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Review Article

A REVIEW ON MEDICINAL PLANTS OF RAJASTHAN HAVING ANTIDIABETIC ACTIVITY

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ABSTRACT

Diabetes is one of the most common chronic diseases in nearly all countries, and continuously increasing in numbers and significance, as changing lifestyles lead to reduced physical activity. Diabetes is the leading cause of blindness, renal failure, and lower limb amputation. Diabetes is also now one of the leading causes of death, largely because of a markedly increased risk of coronary heart disease and stroke. Due to the existing synthetic drugs have many limitations, the medicine from plants is drawing ever-increasing attention worldwide, due to their low toxicity and few side effects. The present review is providing data of some important medicinal plants species possessing antihyperglycemic and antidiabetic activity. It would provide a handbook for the research related to diabetes. Further, efforts should be made to implement these plants based drugs in clinical trials.

Keywords: Antidiabetic, Antihyperglycemic, Hypolipidemic

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INTRODUCTION

Diabetes mellitus (DM) is the most common metabolic disorder characterized by irregulation of carbohydrate, protein, and fat metabolism. It leads to high blood glucose concentration or hyperglycemia and secondary to an absolute or relative lack of the hormone insulin [1]. Insulin unavailability may be due to degenerative changes in β-cells in the pancreatic islets, reduced effectiveness of the hormones due to the formation of anti-insulin antibodies or inactive complexes, immune-mediated islet cytotoxicity, or inappropriate secretion of hormones by neoplasm in other endocrine organs [2]. Deficiency or insensitivity causes glucose to accumulate in the blood, leading to various complications. Polydipsia, polyphagia, and excessive weight loss occurred due to this. Classification of DM is based on its etiology and clinical presentation. There are four types of DM such as type 1 diabetes, type 2 diabetes, gestational diabetes, and other specific types [3]. Type I diabetes, often referred to as juvenile diabetes, is insulin dependent and known to affect only 5% of the diabetic population. Type 1 diabetes is said to account for only a minority of the total burden of diabetes in a population although it is the major type of diabetes in younger age groups at majority of well-to-do countries. The incidence of type 1 diabetes is increasing in both rich and poor countries. Type 2 DM accounts for over 85% of DM worldwide and is associated with a high incidence of morbidity and mortality. It is estimated that 143 million people worldwide suffering from this disease. It has been predicted that the number may probably double by 2030. With an estimated 50.8 million people living with diabetes, India has the world's largest diabetes population, followed by China with 43.2 million. In 2011, it was reported that one person died from diabetes-related causes every 7 s. Annual global health-care spending on diabetes was up to US $465 billion in 2011 (International Diabetes Federation, 2011a). In the management of type 2 DM, lifestyle modification (exercise, weight control, and nutrition) is crucial [4].

At present, available therapy for diabetes includes insulin and a range of oral hypoglycemic agents such as sulfonylureas, metformin, glucosidase inhibitors, and troglitazone. However, these are reported to produce serious adverse side effects such as liver problems, lactic acidosis, and diarrhea [5].

Plants have their chemical compounds which demonstrate alternative and safe effects on DM. The majority of plants contain various phytoconstituents, namely glycosides, alkaloids, terpenoids, flavonoids, carotenoids, etc., that is, frequently implicated as having antidiabetic effect [6]. To date, hundreds of herbs and traditional medicine formulas have been reported to have been used for the treatment of DM. In the past decade, research has been focused on scientific evaluation and justification of traditional drugs of plant origin and screening of more effective and safe antidiabetic potentials has continued to be an important area.

ANTIDIABETIC ACTIVITY OF MEDICINAL PLANTS OF RAJASTHAN

Rajasthan, the largest state of India exhibits variety in physiognomy, climate, and soil, therefore, the vegetation including a wide variety of medicinal plants. The tribals of remote areas of Rajasthan are totally dependent on indigenous system of medicine for their health as it is difficult for them to get modern medical facilities for their day-to-day health problems. The traditional healers of Rajasthan are having a commendable knowledge of the medicinal intrinsic worth of plants that grow around them [7]. Various ethnobotanical studies carried out in Rajasthan indicate that some plants are being used for their antidiabetic potential by most of the tribals.

