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A Review of Herbal medicinal plants used to treat diabetics mellitus

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Abstract:

Traditional medicine is a body of knowledge, skills, and practices based on the experiences of traditional cultures used to maintain health and treat various diseases. It mainly involves the use of herbal medicinal plants and natural substances for therapeutic purposes. Traditional herbal medicines have been used for many years and are considered important in healthcare systems because they contain biologically active compounds that help in preventing and managing diseases. Diabetes mellitus is a chronic metabolic disorder characterized by high blood glucose levels due to insufficient insulin secretion or insulin resistance. Herbal medicinal plants play an important role in the management of diabetes because they contain various phytochemicals and biologically active compounds. These phytochemicals help in reducing blood glucose levels and improving insulin activity in the body. Many herbal plants have been traditionally used for the treatment of diabetes and are considered safe and effective. Therefore, herbal medicinal plants are considered a promising source for the natural management of diabetes mellitus. [1, 2]

INTRODUCTION:

Definition and Overview

Diabetes mellitus (DM) is a chronic (long-lasting) metabolic disorder characterised by persistent elevation of blood glucose levels (hyperglycaemia) resulting from defects in insulin (a hormone) secretion, insulin action, or both. It affects carbohydrate, fat, and protein metabolism, thereby impacting multiple organ systems.

Epidemiology and Global Impact

Globally, DM has reached epidemic proportions, with a rising prevalence in both developed and developing countries. The burden of this disease poses significant challenges to public health, healthcare infrastructure, and economic systems.

Etiology (Causes) and Pathophysiology (Mechanism)

The etiopathogenesis (cause & mechanism) of DM involves multiple pathways. In Type-1 DM, autoimmune destruction of pancreatic β-cells leads to absolute insulin deficiency. In Type-2 DM, insulin resistance and progressive β-cell dysfunction predominate. Persistent hyperglycaemia causes vascular and tissue damage, setting the stage for complications.

Classification / Types

DM is broadly classified into major types: Type-1 (insulin-dependent), Type-2 (non–insulin-dependent), gestational, and other specific types caused by genetic defects or secondary conditions.

Symptoms and Clinical Presentation

Classic symptoms of DM include polyuria (frequent urination), polydipsia (excessive thirst), unexplained weight loss, fatigue (tiredness), and blurred vision. However, early stages—especially of Type-2 DM—may be insidious (gradual) and asymptomatic.

Complications

If left uncontrolled, DM leads to microvascular (small blood-vessel) complications such as retinopathy (eye damage), nephropathy (kidney damage), neuropathy (nerve damage), and macrovascular (large vessel) complications like cardiovascular disease.

Current Management and Limitations

Although numerous synthetic and biochemical agents are available to manage DM, they often come with limitations such as side-effects, requirement for lifelong therapy, and inability to reverse the disease entirely. Hence, interest in complementary strategies including herbal medicines is growing. [3]

Mechanism of Herbal Antidiabetic Agents

- **Insulin Secretion Stimulation:**
  → Herbal drugs help in stimulating insulin release from the pancreatic β-cells (insulin-producing cells).
- **Regeneration of Pancreatic Cells:**
  → They repair and regenerate damaged β-cells, improving insulin production naturally.
- **Enhanced Glucose Uptake:**
  → Herbs increase glucose utilization by muscles and other tissues, reducing blood sugar levels.
- **Inhibition of Glucose Absorption:**
  → Some herbal agents block intestinal absorption of glucose, lowering post-meal sugar spikes.
- **Reduction of Hepatic Gluconeogenesis:**
  → They suppress glucose formation in the liver, helping to maintain normal glucose balance.
- **Antioxidant Activity:**
  → Herbal compounds show antioxidant effects, protecting pancreatic cells from oxidative stress (cell damage due to free radicals).
- **Improved Insulin Sensitivity:**
  → They enhance the response of body cells to insulin, improving glucose control and metabolism. [4,5]

Table:

