ISSN : 2319-2607 (Print); 2583-0856 (Online) IISUniv.J.Sc.Tech. Vol.12(1), 55-62 (2023)

REVIEW ARTICLE

The Role of Medicinal Plants in the Management of Diabetes: A Review

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Abstract

Diabetes mellitus is a metabolic disorder characterised primarily by hyperglycaemia induced by defects in insulin production, insulin secretion or both. Diabetes risk factors include obesity, hypertension, hereditary genetics, etc. Biguanides, sulfonylureas, meglitinides, are some of the medications that are commonly used to treat diabetes; however, effective therapy remains elusive. As a result, studies are being conducted to identify alternative and effective diabetes therapies. Medicinal plants are a promising source and can be used to build complementary therapies. Diabetes had been traditionally treated using medicinal plants in India. This review article includes a discussion of the plants that have been found to have blood glucose lowering impact.

Keywords: Diabetes, Hyperglycaemia, Medicinal plant , Phytochemicals

Introduction

Plants are not only important in health care, but they are also the best chance for future medicine that is, both safe and effective. As per WHO, between 35000 and 70000 plants have been utilized as medicines, accounting for 14-28% of the estimated, 250,000 plants worldwide (Kumar *et al*., 2010).

The major number of people globally uses plant as medications for basic health maintenance. Public discontent with the cost of prescribed allopathic medications, along with a desire to switch to traditional or natural therapies, over the last 20 years, has led to an upsurge in the use of plants (Ekor, 2014).

According to Sarian *et al.* (2017), there is a long history of using herbs to treat diabetes mellitus. Since ancient times, man has used them to cure diabetic mellitus, and this method is still common today. For basic healthcare in India and its states, plants offer a plentiful supply of raw materials. The purpose of using plants, as source of therapeutic agents could be their effectiveness in curing a disease and no side effects.

High blood glucose levels are a symptom of diabetes mellitus, a metabolic disorder brought on by modifications in the metabolism of proteins, lipids, and carbohydrates. This medical condition is triggered by deficiencies in insulin production, action, or both (CDC, 2022). Indian Diabetes Federation (2021) reported that the number of people living with diabetes in India to be 90 million and it is estimated to increase to 152 million by 2045. Apart from this there are many people who are yet to be diagnosed.

These herbal plants have always been a great source of medication, and many pharmaceuticals are produced directly or indirectly from them. Majority of the people, particularly those living in villages, rely primarily on these plants to treat and cure various ailments.

Table 1 provides detailed insights on the development of pharmacological moieties against diabetes by compiling the most noticeable medicinal plants and their extracted antidiabetic phytochemicals.The graphical abstract of phytochemicals working action has been also presented in Fig. 1.

Ricinus communis

In India, this plant is commonly known as castor bean and it is widely available in India. It comprises a variety of chemical elements, including steroids, alkaloids, saponins, glycosides and flavonoids (Fig. 2). The fruits and seeds of this plant contain stearic, and glycosides (Kumar, 2017). It is utilised as an anticancer, anti-diabetic, antibacterial, hepatoprotective, and other

