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Review Article

ANTIDIABETIC MEDICINAL PLANTS: A REVIEW

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ABSTRACT

Diabetes is a metabolic disorder which is mainly characterized by hyperglycaemia and arises by the defects in insulin secretion or insulin action or both. It is categorized into two types, type-I and type-II diabetes. The risk factors that are responsible for diabetes are genetic factor, obesity, hypertension etc. Conventionally many drugs are used for the treatment of diabetes such as biguanides, sulfonylureas, meglitinides etc. But the desired effective treatment is still not to be achieved. So researches are going on for the development of alternate effective therapy against diabetes. Medicinal plants are promising source and also very useful for the development of complimentary therapy. In India medicinal plants are widely used traditionally for the prevention and cure of diabetes. This review article consists the description of the herbs which are reported to have good antidiabetic property.

KEYWORDS: Diabetes, alternative therapy, herbs, hyperglycaemia.

INTRODUCTION

Diabetes mellitus is a very common metabolic disorder which affects the human population throughout the world, characterized by hyperglycaemia and arises due to defects in insulin secretion, insulin action or both. Chronic hyperglycaemia which is a common effect of uncontrolled diabetes causes long-term damage, dysfunction and failure of several organs such as kidneys, eyes, nerves, heart and blood vessels[1]. Diabetes is mainly categorized into two types, type-I diabetes and type-II diabetes.

Type-I diabetes is known as insulin dependent diabetes and characterized by deficient production of insulin, requires daily administration of insulin. This happens due to the cellular-mediated autoimmune destruction of the β cells of pancreas.

Type-II diabetes commonly known as non-insulin dependent diabetes which causes due to the ineffective use of the insulin by the body. The following risk factors are commonly involved in the development of type-II diabetes such as genetic factors, obesity, poor diet, insufficient physical activity, advancing age, hypertension etc.[2-3]. There is a another class of diabetes is reported known as gestational diabetes which mainly arises from glucose intolerance, with an onset during pregnancy. This is a temporary condition but it may carries the long term risk of diabetes[4].

According to World Health Organization, in 2014 it is found that 422 million adults are affected by diabetes. It causes 1.5 million deaths in 2012 and it is seen that the majority of population are mainly affected by type-II diabetes. It is also found that previously type-II diabetes was diagnosed among adults but now it occurs in children also[5]. The oxidative stress is a known pathogenic mechanism in the development and progression of diabetes which causes due to increased free radical production and impaired antioxidant defenses[6-8].

Many drugs are used conventionally for the prevention and management of diabetes such as biguanides, sulfonylureas, meglitinides, PPAR-γ agonists (glitazones), α-glucosidase inhibitors, DPP-4 inhibitors, SGLT2 inhibitors, dopamine-2 agonists etc. But still effective treatment against diabetes yet to be achieved[9]. Research is going on for establishing alternative effective therapies against diabetes. The medicinal plants played an important role in this research as they always are an exemplary source of drugs. In India many herbs are found to be useful for the management of diabetes. From the ethnobotanical information it is found that approximately 800 plants may possess antidiabetic potential[10].

From the knowledge and detailed survey of the medicinal plants we might be able to discover new drugs which are therapeutically active and also cheaper. There are certain advantages of using herbs in the treatment, such as they are easily available, low side effects etc. In this review description about the antidiabetic medicinal plants are given which are reported to have good therapeutic activity by thorough literature survey.

REVIEW

The review work was carried out by thorough searching of different research articles and patents from different online journals from Pubmed, Google scholar, Science direct etc. The literature of scientifically validated plants are also collected which are having good antidiabetic property.

Pterocarpus santalinus (*Fabaceae*)

The plant is commonly known as red sandalwood and saunderswood is widely found in South India. It contains several chemical constituents, such as carbohydrates, steroids, anthocyanins, saponins, tannins, phenols, triterpenoids, flavonoids, glycosides[11]. The main active constituent of the plant is santalin. It also contains pterocarpol, pterocarptriol, ispterocarpolone, pterocarpo-diolones with β-eudeslol and cryptomeridol[12]. It is used as antidiabetic, antihelmintic, aphrodisiac and astringent tonic. It is also used in the treatment of inflammation and ulcer. Several studies are reported which shows about the antidiabetic property of the plant. The heartwood cups for drinking water is the traditional use of the plant in the treatment of diabetes[13-14]. Rao *et al* reported that the hypoglycemic activity at a dose level of 0.25 g/kg body weight/day was showed by the ethanolic fraction of the plant[15]. Halim and Mishra found that when the 250 mg/kg of aqueous extract of the plant is coadministered with vitamin E to the streptozotocin induced diabetic rats then it caused significant lowering of blood pressure [16].