S.NO	PLANT NAME	BIOLOGICAL SOURCE	FAMILY	CHEMICAL CONSTITUENTS	PARTS USED	USES
1	**Acacia**	The biological source of acacia, commonly known as gum arabic, is the dried, gummy exudate obtained from the stems and branches of acacia senegal and acacia seyal trees.	Leguminaceae	Catechins gallic acid, quertecin ,luteoline	Gum and bark	Diabetics,skindisorder, antiflammatory.
2	**Aloe vera**	The biological source is the fleshy leaves, from which both gel and latex are obtained	Liliaceae	Aloin,aloe-emodin,glucomannan,and chromium	Gel	Diabetes management ,skin care ,digestive issue.
3	**Alliumcepa**	The biological source of allium cepa (common onion) is the edible bulb of the plant,	Lilliaceae	Dipropyl disulphide oxide	Driedpowder	Antidiabetics,respiratoryissues,anti-bacterial properties.
4	**Annonasq-uamosa**	Biological source: annona squamosa is a small and well-branched tree belonging to annonaceae that gives edible fruits known as sugar apple.	Annonaceae	Annonine,anonaine,asimilobine,quercetin	Leaves	Diabetics,antioxidant.
5	**Axonopuscompressus**	The biological source of *axonopuscompressus* is the **entire plant of the grass species *axonopuscompressus* (sw.) P. Beauv.**	Poaceae	Alkaloids, flavonoids, tannins, saponins, and polyphenols,	Leaves	Antidiabetic
6	**Azandirachta indica**	It is consist of fresh or dried leaves & seed oil of ***azandirachata indica***	Meliaceae	The chemical constituents areazandirachtin,nimbin,nimboside,quercetin,3-glucoside,nimbidin&azadirone	The leaves of neem are commonly used in traditional medicine for diabetics	Anti-diabetics,anti-inflammatory, anti-bacterial.
7	**Berberis vulgaris**	The biological source of *berberis vulgaris* is the dried root, root bark, stem bark, and sometimes the fruits of the shrub *berberis*vulgaris **l.,**	Berberidaceae	Berberine**,** an alkaloid	Root	Hypoglycaemic
8	**Brassica juncea**	The biological source of *brassica juncea* (l.) Czern. &coss. Is the dried seeds of the plant	Brassicaceae	The main chemical constituents of *brassica juncea* with potential benefits for diabetes mellitus include glucosinolates (and their breakdown products like isothiocyanates) and	Seeds,leaves	Hypoglycemic and antihyperglycemic effects

				polyphenols..		
9	**Caesalpinia digyna**	The biological source of *caesalpiniadigyna* is the **roots and other aerial parts (stems, leaves, pods) of the prickly, scandent shrub or climber *caesalpiniadigyna*rottl.**	Fabaceae	Bergenin, caesalpinins (a and c), flavonoids, tannins, and possibly other polyphenolic compounds,	Root	Antidiabetic
10	**Centaurium erythrea**	The biological source of *centauriumerythraea* is the dried aerial parts (herb) of the flowering plant *centauriumerythraea*rafn.	Gentianaceae	Secoiridoid glycosides (like swertiamarin and gentiopicroside), flavonoids, xanthones, and phenolic acids**,**	Leaf	Antidiabetic
11	**Carica papaya**	The biological source of *carica papaya* l. Is the fresh or dried ripe fruit of the plant	Caricaceae.	The main chemical constituents of *carica papaya* with potential anti-diabetic activity include alkaloids, flavonoids, saponins, triterpenoids, and phenolic acids.	Leaves, fruits, seeds.	Low glycemic index, high fiber and antioxidant content
12	**Fenugreek**	It consist of seeds &leaves of ***trigonellafoenum-graecum***	Fabaceae	The chemical constituents are 4-hydroxyisoleucine,saponins,fibe-r	Seeds	Antidiabetics,antimicrobial,antiinflammatory,antioxidant.
13	**Gymnemasylvestre**	The drug consist of leaves of ***gymnemasylvestre***	Aselepidaceae	The chemical constituents are found gymnemicacid,gurmarin,quercitol	Leaves	Remedy for diabetics,weightloss,inmicrobial infection.
14	**Momordica charantica**	Karela consist of fresh green fresh of plant known as ***momordicacharantia***	Cucurbitaceae	The main chemical constituents for treating diabetics mellitus are charantin,momordicin,cucurbitacins and steroids	The fruits, seeds & leaves used but fruits are most commonly used part	Diabetics,fev-er,rheumatis-m,skindisease,anti-inflamatory&antioxidant
15	**Moringa olifera**	It consist of dried long slender,seed pods of ***moringa olifera***	Moringaceae	The chemical constituents are quercetin,kaempferol,isothiocyanates	Leaves	Antidiabetic,antiobesity,antioxidant,antiallergic,antifungal