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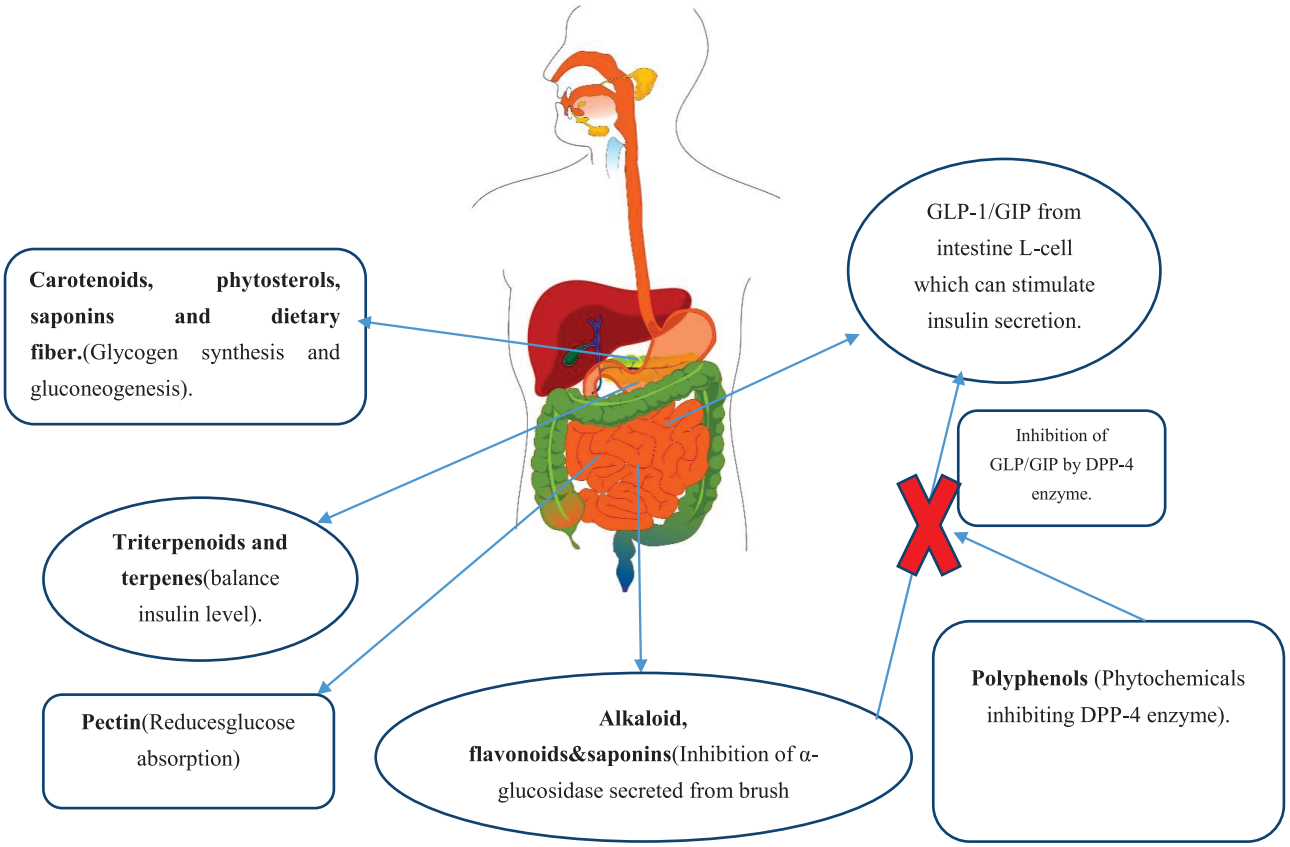

Fig. 1. Mechanisms of action of several bioactive phytochemicals obtained from different medicinal plants.

Table 1. A brief description of plants having anti diabetic property

S. No.	Plant	Family name	Common name	Plant part used	Bioactive Phytochemical	References
1	*Ricinus communis*	Euphorbiaceae	Castor bean	Whole plant	Alkaloid, saponins, glycoside Flavonoids	Kumar, 2017
2	*Emblica officinalis*	Euphorbiaceae	*Amla*	Seed &fruit	Vitamin C and gallic acid	Jain and Das, 2016
3	*Cocos nucifera*	Arecaceae	Coconut	Fruit & flower	Phenol, Tannin and Terpenes	Lima*et al.*, 2015
4	*Brassica juncea*	Brassicaceae	Brown mustard	Seed	Triterpene, Alkaloid and flavonoids	Parikh and Khanna 2014
5	*Murraya koenigii*	Rutaceae	*Curry patta*	Leaf	Triterpenes and limonene	Rana*et al.*, 2004
6	*Coccinia grandis*	Cucurbitaceae	*Kundru*	Whole plant	Flavonoids, triterpenoids, glycoside, alkaloid and pecti	Deokate an khadabadi, 2012
7	*Helicteres isora*	Malvaceae	Indian screw tree	Fruit and bark	Flavonoids, glycoside, alkaloi	Gayathri*et al.*, 2010
8	*Aloe vera*	Asphodelaceae	Aloe	Leaf	Anthraquinone and glycoside	Sharrif and Verma 2011
9	*Allium sativum*	Amaryllidaceae	Garlic	Fruit	Trisulfides and disulfides	Douiri*et al.*, 2013
10	*Nigella sativa*	Ranunculaceae	Black cumin	Seed	Thymoquinone, alkaloid, and saponin	Forouzanfar *et al*, 2014
11	*Psidium guajava*	Myrtaceae	Gauva	Leaf	Triterpenes and polyphenol	Oh*et al.*, 2005
12	*Cyamopsis tetragonoloba*	Fabaceae	Cluster bean	Fruit	Proteins, fibers, CHO, flavonoids and kaemferol	Sharma*et al.*, 2011

