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HERBAL PLANT USED FOR ANTI-DIABETIC AND ANTI-OXIDANT TREATMENT

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ABSTARCT

These plants have been traditionally used in various cultures for managing diabetes and oxidative stress. It's important to consult healthcare providers before using any herbal treatments, especially for chronic conditions like diabetes. Anti-diabetic plants may work through multiple pathways including modulation of glucose metabolism, reduction of glucose absorption in the intestines, and enhancement of glucose uptake in tissues. Anti-oxidants from plants neutralize free radicals, reducing oxidative damage to cells and tissues, which is crucial in preventing diabetes-related complications like neuropathy, retinopathy, and cardiovascular diseases. Some plant s used for the treatment of the Treatment of the anti-diabetic and anti-oxidants. Various plants have shown significant anti-diabetic properties through mechanisms such as enhancing insulin secretion, improving insulin sensitivity, and inhibiting carbohydrate-metabolizing enzymes. Notable examples include bitter melon (*Momordicacharantia*), fenugreek (*Trigonella foenum-graecum*), and cinnamon. Plants exhibit strong anti-oxidant activities, which help in mitigating oxidative stress, a contributing factor to diabetes complications. Plants like turmeric (*Curcuma longa*), green tea (*Camellia sinensis*), and garlic (*Allium sativum*) are well-known for their high antioxidant contents.

KEYWORDS: Anti-diabetic, Anti-oxidants, healthcare, Oxidative stress, Plants.

INTRODUCTION

DIABETES: Diabetes is one of the major diseases worldwide and is the third leading cause of death in the United States. Anti-diabetic drugs are used in the treatment of diabetes mellitus to control glucose levels in the blood. Most of the drugs are administered orally, except for a few of them, such as insulin, exenatide, and pramlintide. In this review, we are going to discuss seven major types of anti-diabetic drugs: Peroxisome proliferator-activated receptor (PPAR) agonist, protein tyrosine phosphatase 1B (PTP1B) inhibitors, aldose reductase inhibitors, α-glucosidase inhibitors, dipeptidyl peptidase IV (DPP-4) inhibitors, G protein-coupled receptor (GPCR) agonists and sodium-glucose co-transporter (SGLT) inhibitors. Here, we are also discussing some of the recently reported anti-diabetic agents with its multi-target pharmacological actions.[1]

Since ancient times, plants have been an exemplary source of medicine. Ayurveda and other Indian literature mention the use of plants in treatment of various human ailments. India has about 45000 plant species and among them, several thousands have been claimed to possess medicinal properties. Research conducted in last few decades on plants mentioned in ancient literature or used traditionally for diabetes have shown anti-diabetic property. The present paper reviews 45 such plants and their products (active, natural principles and crude extracts) that have been mentioned/used in the Indian traditional system of medicine and have shown experimental or clinical anti-diabetic activity. Indian plants which are most effective and the most commonly studied in relation to diabetes and their complications are: Allium cepa, Allium sativum, Aloe vera, Cajanus cajan, Coccinia indica, Caesalpinia bonducella, Ficus bengalenesis, Gymnema sylvestre, Momordica charantia, Ocimum sanctum, Pterocarpus marsupium, Swertia chirayita, Syzigium cumini, Tinospora cordifolia and Trigonella foenum graecum. Among these we have evaluated M. charantia, Eugenia jambolana, Mucuna pruriens, T. cordifolia, T. foenum graecum, O. sanctum, P. marsupium, Murraya koeingii and Brassica juncea. All plants have shown varying degree of hypoglycemic and anti-hyperglycemic activity.[2] Diabetes mellitus is one of the common metabolic disorders acquiring around 2.8% of the world's population and is anticipated to cross 5.4% by the year 2025. Since long back herbal medicines have been the highly esteemed source of medicine therefore, they have become a growing part of modern, high-tech medicine. In view of the above aspects the present review provides profiles of plants (65 species) with hypoglycaemic properties, available through literature source from various database with proper categorization according to the parts used, mode of reduction in blood glucose (insulinomimetic or insulin secretagogues activity) and active phytoconstituents having insulin mimetics activity. From the review it was suggested that, plant showing hypoglycemic potential mainly belongs to the family Leguminoseae, Lamiaceae, Liliaceae, Cucurbitaceae, Asteraceae, Moraceae, Rosaceae and Araliaceae. The most active plants are Allium sativum, Gymnema sylvestre, Citrullus colocynthis, Trigonella foenum greacum, Momordica charantia and Ficus bengalensis. The review describes some new bioactive drugs and isolated compounds from plants such as roseoside, epigallocatechin gallate, beta-pyrazol-1-ylalanine, cinchonain Ib, leucocyandin 3-O-beta-d-galactosyl cellobioside, leucopelargonidin-3- O-alpha-L rhamnoside, glycyrrhetinic acid, dehydrotrametenolic acid, strictinin, isostrictinin, pedunculagin, epicatechin and christinin-A showing significant insulinomimetic and antidiabetic activity with more efficacy than conventional hypoglycaemic agents. Thus, from the review majorly, the antidiabetic activity of medicinal plants is attributed to the presence of polyphenols, flavonoids, terpenoids, coumarins and other constituents which show reduction in blood glucose levels. The review also discusses the management aspect of diabetes mellitus using these plants and their active principles.[3]