16	**Nigella sativa**	Nigella sativa, commonly known as black cumin or black seed	Ranunculaceae	Thymoquinone,nigellidine , melanthin	Seeds	Diabetics,antimicrobial properties.
17	**Pterocarpus marsupium**	It consist of dried juice of the plant obtaines by making vertical incision on stem ***pterocarpus marsupium***	Leguminosae	The main chemical constituents for treating diabetics mellitus are pterosupin,marsupol,epicatechin	The bark &heartwood of pterocarpus marsupium is commonly used.	Diabetics management,woundhealing,anti –bacterial &anti-inflammatory.
18	**Sygiumcumini**	It is fruit of ***syzgiumcumini tree***	Myrtaceae	The chemical constituents of syzygiumcuminifor treating diabetics mellitus,jamboline,jambasine,corosolic acid	Seeds	Antidiabetics,antiinflammatory ,antiallergic
19	**Tinospora cordifolia**	It is consist of dried, matured piecies of stem ***tinospora cordifolia***	Menispermeceae	The chemical constituents are found in tinospora cordifolia are berberine, tinocordiside,cordifoliosside,jatrorrhizine	Stem	Anti-diabetics, anti-inflammatory,antioxidant, immunomodulatory
20	**Vinca**	Consist of dried entire plant and aerial part of catharanthus roseus linn.	Apocynaceae	Vincristine and vinblastine, catharanthine	Leaves	Antidiabetic, Hyperglycemic

1.Acacia:

Acacia species are rich in flavonoids and tannins, which help reduce blood glucose levels by inhibiting α-amylase and α-glucosidase enzymes. These compounds enhance insulin secretion and improve insulin sensitivity. The antioxidant activity of Acacia also protects pancreatic β-cells from oxidative damage, aiding glycemic control. [6,7]

2.Aloe vera:

Aloe vera contains polysaccharides (acemannan), flavonoids, and anthraquinones that exhibit strong antidiabetic activity. It helps lower blood glucose by stimulating insulin secretion, enhancing glucose uptake, and repairing pancreatic β-cells. Its antioxidant and anti inflammatory effects further improve glycemic control and protect against diabetic complications. [8,9]

3.Allium cepa:

Allium cepa contains bioactive compounds like **quercetin** (a natural antioxidant that protects cells) and **sulfur-containing compounds** such as **allyl propyl disulfide**, which help reduce blood glucose levels. Studies suggest it enhances **insulin sensitivity** (how well cells respond to insulin) and supports **lipid metabolism** (fat breakdown), making it beneficial in diabetes management[10, 11, 12]

4.Annona squamosa:

Annona squamosa contains active compounds such as **annonacin, quercetin, and alkaloids** that help lower blood glucose levels. These compounds enhance **glucose uptake (absorption of sugar by cells)**, stimulate **insulin secretion**, and show **antioxidant activity**, which protects pancreatic β-cells (cells that produce insulin) from oxidative stress. Thus, the plant exhibits strong potential as a natural antidiabetic agent.[13, 14, 15,]

5.Axonopus compressus:

