rat	44
35	*Syzygium cordatum*	NA	Leaf	Aqueous	Polysaccharide	p.o., 28d	STZ rat	45
36	*Ficus bengalensis*	Banyan tree	Bark	Methanolic	Leucopelargonidin	NA	NA	46
37	*Ficus carica*	Anjir	Leaf, Fruit	Aqueous	Invert sugar	NA	NA	47
38	*Egyptian Morus alba*	NA	Stem Bark	Alcoholic	NA	p.o., 10d	STZ rat	48
39	*Artocarpus heterophyllus*	Jackfruit	Fruit	Aqueous	Sapogenin	250-500	Alloxan rat	49
40	*Gymnema sylvestre*	Sugar destroyer	Leaf	Aqueous	Gymnemic acid, Gymnema, Saponin	100-200	NA	50
41	*Hordeum vulgare*	Barley	Seed	Aqueous	Beta-glucan	250-500	Alloxan rat	51
42	*Triticum*	Wheat	Whole	Aqueous	Albumin	NA	NA	52

	vulgare		Plant					
43	*Hygrophila auriculata*	Talmakhana	Whole Plant	Methanolic	Albumin	NA	NA	53
44	*Strobilanthes crispus*	NA	Leaf	Aqueous	Unknown	p.o., 21d	STZ rat	18
45	*Ibervillea sonorae*	Huereque	Root	Aqueous	Monoglyceride (MG), Fatty acid			54
46	*Momordica charantia*	Bitter melon	Whole Plant	methanolic, Aqueous, chloroformic	Charantin, Momordicin, Galactosebinding lectin Non-bitter, Diosgenin, Cholesterol	p.o., 27-30d; 10-20 mg/kg	STZ rat	55
47	*Coccinia indica*	Ivy-gourd	Fruit	Alcoholic	B-amyrin, Lupeol, Cucurbitacin B	150	Alloxan rat	56
48	*Cucumis metuliferus*	Jelly melon	Fruit	Fruit extract	B-carotene, Fatty acid	1000-1500	Alloxan rat	57
49	*Momordica cymbalaria*	Kaarali-kanda	Fruit	Aqueous	Steroidal glycoside or phenolics	0.5g/kg	STZ rat	58
50	*Momordica balsamina*	Balsam apple	Fruit	Methanolic	Momordicin, Vitamin C, Resinacid, Fixed oil, Carotene, Aromatic volatile oil	250-500	STZ rat	59
51	*Jatropha curcas*	Barbados nut	Whole Plant	Aqueous	Diterpene	NA	NA	60
52	*Phyllanthus emblica*	Indian gooseberry	Fruit	Aqueous	Tannin	350	Alloxan rat	61
53	*Emblica officinalis*	Amla	Fruit	Aqueous	Tannoid	250	STZ rat	21
54	*Mangifera indica*	Mango tree	Leaf, Stem Bark, Fruit	Aqueous, Alcoholic	Mangiferin, Phenolics, Flavonoid	100-200 mg/kg	STZ rat Alloxan rat	62
55	*Rhus coriaria*	Sicilian Sumac	Fruit	Ethanolic	Limonene, Nonanal, Dec-2 (Z)-enal	400	Alloxan wister rat	63
56	*Mentha piperita*	Peppermint	Leaf	Aqueous	Essential oil, Terpen, Flavonoid. Vanadium, Zinc,	200	STZ rat	64