***Acacia nilotica* (Family - *Mimosaceae*, Local name - Babul, Kikar)**
It is a moderate-sized tree with a spreading crown. It is indigenous to the Indian subcontinent as also in Tropical Africa, Burma, Sri Lanka, Saudi Arabia, and Egypt, and in West and East Sudan. In India, natural babul forests are generally found in Rajasthan. It contains catechin, gallolyated flavan-3, 4-diol, robidandiol, androstene steroid, d-pinitol carbohydrate, catechin-5-galloyl ester, and gallic, m-digallic, and chlorogenic acids, the plants in the Middle East are also rich in potassium, phosphorus, magnesium, iron, and manganese [8]. A study shows that the leaves extract of this plant has significant hypoglycemic, antioxidant, and hypolipidemic effect. This potential activity of *A. nilotica* leaf might be due to the presence of its phytochemicals or the collective action of many active ingredients (Fig. 1).

***Argemone mexicana* L. (Family - *Papaveraceae*, Local name - Pili kateli/Satayanasi)**
It is commonly known as prickly poppy and is an indigenous herb used as a medicinal plant in several parts of Rajasthan. The plant consists of alkaloids, namely berberine, protopine, sarguinarine, optisine, chelerythrine, etc. Medicinal plants being the effective source of both traditional and modern

medicines are genuinely useful for primary health care. Hypoglycemic and antidiabetic activity of ethanolic and aqueous extracts of whole plants have been reported in normoglycemic and alloxan-induced hyperglycemic rats by single-dose and multi-dose treatment [9] (Fig. 2).

***Capparis decidua* (Family - *Capparidaceae*, Local name - Kair)**
C. decidua is the native plant of Thar desert. The plant is xerophytic and drought resistant; belongs to family *Capparidaceae*. The genus *Capparis* comprises 250 species including trees, shrubs, and woody climbers, but in India, only 26 species of the genus are reported [10,11] commonly known as teent in Rajasthan. The plant is rich in nutrient, used for nutraceutical purposes by local people. Young berries are used to make pickle and vegetable [12]. The plant is an important component of desert ecosystem. Various phytoconstituents have been isolated from *C. decidua*. Various phytoconstituent have been isolated from *C. decidua* such as β-sitosterol, spermidine alkaloid, isocodonocarpine, Capparine, Cappariline, Capparinine are isolated from root [10,13]. Ethanolic extract of aerial part of the plant showed anti-inflammatory and analgesic activity. Fruits have antidiabetic, hypolipidemic, anti-atherosclerotic, and antihypertensive activities. Alcoholic extract obtained from bark, flower, and fruit showed hypolipidemic activity in model rat (Fig. 3).

***Catharanthus roseus* (Family - *Apocynaceae,* Local name - Rose periwinkle)**
Catharanthus is commonly used in most of the herbal preparations for diabetes. It has been reported to consist of anticancer activity [14], antidiabetic activity (flowers and leaves) [15], hypolipidemic activity [16], and antioxidant activity [17]. The main phytoconstituents present in this plant are alkaloids [14], flavonoids [18], and steroids [19]. It has been used effectively in various traditional systems of medicines for the treatment of diabetes. Catharanthine is the major active phytoconstituents in *C. roseus* that shows antidiabetic activity (Fig. 4).

***Datura inoxia* Mill. (Family - *Solanaceae*, Local name - Dhatura)**
It is a low growing, spreading perennial with hairy 2–5 in. leaves, white flowers, and a spiny fruit plant. This plant conquers a very special place in Ayurveda since all plant parts, namely flowers, leaves, root, stem, fruit, and seeds, have been meritoriously employed for a range of treatments such as insanity, rabies, and leprosy. *D. inoxia* includes atropine, scopolamine hyoscyamine, with an olides (lactones) and other tropanes. Leaf extracts show flavonoids, phenolic compounds, cardiac glycosides, and sugars, and the formation of the Fe_3O_4 nanoparticles was first monitored using UV-Vis absorption spectroscopy typical surface plasma absorption maxima at 270–290 nm. Seed extracts of *D. inoxia* have the strongest antioxidant potential [20] (Fig. 5).