Axonopus compressus is a perennial grass known for its rich content of **phenolic compounds, flavonoids, and alkaloids**, which exhibit **antioxidant and antihyperglycemic** (blood sugar–lowering) effects. Studies suggest that its extracts improve **glucose tolerance**, enhance **insulin action**, and reduce **oxidative stress** associated with diabetes. This indicates its potential role as a supportive herbal therapy in diabetes management[16]

6.Azadirachta indica:

Azadirachta indica is a well-known medicinal tree rich in **azadirachtin, nimbin, and flavonoids**, which show strong **antidiabetic and antioxidant** properties. These compounds act by stimulating **insulin secretion**, enhancing **glucoseuptake**, and inhibiting **glucose absorption** in the intestine. Neem also helps protect **pancreatic β-cells** from damage caused by oxidative stress, thereby improving overall glycemic (blood sugar) control.[17,18,19]

7.Berberis vulgaris:

Berberis vulgaris contains **berberine**, a major bioactive alkaloid known for its strong **antihyperglycemic** (blood sugar–reducing) and **antioxidant** effects. It improves **insulin sensitivity**, enhances **glucose uptake** in peripheral tissues, and reduces **hepatic gluconeogenesis** (glucose production in the liver). The plant also protects pancreatic β-cells and helps maintain lipid balance, making it an effective herbal remedy in diabetes management [20, 21]

8.Brassica juncea :

Brassica juncea is rich in **flavonoids, phenolic acids, and glucosinolates**, which contribute to its **antidiabetic and antioxidant** effects. The extracts help reduce **blood glucose levels** by enhancing **insulin secretion** and improving **glucose utilization** in tissues. Its antioxidant compounds also protect pancreatic β-cells from oxidative damage, supporting better glycemic control in diabetic conditions.[22,23]

9.Caesalpinia digyna:

Caesalpinia digyna contains **flavonoids, tannins, and stilbenoids** that exhibit strong **antidiabetic and antioxidant** activities. These compounds help in **reducing blood glucose levels**, enhancing **insulin release**, and improving **glucose uptake** by cells. The plant also minimizes **oxidative stress** and prevents **pancreatic β-cell damage**, thereby supporting healthy insulin function and glucose metabolism.[24]

10.Centaurium erythrea:

Centaurium erythraea is rich in **secoiridoid glycosides, flavonoids, and xanthones**, which are responsible for its **antidiabetic and hepatoprotective** (liver-protecting) effects. The plant promotes **insulin secretion**, improves **glucose utilization**, and enhances **glycogen storage** in the liver. Its antioxidant compounds also help reduce oxidative stress, supporting better pancreatic function and metabolic balance.[25,26,27]

11.carica papaya:

Carica papaya contains **flavonoids, alkaloids, and saponins** that contribute to its strong **antidiabetic and antioxidant** properties. The extracts help in **regenerating pancreatic β-cells**, enhancing **insulin secretion**, and improving **glucose uptake** in peripheral tissues. Its antioxidant activity also reduces **oxidative stress**, which helps in maintaining better glycemic control and preventing diabetic complications.[28, 29, 30]

12.Fenugreek:

Trigonella foenum-graecum, commonly known as fenugreek, contains **trigonelline, 4-hydroxyisoleucine, and galactomannan** — compounds known for their **antidiabetic, hypoglycemic (blood sugar–lowering), and antioxidant** effects. It helps **stimulate insulin secretion**, **delay glucose absorption** from the intestine, and **enhance glucose utilization** in tissues. Fenugreek also improves **lipid metabolism**, helping maintain both blood sugar and cholesterol balance.[31, 32]

13.Gymnema sylvestre :

Gymnema sylvestre is a perennial woody vine belonging to the family *Apocynaceae*. Its major active compounds include **gymnemic acids** and **saponins**, which contribute to its antidiabetic effects. The herb **stimulates insulin secretion**, promotes **regeneration of pancreatic beta cells**, reduces **glucose absorption in the intestines**, and enhances **peripheral glucose uptake**. These mechanisms make it effective in controlling hyperglycemia (high blood sugar) in type 2 diabetes.[33, 34]