drugs. Dhar *et al*. (1968) found that the plant's stem, leaves and root extract had hypoglycaemic action in albino rats at a level of 250 mg/kg of body weight. Shokeen *et al*. (2008) reported strong hypoglycaemic impact of a plant's root extract, at a dose of 400 mg/kg of body weight in diabetic rats.

Fig.2. *Ricinus communis* (Source: Kumar, 2017)

Emblica officinalis

Common name of this plant is *amla*. It has vitamin C, gallic acid, tannins, and other nutrients (Jain and Das, 2016). It has anti-aging, anti-cancer, antiviral, anti-inflammatory and other properties (Fig. 3). Mehta *et al*. (2009) reported that extract of plant's seeds, at a dose of 300 mg/kg of body weight, demonstrated considerable hypoglycaemic action in type 2 diabetic rats. Similarly, Akhtar et al. (2011) conducted a study in which both normal and diabetic participants receiving 3 g *Emblica officinalis* powder per day that showed a significant decrease (P≤0.05) in fasting and post-prandial blood glucose levels on the 21st day when compared with their baseline results.

Fig 3. *Emblica officinalis* (Source- Mehta *et al*., 2009)

Cocos nucifera

This plant popularly known as coconut and is widely available in India. It contains phenols, tannins, flavonoids, triterpenes, steroids, and alkaloids, and other major chemical constituents (Lima *et al*., 2015) (Fig. 4). Pharmacologically, it has anti-inflammatory, antimalarial, antifungal, analgesic, antioxidant, cardioprotective, antiparasitic and antibacterial effect. Saranya *et al*. (2014) discovered that the extract of plant flowers had considerable anti-diabetic action on rats at a dosage of 300 mg/kg of body weight. Tyagi *et al*. (2015) too, reported that fruit showed antidiabetic property in rodents at a dose of 450 mg/kg of body weight. *Cocus nucifera* extract (250 mg/kg and 500 mg/kg) and the combination of extract (250 mg/kg) with metformin (22.5 mg/kg) substantially reduced postprandial blood glucose levels (p≤0.0001) on the 7th, 14th, 21st, and 28th days of application. A study of pancreatic tissue revealed that therapy with *Cocus nucifera* in conjunction with metformin restored the pancreas' dilapidated structure (Kaur *et al*., 2020).

Fig. 4. *Cocos nucifera* (Source: Lima *et al*., 2015)

Brassica juncea

This plant is popularly known as brown mustard and is found throughout Europe, Africa, North America, and Asia. It includes a variety of significant chemical constituents, including triterpenes, saponins, alkaloids and flavonoids (Parikh and Khanna, 2014). It has exhibited diuretic and anti-diabetic properties (Fig. 5). Thirumalai *et al*. (2011) reported a strong hypoglycaemic activity when diabetic rats were given dosages of seed extract at a rate of 350 mg/kg, and 450 mg/kg of body weight. The administration of *Brassica juncea* seed extract to diabetic rats resulted in lowering of blood glucose levels to 290 mg/dl, 180 mg/dl, and 101 mg/dl at 1 hour, 2 hours, and 4 hours, respectively.