***Morus alba* (Family - *Moraceae*, Local name - White mulberry)**
It is usually a short-lived plant native to north China. Moracin M, steppogenin-4′-O-β-D-glucoside, and mulberroside A were isolated from the root bark of *M. alba* L. These all produced hypoglycemic effects [21]. Hypolipidemic and antioxidant effects from freeze-dried powder of mulberry (*M. alba* L.) fruit are also investigated [22]. Mulberroside A, a glycosylated stilbenoid, can be useful in the treatment of hyperuricemia and gout [23,24]. An ethanolic extract of mulberry leaf has antihyperglycemic, antioxidant, and antiglycation effects in chronic diabetic rats [25] (Fig. 6).

***Pterocarpus marsupium* (Family - Fabaceae, Local name - Indian Kino Tree)**
Pterocarpus is a genus of pantropical trees. The diseases commonly treated by *Pterocarpus* in the Ayurveda system are diabetes, inflammation, and bleeding. The bark of plant is also useful for bleeding and toothaches. The leaves are often applied externally as a remedy for skin diseases ethyl acetate extract of root contains benzofuranone, marsupium stilbene, pterostilbene, etc., marsupium and pterostilbene significantly lower the blood glucose levels useful in diabetic rats while pterostilbene acts as hypolipidemic, hypoglycemic, significant reduction in glycosylated Hb, and increase in total Hb level. The wooden glass made up of heartwood of *P. marsupium* is being used for drinking water to control blood sugar and strong antidiabetic in Ayurvedic system of medicine. Heartwood of *P. marsupium* has been examined clinically and found efficient in insulin-independent DM patients (type 2 DM) [26] (Fig. 7).

***Tinospora cordifolia* (Family - Menispermaceae, Local name - giloy)**
T. cordifolia is a shrub that is native to India. Its root, stems, and leaves are used in Ayurvedic medicine. It is used for diabetes, high cholesterol, allergic rhinitis (hay fever), upset stomach, gout, lymphoma and other cancers, rheumatoid arthritis, hepatitis, peptic ulcer disease, fever, gonorrhea, syphilis, and to boost the immune system. *T. cordifolia* is the major sources

Fig. 1: ***Acacia nilotica***

Fig. 2: ***Argemone mexicana L***

Fig. 3: ***Capparis decidua***

Fig. 4: ***Catharanthus roseus***

Fig. 7: ***Pterocarpus marsupium***

Fig. 5: ***Datura inoxia*** **Mill.**

Fig. 8: ***Tinospora cordifolia***

Fig. 6: ***Morus alba***

Fig. 9: ***Tridax procumbens*** **Linn.**

of tinosporine, cordifolide, tinosporide, cordifole, and columbin that regulate cholesterol synthesis and glycolysis [27-29] (Fig. 8).

Tridax procumbens **Linn. (Family - Asteraceae, Local name - Rukhari)**
It is a species of flowering plant in the daisy family. It is best known as a widespread weed and pest plant. It has been extensively used in Indian traditional medicine as anticoagulant, antifungal and insect repellent, in bronchial catarrh, diarrhea, and dysentery. Moreover, it comprises wound remedial activity and promotes hair growth. It is also diverse as Bhringraj, which is well-known Ayurvedic medicine for liver disorders [30]. Antioxidant properties [31] of this plant have also been demonstrated (Fig. 9).