					Chromium, Copper, Iron, Potassium, Sodium,			
57	*Ocimum sanctum*	Holy basil	Leaf	NA	Eugenol (1-hydroxy-2-methoxy-4-Allylbenzene)	100-200	STZ rat	65
58	*Salvia officinalis*	NA	Leaf	Aqueous		p.o.,	STZ rat	18
59	*Moringa oleifera*	Moringa	Whole plant	Aqueous	Not known	NA	STZ rat	18
60	*Musa sapientum*	Sweet banana	Flower	Aqueous	Flavonoid, Steroid, Glycoside	NA	NA	66
61	*Musa paradisiaca*	Banana	Fruit	Methanolic	Dietary fibre, Pectin	100-800	STZ rat	25
62	*Nelumbo nucifera*	Sacred lotus	Flower	Methanolic	Tolbutamide	100-500	STZ rat	67
63	*Nigella sativa*	Roman coriander	Whole plant	Aqueous	Thymoquinone	NA	NA	68
64	*Turnera diffusa*	Damiana	Leaf	Aqueous	Flavonoid, Terpene	100-500	STZ rat	18
65	*Urtica dioica*	Nettles	Leaf	Aqueous	Flavonoid, Coumarin, Lectin	250	STZ rat	18
66	*Vaccinium myrtillus*	Bilberry	Leaf, Fruit	Aqueous	Anthocyanoside	300	STZ rat	69
67	*Vaccinium angustifolium*	Wild blueberry	Fruit	Ethanolic	Phenolic	12.5 mg/ml	STZ rat	40
68	*Aloe vera*	Barbados aloe	Leaf	Ethanolic	Pseudoprototinosaponin, Prototinosaponin	P.o., 28d	Db/db mice	70
69	*Amaranthus esculentus*	NA	Whole plant	Oil fraction	Flavonoid	P.o., 21d	STZ rat	71
70	*Annona squamosa*	NA	Leaf, Fruit-Pulp	NA	NA	P.o., 10-30d; p.o., 10-15d	STZ rat, Alloxan rabbit	72
71	*Malmea depressa*	NA	Root	Aqueous, Ethanolic, n-butanol fraction	NA	p.o., AT	STZ rat	73
72	*Bryophyllum pinnatum*	NA	Leaf	Alcoholic	NA	p.o./i.p., AT	STZ rat	74
73	*Canarium schweinfurthi*	NA	Stem bark	Methanolic Methylene	NA	p.o.,14 d	STZ rat	75

				chloride				
74	*Chamaemelum Nobile*	NA	Leaf	Aqueous	NA	p.o., 15d	STZ rat	76
75	*Eugenia jambolana*	NA	Fruit pulp, Seed	Aqueous	Pandanus odorus	p.o., AT	STZ rabbit	77
76	*Artemisia sphaerocephala*	Wormwood	Fruit	Aqueous	Polysaccharide	200	Alloxan rat	78
77	*Taraxacum officinale*	Dandelion	Fruit	Aqueous	Terpenes	300	Alloxan rat	79
78	*Coscinium fenestratum*	NA	Stem bark	Alcoholic	NA	p.o., 12d	STZ rat	80
79	*Hintonia standleyana*	NA	Stem bark	methanolic	NA	p.o., AT	STZ rat	81
80	*Morinda citrifolia*	Indian mulberry	Fruit	Fruit juice	Saponin, Triterpene, Steroid, Flavonoid	2 ml/kg	STZ rat	82
81	*Hypoxis hemerocallidea*	NA	Fruit	Aqueous	NA	p.o., AT	STZ mice	83
82	*Piper betle*	Pan	Leaf	Aqueous	NA	p.o., 30 d	STZ rat	84
83	*Scoparia dulcis*	NA	Whole Plant	Aqueous	NA	p.o., 21-42 d	STZ rat	85
84	*Terminalia chebula*	Chebulic myrobalan	Seed, Fruit	chloroform, Aqueous	Shikimic, Gallic, Triacontanoic, Palmitic acid, β-sitosterol, Daucosterol	p.o., AT; 200 mg/kg	STZ rat	87
85	*Terminalia Superba*	NA	Stem bark	methanolic, methylene chloride	NA	p.o., 14 d	STZ rat	86
86	*Terminalia Catappa*	Indian almond	Fruit	Petroleum ether, Methanolic Aqueous	Phenolics	68	Alloxan rat	87
87	*Tremella mesenterica*		Fruit	Isolated compound	Palmitic acid	p.o., 14 d	STZ rat	18
88	*Ziziphus spina Christi*	Christ thorn	Leaf	n-butanol fraction, Hydroalcoholic	Christinin-A, Fatty acid	p.o., AT; 500 mg/kg	STZ rat, Alloxan Dog	88
89	*Carica papaya*	Papaya	Fruit	Aqueous	Saponin, Tannin, Alkaloid, Flavonoid Anthraquinone	100-400	Wistar rat	21