Antioxidant

The term “antioxidant” is not always clearly defined in either popular or scientific literature. In the most general sense, a natural or synthetic antioxidant directly or indirectly functions to minimize damage to biomolecules (mostly proteins, lipids, and DNA) caused by reactive oxygen species (ROS) and/or reactive nitrogen oxide species (RNOS). Screening complex mixtures of organic molecules (e.g., a fruit juice) for their in vitro antioxidant capacities is popular, but the health-related significance of such measurements is questionable. An “antioxidant nutrient” can be either a precursor or cofactor for an antioxidant molecule or can be an antioxidant in its own right. For example, “selenium” is considered an “antioxidant nutrient” but dietary selenium, in the form of selenite or selenate, is not a functional antioxidant: selenite and selenate must convert to L-selenocysteine which can then get incorporated into glutathione peroxidase (GPX) which is a key antioxidant selenoenzyme. Gamma-tocopherol which is the primary dietary form of vitamin E is both an antioxidant nutrient as well as a functional antioxidant. This article will focus on physiologically significant antioxidants that have been studied either in humans, animal models, or relevant in vitro cellular models. The physiochemical and physiological properties of individual antioxidants are complex, and not all molecules that function as antioxidants are necessarily beneficial to human health. A key goal is to understand how antioxidants modulate acts in signal transduction pathways.[4] Natural extracts are the source of many antioxidant substances. They have proven useful not only as supplements preventing diseases caused by oxidative stress and food additives preventing oxidation but also as system components for the production of metallic nanoparticles by the so-called green synthesis. This is important given the drastically increased demand for nanomaterials in biomedical fields. The source of ecological technology for producing nanoparticles can be plants or microorganisms (yeast, algae, cyanobacteria, fungi, and bacteria). This review presents recently published research on the green synthesis of nanoparticles. The conditions of biosynthesis and possible mechanisms of nanoparticle formation with the participation of bacteria are presented. The potential of natural extracts for biogenic synthesis depends on the content of reducing substances.[5] Numerous plant compounds and their metal-ion complexes exert antioxidative, anti-inflammatory, anticancer, and other beneficial effects. This review highlights the different bioactivities of flavonoids, chromones, and coumarins and their metal-ions complexes due to different structural characteristics. In addition to insight into the most studied antioxidative properties of these compounds, the first part of the review provides a comprehensive overview of exogenous and endogenous sources of reactive oxygen and nitrogen species, oxidative stress-mediated damages of lipids and proteins, and on protective roles of antioxidant defense systems, including plant-derived antioxidants. Additionally, the review covers the anti-inflammatory and antimicrobial activities of flavonoids, chromones, coumarins and their metal-ion complexes which support its application in medicine, pharmacy, and cosmetology.[6]