***Brassica juncea* (Brassicaceae)**

This plant is commonly known as brown mustard, Chinese mustard is widely found in Europe, Africa, North America and Asia. It contains several important chemical constituents such as triterpenes, Saponins, alkaloids, flavonoids etc[17]. It is pharmacologically used as antiscorbutic, diuretic, stimulant, stomachic, antihelmintic, antidysentric, diaphoretic, antiarthritic. Thirumalai T *et al* reported that the aqueous seed extract of the plant showed potent hypoglycemic activity at a dose level of 250, 350 and 450 mg/kg in streptozotocin induced diabetic male albino rat[18].

***Swertia punicea (*Gentianaceae)**

The plant is commonly available in India, Pakistan, China, Japan and other Asian countries. It contains important group of constituents such as xanthonoids, terpenoids, flavonoids, alkaloids, irridoid glycosides etc. Among them xanthonoids are the most abundant class of compounds[19]. It is therapeutically used as a hypoglycemic, antihepatotoxic, anti-inflammatory, anti-malarial, antioxidant, antimicrobial etc. There are numerous studies are reported about the antidiabetic property of the herb. A study which is reported by Pen and Fang clearly states that this plant has a potent hypoglycemic effect [20]. Wen L., Chen J.C reported that the hypoglycemic effect was showed by the ethanol extract and ethyl acetate soluble fractions of the plant in streptozotocin induced type-II diabetic mice[21]. A study reported by L.Y. Tian *et al* states that the significant antidiabetic effect was showed by the xanthone derivatives Methylswertianin and Bellidifolin isolated from the plant at the dose of 200mg/kg body wt. /day in the Streptozotocin (STZ)-induced type 2 diabetic male BABL/c mice[22].

***Gymnema sylvestre* (Asclepiadaceae)**

It is a perennial woody vine that is mainly grown in tropical areas of India, Africa and Australia. The main active constituent of the plant is gymnemic acid. Other active constituents are flavones, anthraquinones, hentri-acontane, pentatria contane, α and βchlorophylls, phytin, resins, d-quercitol, tartaric acid, formic acid etc[23]. Daisy *et al* found that in streptozotocin induced diabetic rats the crude extracts of the plant and its isolated compound dihydroxy gymnemic triacetate showed significant hypoglycemic effect in dose and time dependent manner[24]. A study reported by Liu *et al* clearly states that insulin secretion from mouse cells was stimulated by the aqueous extract of the leaves of the plant and isolated human islets *in vitro* without compromising cell viability at the doses of 0.06-2 mg/ml and 0.125 mg/ml[25].

***Ricinus communis (*Euphorbiaceae)**

This plant is a species of perennial flowering plant and widely available in India. It contains several chemical constituents such as steroids, Saponins, alkaloids, flavonoids and glycosides etc. The seeds and fruits contain 45% of fixed oil which contains glycosides of ricinoleic, isoricinoleic, stearic, dihydroxystearic acids[26]. Pharmacologically it is used as an anticancer, antioxidant, antiulcer, antimicrobial, antidiabetic, hepatoprotective, central analgesic, antiasthmatic etc. Dhar ML *et al* reported that the root, stem and leaves of the plant showed hypoglycemic activity in the albino rats at the dose of 250 mg/kg in the initial screening studies[27]. Poonam Shokeen *et al* reported that the ethanolic extract of the roots of the plant showed potent blood glucose lowering activity in alloxan induced diabetic rats at a dose of 500 mg/kg[28].

***Combretum micranthum* (Combretaceae)**

This plant is commonly found in Northwestern Nigeria, Senegal, Mali and Gambia. It contains several classes of compounds such as alkaloids, flavonoids, tannins, terpenoids etc[29]. It has several pharmacological uses such as antioxidant, anti-inflammatory, antimicrobial etc. Aminu Chika *et al* reported about the potential antidiabetic property of the aqueous leaf extract of the plant at a dose level of 100mg/kg in diabetic and sub-diabetic rats[30].