Xanthium strumarium **Linn. (Family - Asteraceae, Local name - Aadha-Shishi)**
This plant is a summer annual that becomes about 2–4' tall. The aerial parts of the plant contain a mixture of unidentified alkaloids, sesquiterpene lactones, namely xanthinin, xanthatin, and xanthosine, guaianolides, germacranolides, and elemanolides, sulfated, glycoside,

Table 1: Plants with antidiabetic activity

S. No.	Plant name	Family	Part used	Extract	Activity	References
1	*Abroma augusta*	*Malvaceae*	Leaves	Methanol	Antidiabetic	[35]
2	*Acacia catechu*	*Leguminosae*	Hardwood	Ethanol and aqueous	Antidiabetic and antidyslipidemic	[36]
3	*Acacia melanoxylon*	*Leguminosae*	Seeds	Hydro alcoholic	Antidiabetic	[37]
4	*Adiantum caudatum*	*Polypodiaceae*	Whole plant	Ethanol	Hypoglycemic and antihyperlipidemic	[38]
5	*Albizia odoratissima*	*Leguminosae*	Bark	Methanol	Hypoglycemic	[39]
6	*Alternanthera ficoidea*	*Amaranthaceae*	Stem and leaves	Ethanol	Antidiabetic	[40]
7	*Andrographispaniculata*	*Acanthaceae*	Leaves	Ethanol	Antidiabetic	[41]
8	*Artocarpus heterophyllus*	*Moraceae*	Fruit	Aqueous	Antidiabetic, antioxidant activity	[42]
9	*Asparagus racemosus*	*Asclepiadaceae*	Roots	Ethanol	Antidiabetic	[43]
10	*Azadirachta indica*	*Meliaceae*	Leaves	Ethanol	Antidiabetic activity	[41]
11	*Bambusa arundinacea*	*Gramineae*	Leaves	Ethanol	Hypoglycemic	[44]
12	*Boerhavia diffusa*	*Nyctaginaceae*	Leaves	Aqueous	Antihyperlipidemic	[45]
13	*Brassica juncea*	*Cruciferae*	Leaves	Methanol	Antihyperglycemic	[46]
14	*Brassica oleracea*	*Cruciferae*	Leaves	Methanol	Hypoglycemic and hypolipidemic	[47]
15	*Calotropis procera*	*Asclepiadaceae*	Leaves	Hydroalcoholic	Antihyperglycemic	[48]
16	*Capsicum annum*	*Solanaceae*	Red chili pepper	Ethanol	Hypoglycemic and hypocholesterolemic	[49]
17	*Cassia fistula*	*Leguminosae*	Bark	Ethanol	Antidiabetic	[50]
18	*Cinnamomumburmannii*	*Lauraceae*	Bark	Aqueous	Hypoglycemic, antidiabetic	[51]
19	*Cissampelos pareira*	*Menispermaceae*	Leaves	Aqueous	Hypoglycemic	[52]
20	*Citrus lemon*	*Rutaceae*	Peel	n-hexane	Hypoglycemic	[53]
21	*Curcuma longa*	*Zingiberaceae*	Rhizome	Aqueous	Hypoglycemic, hypolipidemic	[54]
22	*Dalbergia sissoo Roxb.*	*Fabaceae*	Bark	Ethanol	Antidiabetic	[55]
23	*Ephedra sinica*	*Gnetaceae*	Whole plant	Hydroalcoholic	Antiobesity and antihyperglycemic	[56]
24	*Eucalyptus camaldulensis*	*Myrtaceae*	Leaves	Aqueous	Antioxidant, antidiabetic	[57]
25	*Euphorbia hirta*	*Euphorbiaceae*	Whole plant	Petroleum ether and methanol	Antidiabetic	[58]
26	*Ficus racemosa*	*Moraceae*	Stem bark	Hexane	Antidiabetic	[59]
27	*Foeniculum vulgare*	*Umbelliferae*	Aerial part	N-hexane, methanol	Antihyperglycemic	[60]
28	*Gymnema sylvestre*	*Asclepiadaceae*	Leaves	Aqueous	Antidiabetes	[61]
29	*Ipomoea batatas*	*Convolvulaceae*	Leaves	Aqueous	Antidiabetic	[62]
30	*Jatropha curcas*	*Euphorbiaceae*	Leaf	Methanol	Antihyperglycemic and hypolipidemic	[63]
32	*Moringa oleifera*	*Moringaceae*	Pods	Methanol	Antidiabetic	[64]
33	*Murraya koenigii*	*Rutaceae*	Leaves	Aqueous	Antidiabetic	[65]
35	*Nelumbo nucifera*	*Nymphaeaceae*	Flower	Ethanol	Hypoglycemic	[66]
36	*Nerium oleander*	*Apocynaceae*	Fresh shoot	Aqueous	Increased glucose uptake and insulin-binding activity	[67]
37	*Nyctanthes arbor-tristis*	*Oleaceae*	Roots	Methanol	Antidiabetic	[68]
38	*Ocimum sanctum*	*Labiatae*	Leaves	Hydroalcoholic	Antidiabetic	[69]
39	*Opuntia dillenii*	*Cactaceae*	Cladodes	Aqueous	Antidiabetic	[70]
40	*Oryza sativa*	*Gramineae*	rice bran	Aqueous ethanol	Antidiabetic	[71]
41	*Panicum maximum*	*Poaceae*	Leaf	Ethanol	Antidiabetic	[72]
42	*Physalis peruviana*	*Solanaceae*	fresh leaves	Aqueous	Antidiabetic	[73]
43	*Piper longum*	*Piperaceae*	Fruits	Ethanol	Antihyperglycemic, antioxidant potential	[74]
44	*Pisum sativum*	*Leguminosae*	Pods	Aqueous	Hypolipidemic and pancreatic lipase inhibitory activity	[75]
45	*Psidium guajava*	*Myrtaceae*	Leaves	Ethanol	Hypoglycemic and antihyperglycemic	[76]
47	*Rauwolfia serpentina*	*Apocynaceae*	Roots	Hydro methanol	Antihyperglycemic	[77]
48	*Syzygium polyanthum*	*Myrtaceae*	Leaf	Methanol	Antihyperglycemic	[78]
49	*Tamarindus indica*	*Leguminosae*	Seeds	Hydro methanol	Antidiabetic, antihyperlipidemic	[79]
50	*Tectona grandis*	*Verbenaceae*	Bark	Methanolic	Antioxidant, antidiabetic	[80]
51	*Terminalia arjuna*	*Combretaceae*	Bark	Aqueous	Antidiabetic	[81]
52	*Tinospora bakis*	*Menispermaceae*	Seeds	Aqueous	Antihyperglycemic and antihyperlipidemic	[82]
53	*Zizyphus mauritiana*	*Rhamnaceae*	Fruits	Ethanol	Antidiabetic	[83]