Plant Used In Antioxidants

1. **Ginger: Ginger (*Zingiber officinale* Roscoe)** is a common and widely used spice. It is rich in various chemical constituents, including phenolic compounds, terpenes, polysaccharides, lipids, organic acids, and raw fibers. The health benefits of ginger are mainly attributed to its phenolic compounds, such as gingerols and shogaols. Accumulated investigations have demonstrated that ginger possesses multiple biological activities, including antioxidant, anti-inflammatory, antimicrobial, anticancer, neuroprotective, cardiovascular protective, respiratory protective, antiobesity, antidiabetic, antinausea, and antiemetic activities.[7]

2. Grape Seed: Grapes are one of the most widely grown fruits and have been used for winemaking since the ancient Greek and Roman civilizations. Grape seeds are rich in proanthocyanidins which have been shown to possess potent free radical scavenging activity. Grape seeds are a complex matrix containing 40% fiber, 16% oil, 11% proteins, and 7% complex phenols such as tannins. Grape seeds are rich sources of flavonoids and contain monomers, dimers, trimers, oligomers, and polymers. The monomeric compounds includes

(+)-catechins, (-)-epicatechin, and (-)-epicatechin-3-O-gallate. Studies have reported that grape seeds exhibit a broad spectrum of pharmacological properties against oxidative stress. Their potential health benefits include protection against oxidative damage, and anti-diabetic, anti-cholesterol, and anti-platelet functions. Recognition of such health benefits of proanthocyanidins has led to the use of grape seeds as a dietary supplement by the consumers. This paper summarizes the studies of the phytochemical compounds, pharmacological properties, and industrial applications of grape seeds.[8]

3. Coriander: Coriander is a widely used plant for its medicinal and biological properties. Both coriander essential oil and extracts are interesting sources of bioactive compounds and are widely used as spices in culinary practice due to their exclusive aroma and flavour. We focus our attention on coriander extracts that are rich in polyphenols. It is well known that plant polyphenols possess different biological activities and several functional foods contain this class of compounds.[9]

4. Curcuma: The activities of turmeric include antibacterial, antiviral, anti-inflammatory, antitumor, antioxidant, antiseptic, cardioprotective, hepatoprotective, nephroprotective, radioprotective, and digestive activities. Phytochemical analysis of turmeric has revealed a large number of compounds, including curcumin, volatile oil, and curcuminoids, which have been found to have potent pharmacological properties.[10]

Plant used in antidiabetes

1. Momordica charantia: In recent years, many studies of *Momordica charantia* (MC) in the treatment of diabetes mellitus (DM) and its complications have been reported. This article reviewed the effect and mechanism of MC against diabetes, including the results from in vitro and in vivo experiments and clinical trials. The common side effects of MC were also summarized. We hope that it might open up new ideas for further mechanism exploration and clinical application as well as provide a scientific theoretical basis for the development of drugs or foods.[11]

2. Gymnema sylvestre: Gymnema sylvestre (Asclepiadaceae), popularly known as "gurmar" for its distinct property as sugar destroyer, is a reputed herb in the Ayurvedic system of medicine. The phytoconstituents responsible for sweet suppression activity includes triterpene saponins known as gymnemic acids, gymnemasaponins, and a polypeptide, gurmarin. The herb exhibits a broad range of therapeutic effects as an effective natural remedy for diabetes, besides being used for arthritis, diuretic, anemia, osteoporosis, hypercholesterolemia, cardiopathy, asthma, constipation, microbial infections, indigestion, and anti-inflammatory. G. sylvestre has good prospects in the treatment of diabetes as it shows positive effects on blood sugar homeostasis, controls sugar cravings, and promotes regeneration of pancreas. The herbal extract is used in dietary supplements since it reduces body weight, blood cholesterol, and triglyceride levels and holds great prospects in dietary as well as pharmacological applications. This review explores the transition of a traditional therapeutic to a modern contemporary medication with an overview of phytochemistry and pharmacological activities of the herb and its phytoconstituents.[12]

3. Allium sativum: The therapeutic effect of garlic on diabetes has been investigated in various studies. Diabetes, especially in advanced stages, is associated with complications such as diabetic retinopathy, which is caused by the alteration in the expression of molecular factors involved in angiogenesis, neurodegeneration, and inflammation in the retina.[13]