***Arbutus unedo* (Ericaceae)**

It is an evergreen shrub which is native to the France and Ireland. There are different classes of compounds are present in this plant such as terpenoids, α-tocopherol, essential oils, phenolic compounds and organic acids[31]. It is used in the treatment of cardiovascular diseases, gastrointestinal disorders, dermatological problems, diabetes, inflammation, hypertension etc. Mrabti H *et al* reported that the aqueous extract of the plant showed significant *in-vitro* and *in-vivo* antidiabetic effect in the streptozotocin-nicotinamide (STZ-NA) induced diabetic mice at the dose of 500 mg/kg and also it improves metabolic alternations[32].

Cocos nucifera (*Arecaceae*)

It is commonly known as coconut widely available in the coastal regions of India. It contains several important chemical constituents such as phenols, tannins, leucoanthocyanidins, flavonoids, triterpenes, steroids, and alkaloids [33]. It is used pharmacologically as an analgesic, anti-inflammatory, anti-bacterial, antifungal, antioxidant, antiparasitic, antimalarial, cardioprotective etc. S. Saranya *et al* found that the significant antidiabetic activity was showed by the flowers extract of the plant in the streptozotocin induced diabetic rats at the dose of 300 mg/kg[34]. Nidhi Tyagi *et al* reported that ethanolic extract of this plant showed potent antidiabetic activity at the doses of 200 mg/kg and 400 mg/kg in the streptozotocin induced diabetic rats[35].

***Sarcopoterium spinosum* (Rosaceae)**

This plant is commonly found in the Mediterranean region and Middle East. Several flavonoids and phenolics compounds are present in this plant such as Quercetin, hesperidin, naringin, rutin, gallic acid, catechol, protocatechuic acid etc[36]. It was used traditionally used for the treatment of diabetes. It is also used in the treatment of digestive problems, inflammation and pain. A study reported by Dafni *et al* states that the root extract of the plant was used in muslim folk medicine for the treatment of

diabetes[37]. Polina Smirin *et al* reported that the root extract of the plant showed potent hypoglycemic activity at a concentration of 0.01 mg/ml in diabetic KK-A^{y} mice[38].

Vernonia anthelmintica (*Asteraceae*)

The commonly known as wild cumin is an annual herbaceous plant and widely found throughout the India. The main active constituent of the plant is Delta-7-avenasterol that is a steroidal compound which is present in the seeds of the plant. It also contains other constituents such as p-hydroxybenzoyl- vernovan and vernovan which are flavan glycosides, other sterols such as 4-alpha-methylvernosterol, vernosterol, bitter principle demanolide lactone etc[39]. It is used in the treatment of inflammation, arthritis, diabetes, cancer etc. Shaik Sameena Fatima *et al* reported that the ethanolic extract of the plant showed potent antihyperglycemic activity at a dose of 100 mg/kg in streptozotocin induced diabetic rats[40].

***Elephantopus scaber (*Asteraceae)**

It is a tropical species of flowering plants which is native to tropical Africa, Eastern Asia, Indian Subcontinent, Southeast Asia, and northern Australia. The major chemical constituents of the plant are sesquiterpene lactones, phenolic acids and flavonoids[41]. Pharmacologically it is used as an anticancer, antitumour, anti-inflammatory, antibacterial, antifungal, anticoagulant, hepatoprotective etc. A study reported by Daisy P *et al* clearly states that in streptozotocin induced diabetic rats significant hypoglycemic effect is showed by the acetone extract of the plant[42].

***Liriope spicata* (Asparagaceae)**

It is an herbaceous flowering plant which is native to East Asia. It contains numerous phytochemical constituents such as steroidal Saponins, polysaccharides etc[43]. Pharmacologically it is used as an anti-inflammatory, anti-asthmatic, anticancer etc. Xianghong Chen *et al* reported that the aqueous extract of the plant showed significant hypoglycemic effect in streptozotocin (STZ)-induced type 2 diabetic male BABL/c mice at the doses of 200 and 100 mg/kg[44].

***Mangifera indica* (Anacardiaceae)**

This plant is commonly known as mango which is native to indian subcontinent. It contains numerous chemical constituents among them polyphenolics, flavonoids and triterpenoids are specific. The main bioactive constituent is mangiferin, which is a xanthone glycoside. The other active constituents present in this plant are isomangiferin, tannins etc[45]. It has several pharmacological uses such as antioxidant, antidiabetic, antiviral, anthelmintic, antiallergenic, antiparasitic, antidiarrhoeal etc. Aderibigbe AO *et al* reported that the aqueous extract of the leaves of the plant showed significant hypoglycemic activity in normoglycaemic and glucose-induced hyperglycaemic mice[46].