					,			
90	*Thespesia populnea*	Portia tree	Fruit	Alcoholic	Populnetin, Herbacetin, Populneol, Quercetin	100-300	Alloxan rat	21
91	*Abelmoschus esculentus*	Gumbo	Fruit	Ethanolic	Carbohydrate, Gum, Mucilage, Phytosterol, Flavonoid, Tannin, Volatile oil	300	Alloxan mice	21
92	*Diospyros peregrine*	Gaub persimmon	Fruit	Aqueous	Lupeol, Betulin, Gallic acid, Betulinic acid, Hexacosane, Hexacosanol, Sitosterol	50-100	STZ rat	21
93	*Diospyros lotus*	Date plum	Fruit	Aqueous	Phenolics	150-1000	STZ rat	21
94	*Ganoderma lucidum*	Reishi mushroom	Fruit	Polysaccharide fraction	Polysaccharide	25-100	STZ rat	21
95	*Grifola frondosa*	Maitake	Fruit	Diethyl ether, Ethyl alcohol	Disaccharide	20% Maitake Extract	Glucose tolerance mice	21
96	*Helicteres isora*	East Indian screw tree	Fruit	Aqueous	Steroid, Terpenoid, Alkaloid, Carbohydrate,	500µg/ml	Glucose tolerance rat	21
97	*Lodoicea sechellarum*	Sea coconut	Fruit	Fruit extract	Carbohydrate	2-4g	Type II diabetic patient	21
98	*Punica granatum*	Pomegranate	Fruit	Ethanolic	Tannin	200	Alloxan mice	21
99	*Panax ginseng*	Ginseng	Fruit	Berry extract	Saponin	150	Glucose tolerance mice	21
100	*Opuntia dillenii*	Prickly pear	Fruit	Polysaccharide extract	Polysaccharide	100-400	STZ rat	21
101	*Lyophyllum decastes*	Fried chicken mushroom	Fruit	Aqueous	Polysaccharide	500	KK-Ay diabetic mice	21
102	*Viburnum opulus*	Cranberry bush	Fruit	Aqueous	Tannin	100	Alloxan mice	21

103	*Butea monosperma*	Flame of the forest	Fruit	Aqueous	Flavonoid	3g	Type II diabetic patient	21
AT: Acute treatment, GLUT-4: Glucose transporter, Hex: Hexane fraction, i.p.: Intraperitoneal route, p.o.: oral route and STZ: Streptozotocin, NA- Data not available								

DISCUSSION

Diabetes mellitus is spreading in an alarming way throughout the world and three fourth of the world populations and considered a major cause of high economic loss which can in turn impede the development of nations. Moreover, uncontrolled diabetes leads to many chronic complications such as blindness, heart disease, and renal failure, etc. For this, therapies developed along the principles of western medicine (allopathic) are often limited in efficacy, carry the risk of adverse effects, and are often too costly, especially for the developing world. Therefore, treating diabetes mellitus with plant derived compounds which are accessible and do not require laborious pharmaceutical synthesis seems highly attractive.

The study revealed that 103 plant species belonging to different families were generally used for treatment of diabetes. The majority of the experiments confirmed the benefits of medicinal plants with hypoglycemic effects in the management of diabetes mellitus. Among the plants used for diabetes, *Annona squamosa, Momordica charantia, Egyptian Morus alba, Lycium barbarum, Allium sativum,* and *Aegle marmelose* seems to be most common plants used to treat diabetes and are available everywhere. The detailed natural plants not only used for the treatment of diabetes but also treated for other ailments. The fruits were most commonly used plant parts and other parts (leaf, root, stem, bark, flower, and whole plant) were also useful for curing.

However, the diabetic model that was most commonly used was the streptozotocin and alloxan-induced diabetic mouse or rat as diabetic models. In this study, most commonly used animal model was STZ rat. In some cases, alloxan mice, glucose tolerance mice, KK-Ay diabetic mice, and diabetic patient were used as a model. Some authors have used hereditary diabetic mice e.g. KK Ay mice as a model of type II diabetes with hyperinsulinemia.

The most commonly involved active constituents are Flavonoid, Tannin, Phenolics, and Alkaloid. Numerous mechanisms of actions have been proposed for these plant extracts. Some hypotheses relate to their effects on the activity of pancreatic ß cells (synthesis, release)

or the increase of insulin sensitivity or the insulin-like activity of the plant extracts. All of these actions may be responsible for the reduction or abolition of diabetic complications.

CONCLUSION

The present review has presented comprehensive details of antidiabetic plants used in the treatment of diabetes mellitus. These medicinal plant traditionally been used for the antidiabetic activity and now these are proved by the scientific studies by in-vivo and in-vitro experiments. The natural medicinal plant based therapies are cheap without any undesirable side effect. Some of these natural herbs are been used as dietary supplement. This review will help the researchers for further studies to evaluate the identification of lead molecule for the treatment of antidiabetic activity. The presences of bioactive chemicals such as flavonoids, alkaloids, triterpinoids, tannins and saponins are mainly responsible for the anti-diabetic action. However, many other active agents obtained from plants have not been well characterized. More investigations must be carried out to evaluate the mechanism of action of medicinal plants with antidiabetic effect.

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