Fig. 5. *Brassica juncea* (Source: Thirumalai *et al*., 2011)

Murraya koenigii

The leaf of *Murraya koenigii* plant, is also known as *curry patta*. The biochemical constituents of this plant are as follows- terpinene (1.2%), caryophyllene (5.5%), terpinenol (1.3%), limonene (5.4%), and humulene (1.2%) (Rana *et al*., 2004) (Fig. 6). It contains antibacterial and antifungal properties, among its other properties. Arulselvan *et al*. (2006) discovered that leaf of plant had blood sugar lowering effect on diabetic rats, making it an effective natural source in the treatment of diabetes than glibenclamide. According to a study published by Vijayanand (2015) leaf extracts of the plant had a substantial blood sugar lowering effect on diabetic rats at dosages of 300 mg/kg and 500 mg/kg of body weight.

Fig. 6. ***Murraya koenigii*** (Source: Vijayanand, 2015)

Coccinia grandis

It is commonly known as *kundru* in India. It contains important biochemical compounds such as, flavonoids, triterpenoids, glycosides, alkaloids and pectin. It is used pharmacologically as an antidiabetic, antibacterial, antioxidant and anti-inflammatory. Deokate and Khadabadi (2012) studied phyto-constituents of Ivy gourd plant and revealed aerial part to have β-sitosterol, alkaloids, cephalandrol, cephalandrins A and B and heptacosane (Fig. 7). Fruit has β-carotene, carotenoids, lycopene and β-sitosterol and the root has alkaloids, triterpenoid, glycoside, flavonoid and β-sitosterol. Medagama and Bandara, (2014) studied the hypoglycaemic property of *Coccinia grandis* on using them as complementary\alternate to medicine to treat hyperglycaemia. Pectin extracted of *Coccinia grandis* fruit showed hypoglycaemic effect in rats. They also claimed that it could reduce elevated levels of glucose-6-phosphotase, hence correcting blood sugar level.

Fig. 7. ***Coccinia grandis*** (Source: Pekamwar *et al*., 2013)

Helicteres isora

Helicteres isora also known as Indian screw tree (*morar phali*) is abundantly distributed throughout India. The chemical components like, flavonoids, glycosides, alkaloids, tannins, phenols, carotenoids, proteins and antioxidants having significant pharmacological properties are present in this plant (Jain *et al*., 2014; Gayathri *et al*., 2010). It is used as a cough suppressant, antidiarrheal, anti-diabetic, antispasmodic, haemostatic, and for other medicinal purposes (Fig. 8). Mukhopadhyay *et al*. (2019) too, reported that fruit extract has potential to cure diabetes mellitus. The hypoglycaemic impact of the extract of *Helicteres isora* bark was studied in streptozotocin (STZ) induced diabetic rats and on normal rats, at a dose of 100 mg/kg and 200 mg/kg of body weight. The results showed lowered blood sugar levels in normal rats (from 63.5–47.5 mg/dl and 68–47 mg/dl) and in diabetic rats from (105-67 mg/dl and 85-66 mg/dl) after 2 hours of daily oral administration of the extract for 21 days indicating its hypoglycaemic impact.

Fig. 8. ***Helicteres isora*** (Source: Gayathri *et al*., 2010)

Aloe barbadensis miller

Aloe barbadensis miller commonly called *aloe vera* is also known for its therapeutic properties and is rich in anthraquinone, glycosides and other compounds (Sharrif and Verma, 2011) (Fig 9). *Aloe vera* leaf at a dose of 250 mg/kg of body weight had a significant anti-diabetic impact in diabetic rodents (Jain *et al*., 2010). Sixty non-insulin dependent subjects were divided into two groups, *i.e*. group I and II, each having thirty subjects. For three months, participants in groups I and II received 100 mg and 200 mg of *aloe vera* leaf powder, respectively. After the trial, there was a substantial ($p \leq 0.01$) drop in fasting blood sugar levels by 11.4% and

15.4%, and in postprandial sugar levels by 18.5% and 27.8% in patients belonging to the two groups I and II, respectively.