14. Momordica charantia :

Momordica charantia is a tropical vine from the family *Cucurbitaceae*. Its antidiabetic activity is mainly attributed to **charantin, vicine, and polypeptide-p**. The plant **stimulates insulin secretion**, improves **glucose uptake by peripheral tissues**, and inhibits **intestinal glucose absorption**, thereby lowering blood sugar levels. It is widely used in traditional medicine tomanage type 2 diabetes.[35]

15. Mangifera indica :

Mangifera indica is a tropical tree belonging to the family *Anacardiaceae*. Its antidiabetic activity is mainly due to **mangiferin, flavonoids, and polyphenols**. The compounds **enhance insulin secretion**, improve **glucose uptake by tissues**, and **inhibit carbohydrate-digesting enzymes** in the gut, thus helping to control blood sugar levels. Its extracts also show **antioxidant activity**, protecting pancreatic beta cells from oxidative stress.[36]

16.Nigella Sativa:

Nigella sativa is an annual flowering plant from the family *Ranunculaceae*. Its antidiabetic properties are mainly due to **thymoquinone, nigellone, and alkaloids**. These compounds **stimulate insulin secretion**, enhance **glucose uptake by peripheral tissues**, and improve **beta-cell function** in the pancreas. Additionally, it exhibits **antioxidant and anti-inflammatory activity**, which protects pancreatic cells from oxidative damage.[37]

17. Pterocarpus marsupium :

Pterocarpus marsupium is a medium-sized tree from the family *Fabaceae*. Its antidiabetic activity is primarily due to **pterostilbene, epicatechin, and marsupin**. These compounds **stimulate insulin secretion**, promote **regeneration of pancreatic beta cells**, and **inhibit glucose absorption** in the intestines. Additionally, it shows **antioxidant activity**, protecting pancreatic cells from oxidative damage, which helps in maintaining normal blood glucose levels.[38, 39]

18. Syzygium Cumini:

Syzygium cumini is an evergreen tree belonging to the family *Myrtaceae*. Its antidiabetic activity is mainly attributed to **jamun seed alkaloids, jamboline, and polyphenols**. These compounds **stimulate insulin secretion**, improve **glucose uptake by peripheral tissues**, and **inhibit carbohydrate-digesting enzymes**, thus reducing postprandial (after meal) blood sugar levels. Additionally, it exhibits **antioxidant activity**, protecting pancreatic beta cells from oxidative stress. [40, 41]

19.Tinospora cordifolia :

Tinospora cordifolia is a climbing shrub from the family *Menispermaceae*. Its antidiabetic effects are mainly due to **berberine, tinosporaside, and alkaloids**. These compounds **stimulate insulin secretion**, improve **glucose uptake by peripheral tissues**, and **enhance beta-cell function** in the pancreas. Additionally, it exhibits **antioxidant and immunomodulatory activity**, protecting pancreatic cells from oxidative damage and supporting overall metabolic health.[42, 43, 44]

20. Vinca :

Vinca (Catharanthus roseus) is a perennial flowering plant from the family *Apocynaceae*. Its antidiabetic activity is mainly due to **vindoline, vincristine, and alkaloids**. These compounds **stimulate insulin secretion**, improve **glucose uptake by peripheral tissues**, and help **regenerate pancreatic beta cells**, thereby aiding in blood sugar regulation. Additionally, it exhibits **antioxidant properties**, protecting pancreatic cells from oxidative stress.[45, 46, 47]

CONCLUSIONS

Herbal medicines play a supportive role in managing Diabetes Mellitus by providing phytochemicals (plant-based active compounds) that help regulate glucose metabolism (sugar processing) and improve insulin sensitivity (body response to insulin). These natural compounds help in the prevention and treatment of many diseases such as infections, inflammation, and other health disorders. Herbal medicines have been used for many years and continue to contribute significantly to healthcare systems around the world. They provide a natural, safe, and effective approach for maintaining health and managing various diseases. Therefore, medicinal plants are considered a valuable source for the development of new therapeutic drugs and for improving human health.

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