***Aloe vera* (Asphodelaceae)**

It is an evergreen perennial plant which mainly grows in tropical climates around the world and also cultivated in large scale for its medicinal values. This plant mainly contains anthraquinone glycosides such as aloe-emodin, barbaloin, isobarbaloin etc[47]. Ayse Can *et al* reported that aloe leaf gel extract shows beneficial effect as an antidiabetic agent[48]. Jain N *et al* reported that the significant antidiabetic activity was showed by the aloe vera gel at a dose of 200 mg/kg in streptozotocin induced diabetic rats.[49]

***Allium sativum* (Amaryllidaceae)**

This plant commonly known as garlic is native to Central Asia and northeastern Iran and widely found in India. It mainly contains essential oil which consists of sulpher compounds such as trisulfides and disulfides[50]. It is pharmacologically beneficial as an antibacterial, antifungal, antiparasitic, antiviral, antihypertensive, antithrombotic etc. A study reported by Eidi A *et al* states that for the future studies on diabetes mellitus the plant should be considered. Because at the doses of 0.1, 0.25 and 0.5 g/kg in streptozotocin-induced diabetic rats[51].

***Nigella sativa* (Ranunculaceae)**

This plant is also known as black cumin and native to the south and southwest Asia. It contains several chemical constituents such as fixed oil, proteins, alkaloid, saponin, essential oil. The fixed oil contains unsaturated fatty acids such as arachidonic acid, linoleic acid, linolenic acid etc., volatile oil contains saturated fatty acids such as nigellone. The alkaloids are present in this plant are nigellicimine, nigellidine etc [52]. The main active constituent is thymoquinone[52]. It is pharmacologically used as antibacterial, antifungal, antioxidant, antidiabetic, anticancer, immunomodulatory, hepatoprotective etc. Pari L *et al* reported that thymoquinone, the main active constituent of the plant showed significant antidiabetic activity at a dose of 80 mg/kg in streptozotocin-nicotinamide induced diabetic rats[53]. Najmi A *et al* reported that the *N.sativa* oil showed significant antidiabetic effect in a group of 30 patients. This clinical study was conducted at a tertiary health care center in North India[54].

***Psidium guajava* (Myrtaceae)**

The plant is commonly known as guava is found widely throughout the India. The leaves of the plant contain an essential oil which is rich in cineol, tannins, triterpenes, flavonoids, resin, eugenol, malic acid etc. The bark contains tannins (12-30%) and calcium oxalate crystals[55]. It is pharmacologically used as an antioxidant, hepatoprotective, anti-allergic, antimicrobial, antiplasmodial, cytotoxic, antispasmodic, cardioactive etc. A study reported by Oh WK *et al* clearly states that the leaf extract of the plant possesses antidiabetic activity in type-II diabetic mice model at a dose of 10 mg/kg[56].

***Fraxinus excelsior* (Oleaceae)**

This plant commonly known as European ash is widely available throughout the Europe. The chemical constituents present in this plant are iridoids, secoiridoids, flavonoids, triterpenes, alkanes etc[57]. It is used for the treatment of diarrhea, osteoarthritis. Eddouks M *et al* reported that the aqueous extract perfusion of the plant showed significant inhibition in glucose reabsorption in normal and streptozotocin-induceddiabetic rats at the dose of 10 mg/kg[58].

Cyamopsis tetragonoloba (*Fabaceae*)

It is commonly known as guar or cluster bean is widely cultivated in India. It contains several chemical constituents such as carbohydrates, proteins, fibers, ascorbic acid, flavonoids such as quercetin, kaemferol etc[59]. It is pharmacologically used for the treatment of diabetes, ulcer, hemolysis, asthma, inflammation etc. Mahomed IM *et al* found that the aqueous extract of the plant reduced the blood glucose level in alloxan induced diabetic rats at a dose of 800 mg/kg[60].

Origanum vulgare (*Lamiaceae*)

It is a flowering plant which is antive to Western and Southwestern Eurasia and also the Mediterranean region. It contains phenolics, phenolic acids, esters and its glycosides, flavonoids, steroids etc[61]. It is used pharmacologically as an antioxidant, antifungal, antibacterial, antithrombin etc. Lemhadri A reported that the aqueous extract of the plant showed significant anti-hyperglycemic activity in normal rats at dose of 20 mg/kg[62].