Fig. 9. ***Aloe barbadensis miller*** (Source: Jain *et al.,* 2010)

Allium sativum

This plant, often called as garlic is extensively used in India. It is mostly composed of essential oil, which contains sulpher chemicals like, trisulfides and disulfides (Douiri *et al*., 2013). It has antibacterial, antifungal, antiparasitic, antihypertensive, and other pharmacological properties (Fig. 10). A research conducted by Eidi *et al*. (2006) found that fruit extract at a dose of 100 mg/kg, 200 mg/kg, and 400 mg/kg of body weight in mice reduced blood glucose level by 37.0%, 42.6%, and 52.8 %, respectively. The findings thus suggested that methanol extract of *Allium sativum* has anti hyperglycaemic impact.

Fig. 10. ***Allium sativum*** (Source: Eidi *et al.,* 2006)

Nigella sativa

Common name of this plant is black cumin and is abundantly found in India. It includes a variety of chemical components, including alkaloid, proteins, saponin, and essential oil (fatty acids like, linoleic acid, linolenic acid) and so on (Forouzanfar *et al*., 2014). Thymoquinone is the major active ingredient of the plant. It has antibacterial, antifungal, antioxidant, antidiabetic, anticancer, immunomodulatory, and hepatoprotective properties (Fig. 11). Thymoquinone, the plant's seeds principal active ingredient, showed considerable antidiabetic efficacy at a dosage of 50 mg/kg of body weight in diabetic rats (Pari and Sankaranarayan, 2009). In a group of 30 patients, Najmi *et al*. (2008) found that *Nigella sativa* oil had a substantial hypoglycaemic effect.

Fig. 11. ***Nigella sativa*** (Source: Najmi *et al.,* 2008)

Psidium guajava

This plant is popularly known as guava and is found all over India. The leaves of this plant contain polyphenols, triterpenes, rosin, eugenol, malic acid, and other nutrients. Calcium oxalate crystals (55%) and tannins (12–30%) are found in the stem (Subashini and Asha, 2017) (Fig. 12). These are used in medicine as an antiallergic, antispasmodic, cardioactive, and for other properties. Mukhtar *et al.* (2004) evaluated the hypoglycaemic efficacy of Psidium guajava leaves in alloxan-induced diabetic rats, and the results demonstrated statistically substantial hypoglycaemic action in both acute and sub-acute stages at an oral dosage of 250 mg/kg body weight.

Fig 12. ***Psidium guajava*** (Source: Oh *et al.,* 2005)

Cyamopsis tetragonoloba

*Cyamopsis tetragonoloba*is popularly known as *guar* or cluster bean and is abundantly grown in eastern region of India. It includes a variety of chemical elements, including proteins, fibres, carbohydrates, ascorbic acid, flavonoids and kaemferol (Sharma *et al*., 2011) (Fig. 13). It helps to treat diabetes, ulcers, asthma, and inflammation. At a dosage of 800 mg/kg of body weight, the cluster bean's aqueous extract exhibited hypoglycaemic effect in diabetic rats. The effect of bean extract on blood glucose levels in normal and alloxan induced diabetic rats was also investigated. Within 3 hours of administration, ethanol extract of beans, at a dose of 250 mg/kg of bodyweight, showed a significant impact on blood glucose levels in alloxan-induced diabetic rats (Mahomed and Ojewole, 2003).

Fig. 13. Cyamopsis tetragonoloba
(Source: Mahomed and Ojewole, 2003)

Conclusion

The path to successfully developing drugs from medicinal plants will encompass use of an integrated strategy that will combine the Ayurvedic knowledge and the literature available on plants having medicinal properties with the recently developed discipline of integrative biology. Plant selection is an important step in the process, therefore it requires a deliberate strategy. Although many plants and plant-derived bioactive phytochemicals have been suggested to be viable for therapies treating diabetes, minimal research has been done on these bioactive compounds. Therefore, researches to determine and ensure the appropriate molecular mechanism of the pharmacological actions of stated antidiabetic phytochemicals are required. Even though plant materials are thought to be safe for consumption, potential anti-diabetic phytochemicals should be evaluated for toxicity in order to create safe and effective herbal medicines.

Conflict of Interest

The Authors declare no conflict of interest.

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