4. Cinnamon (Cinnamomum verum): Improves insulin sensitivity and lowers blood sugar levels by enhancing glucose uptake by cells. Amounts of Insulin Receptor (IR), Insulin Receptor substrates, and GLUT4 receptors are increased due to cinnamon which enables the entry of glucose into the cells. A study revealed that Cinnamomum zeylanicum extracts enhance the translocation and production of GLUT4 to the plasma membrane in the adipose tissue.[14]

5. Aloe Vera (Aloe barbadensis): May enhance insulin sensitivity and improve blood glucose management. Numerous studies have demonstrated that A. vera has the potential to reduce blood glucose levels by protecting pancreatic cells and/or improving insulin sensitivity. Furthermore, the lipid-lowering impacts of A. vera may be contributed to lipid catabolism or/and anabolism regulation.[15]

6. **Turmeric (Curcuma longa):** Curcumin, the active ingredient, has been shown to reduce blood glucose levels and improve insulin sensitivity. Curcuminoids have been shown to improve insulin resistance, decrease glucose and insulin levels, increase adiponectin release, and reduce the levels of leptin, resistin, interleukin (IL)-6 IL-1β, and tumor necrosis factor-α in patients with T2DM.[16]

7. Fenugreek (Trigonella foenum-graecum): Contains soluble fiber that helps control blood sugar levels. Its seeds are known to improve glucose tolerance. Fenugreek is used for medicinal purposes in various traditions. Some studies have demonstrated that the seeds of this plant may have an anti-diabetic effect by lowering fasting blood sugar levels and improving glucose tolerance. We conducted a systematic review of the hypoglycemic effects of fenugreek.[17]

8. Neem (Azadirachta indica): Helps in lowering blood sugar levels and improving glucose tolerance. Metabolic syndrome is a condition associated with obesity, diabetes, dyslipidemia, and high blood pressure. Recently, the use of phytochemicals is suggested in the control and treatment of metabolic syndrome. The *Azadirachta indica* (neem) is an evergreen tree belonging to the family of Meliaceae. Multiple studies have been confirmed the anti-diabetic and anti-hypertension, anti-hyperlipidemia, and anti-obesity effects of neem. In this review, we reported the protective effects of neem against the complications of metabolic syndrome with a special focus on mechanisms that are involved. It has been shown that neem can control hyperglycemia and hypertension through over-expression of transcription factor nuclear factor erythroid 2–related factor 2 (Nrf2) and anti-oxidant effects. Neem also reduced the glucose uptake through up-regulation of glucose transporter 4 (GLUT4) and inhibition of key intestinal enzymes such as glucosidases. Moreover, neem showed anti-hypertensive effects possibility via the block of calcium channels, up-regulation of endothelial nitric oxide synthase (eNOS), and extracellular signal-regulated kinases 1/2 (ERK1/2) signaling pathway. Anti-oxidant effects play an important role in protective mechanisms of neem against metabolic syndrome and its complications.[18]

CONCLUSION

Plants for anti-diabetic and anti-oxidant treatments offers significant promise, particularly given the global rise in diabetes prevalence and the associated oxidative stress. Natural compounds from plants are emerging as beneficial alternatives or complementary therapies to conventional synthetic drugs due to their bioactive properties, fewer side effects, and holistic benefits. Various plants have shown significant anti-diabetic properties through mechanisms such as enhancing insulin secretion, improving insulin sensitivity, and inhibiting carbohydrate-metabolizing enzymes. Notable examples include bitter melon (*Momordica charantia*), fenugreek (*Trigonella foenum-graecum*), and cinnamon (*Cinnamomum verum*). Many plants exhibit strong anti-oxidant activities, which help in mitigating oxidative stress, a contributing factor to diabetes complications. Plants like turmeric (*Curcuma longa*), green tea (*Camellia sinensis*), and garlic (*Allium sativum*) are well-known for their high antioxidant contents.