Agrimonia eupatoria (*Rosaceae*)

This plant is commonly known as agrimony is available throughout the Europe. It contains many important pharmaceutically active constituents such as terpenes, phenolic compounds, tannins, flavonoids, proteins, carbohydrates and vitamins[63]. It is therapeutically used as an antiviral, antibacterial, antitumour, analgesic, immunomodulatory, antioxidant, hepatoprotective etc. Gray AM *et al* reported that the aqueous extract of the plant showed significant antihyperglycaemic effect in streptozotocin induced diabetic mice at the doses of 1 mg/ml and 0.25-1 mg/ml[64].

***Emblica officinalis* (Euphorbiaceae)**

Commonly known as amla, this plant is widely available in India. It contains vitamin C, tannins, gallic acid, ellagic acid, chebullagic acid etc[65]. It is used as an antiaging, anti-amnesiac, anti-inflammatory, anti-bacterial, anti-cancer, anti-fungal, anti-viral, anti-venom, anti-ulcerogenic, astringent etc. Shikha Mehta *et al* reported that the aqueous extract of the seeds of the plant showed definite hypoglycaemic activity in streptozotocin induced type-II diabetic rats at the dose of 300 mg/kg[66].

***Acacia arabica* (Fabaceae)**

It is cultivated throughout the India. It contains phenolics, tannins, gallic acid, protocatechuic acid pyrocatechol, catechin, epigallocatechin-7-gallate, quercetin, isoquercetin etc[67]. It is pharmacologically used as an antibacterial, antifungal, antiviral, antimalarial, antidiarrhoeal, immunomodulatory, anti-inflammatory, antioxidant, antiabortifacient, antiulcer etc. A study reported by Hegazy GA *et al* clearly indicates that this plant extract showed significant hypoglycaemic activity in albino rats at the doses of 100 mg/kg and 200 mg/kg[68]. Mohammad Yasir *et al* found that cold aqueous extract of the plant gives higher antihyperglycaemic activity in diabetic and normal rats at the dose of 400 mg/kg[69].

***Murraya koenigii* (Rutaceae)**

This plant is commonly known as curry patta is widely available in India. The major chemical constituents present in this plant are α-pinene (51.7%), sabinene (10.5%), β-pinene (9.8%), β-caryophyllene (5.5%), limonene (5.4%), bornyl acetate (1.8%), terpinen-4-ol (1.3%), γ-terpinene (1.2%) and α-humulene (1.2%)[70]. It has several therapeutic activities such as antibacterial, antifungal, antiprotozoal etc. Arulselvan P *et al* found that the plant extract is more effective than glibenclamide in the treatment of diabetes because ethanolic extract of this plant possesses potent hypoglycaemic activity in streptozotocin induced diabetic rats[71]. A study reported by S.Vijayanand states that leaf extracts of the plant showed significant hypoglycaemic effect in alloxan induced diabetic albino rats at the doses of 250 and 500 mg/kg[72].

***Helicteres isora* (Malvaceae)**

This plant is widely distributed throughout the India. It contains important pharmaceutically active chemical constituents such as antioxidants, proteins, phenols, flavonoids, alkaloids, glycosides, carotenoids, tannins etc[73-74]. It is used therapeutically as an expectorant, antidiarrhoeal, antidiabetic, antispasmodic, haemostatic etc. Chakrabarti R *et al* reported that the ethanolic extract of the plant has the potentiality for the treatment of type-II diabetes as it showed significant antidiabetic effect in diabetic C57BL/KsJdb/db mice at the dose of 300 mg/kg[75].

DISCUSSION

From the ancient times medicinal plants are used for the treatment of many diseases like as diabetes. The herbs are widely used in the treatment because they are considered as more safe and more effective. By utilizing the ethno botanical and ethno pharmacological knowledge we came to know about the medicinal plants which have potent antidiabetic activity. This review article described about the medicinal plants which are commonly used for the treatment of diabetes. The parts of the plant such as leaf and the specific extract such as acetone extract which are more effective are also described here. It is also seen that several researches are also carried out for the desire of establishing an effective treatment against diabetes in India as well as abroad also.

CONCLUSION

In India several medicinal plants are used traditionally in many forms in the treatment of diabetes. Current research of the antidiabetic activity of the herbs helps to develop effective herbal therapies for such purpose. For the discovery of new potential antidiabetic compounds suitable information about medicinal plants are needed. This article is prepared for providing proper information regarding the medicinal plants having antidiabetic property. The informations which are discussed here regarding the medicinal plants might be helpful for further research on diabetes.

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