Fig. 10: *Xanthium strumarium* **Linn.**

xanthostrumarin, atractyloside, and carboxyatractyloside. Fruits are rich in Vitamin C. This plant is found to possess diverse biological activities including antibacterial, antifungal, antimalarial, anti-rheumatic, antispasmodic, antitussive, cytotoxic, hypoglycemic, stomachic, tonic, diuretic, sedative, allergic rhinitis, sinusitis, urticaria, constipation, diarrhea, lumbago, leprosy, and pruritis [32,33]. The acetone extract of fruits of *X. strumarium* L. is reported to have antidiabetic activity due to the presence of phenolic compounds [34] (Fig. 10).

Plants listed above also have been reported with antioxidant, antihyperglycemic, and hypoglycemic effects which may be important in the management of diabetes (Table 1).

CONCLUSION

This review reports the advantages of herbal drugs over the synthetic drugs. Major fraction of the plants listed above has been reported with antioxidative and antihyperglycemic effect which may be important in the management of these diseases. The result of this review can be helpful for the drug industry to study on the components of these herbs and investigate further to find a component with higher efficacy. Further, well-designed clinical trials are still needed to focus on safe and cost-effective herbal products.

AUTHORS' CONTRIBUTION

Charuta Mathur: The main author is doing her thesis on "antidiabetic activity of methanolic crude extract of *Capparis decidua* in male albino rats." Dr. R.S Gupta: Corresponding author is the supervisor of main author. He has been working as Associate Professor in the Department of Zoology, University of Rajasthan. He has been involved in various projects of antifertility and antidiabetic activity of various plant extracts.

CONFLICTS OF INTEREST

There are no conflicts of interest in the submitted review article.

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