REFERENCES

1. Dowarah J, Singh VP. Anti-diabetic drugs recent approaches and advancements. Bioorg Med Chem., 2020; 28(5): 115263.
2. Mohammad M, Mohit C, Rakesh P, Rakesh K J. Qualitative Phytochemical Investigation and Antioxidant Activity of Chlorophytum Borivilianum Santapau & R.R.Fern. Leaves. Journal of Coastal Life Medicine., 2023; 11(1): 611–617.
3. Patel DK, Prasad SK, Kumar R, Hemalatha S. An overview on antidiabetic medicinal plants having insulin mimetic property. Asian Pac J Trop Biomed., 2012; 2(4): 320-30.
4. Stone WL, Pham T, Mohiuddin SS. Biochemistry, Antioxidants. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing, 2024 Jan.
5. Flieger J, Flieger W, Baj J, Maciejewski R. Antioxidants: Classification, Natural Sources, Activity/Capacity Measurements, and Usefulness for the Synthesis of Nanoparticles. Materials (Basel), 2021; 14(15): 4135.
6. Khalid M, Alqarni M.H, Alsayari, A, Wahab S. Anti-Diabetic Activity of Bioactive Compound Extracted from *Spondias mangifera* Fruit: In-Vitro and Molecular Docking Approaches. *Plants*, 2022; 11: 562.
7. Mao QQ, Xu XY, Cao SY, Gan RY, Corke H, Beta T, Li HB. Bioactive Compounds and Bioactivities of Ginger (*Zingiber officinale* Roscoe). Foods., 2019; 8(6): 185.
8. Ma ZF, Zhang H. Phytochemical Constituents, Health Benefits, and Industrial Applications of Grape Seeds: A Mini-Review. Antioxidants (Basel)., 2017; 6(3): 71.
9. Scandar S, Zadra C, Marcotullio MC. Coriander (*Coriandrum sativum*) Polyphenols and Their Nutraceutical Value against Obesity and Metabolic Syndrome. Molecules., 2023; 28(10): 4187.
10. Prasad S, Aggarwal BB. Turmeric, the Golden Spice: From Traditional Medicine to Modern Medicine. In: Benzie IFF, Wachtel-Galor S, editors. Herbal Medicine: Biomolecular and Clinical Aspects. 2nd edition. Boca Raton (FL): CRC Press/Taylor & Francis, 2011.
11. Liu Z, Gong J, Huang W, Lu F, Dong H. The Effect of *Momordica charantia* in the Treatment of Diabetes Mellitus: A Review. Evid Based Complement Alternat Med., 2021; 2021: 3796265.

12. Sanie-Jahromi F, Zia Z, Afarid M. A review on the effect of garlic on diabetes, BDNF, and VEGF as a potential treatment for diabetic retinopathy. Chin Med., 2023; 18(1): 18.
13. Sanie-Jahromi F, Zia Z, Afarid M. A review on the effect of garlic on diabetes, BDNF, and VEGF as a potential treatment for diabetic retinopathy. *Chin Med*., 2023; 18(1): 18.
14. Mohsin SN, Saleem F, Humayun A, Tanweer A, Muddassir A. Prospective Nutraceutical Effects of Cinnamon Derivatives Against Insulin Resistance in Type II Diabetes Mellitus-Evidence From the Literature. Dose Response., 2023; 21(3): 15593258231200527.
15. Zhang DW, Fu M, Gao SH, Liu JL. Curcumin and diabetes: a systematic review. Evid Based Complement Alternat Med., 2013; 2013: 636053.
16. Marton LT, Pescinini-E-Salzedas LM, Camargo MEC, et al. The Effects of Curcumin on Diabetes Mellitus: A Systematic Review. *Front Endocrinol (Lausanne)*., 2021; 12: 669448.
17. Geberemeskel GA, Debebe YG, Nguse NA. Antidiabetic Effect of Fenugreek Seed Powder Solution (Trigonella foenum-graecum *L.*) on Hyperlipidemia in Diabetic Patients. J Diabetes Res., 2019; 20(19): 8507453.
18. Yarmohammadi F, Mehri S, Najafi N, Salar Amoli S, Hosseinzadeh H. The protective effect of *Azadirachta indica* (neem) against metabolic syndrome: A review. Iran J Basic Med Sci., 2021; 24(3): 280-292.