Antidiabetic Agents Produced From Medicinal and Aromatic Plants

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Herbal Medicine – A Benign and Conventional Medical System

Antidiabetic Agents Produced From Medicinal and Aromatic Plants

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Abstract:
One of the most severe endocrine metabolic diseases is diabetes mellitus. Diabetes mellitus is a clinical disease distinguished by a deficit in the production of insulin or resistance to the action of insulin. It caused remarkable mortality due to its difficulties. While used since ancient times for the treatment of diabetes mellitus, medicinal and aromatic plants have been recommended as rich yet unexploited promising sources of anti-diabetic drugs. Natural herbs for the treatment of diabetes focus on lowering the level of blood sugar and reducing the adverse effects of the disease. Globally, diabetes is an increasing health concern which is now emerging as an epidemic. About 700-800 plants are exhibiting anti-diabetic activity that has been studied. Consequently, there is great potential for the exploration of natural products with anti-diabetic properties. In this paper, an endeavor has been made to provide an outline of certain medicinal and aromatic plants with their bioactive phytoconstituents and mechanism of action which have been scrutinized for their anti-diabetic activity.

Keywords: Anti-diabetic agent, Diabetes mellitus,Insulin, Medicinal plants, Phytoconstituents.

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Introduction

Medicinal plants prove to be a major medicinal boost for the relief of human illnesses. Plants have been used for several thousand years in traditional medicine. Herbal therapies play a distinct role in our lives, offering awareness like traditional medicine and about the use of medicinal plants and its part.The healing activity of the medicinal and aromatic plants depends upon the nature of phytochemicals present

in the plants. WHO reports that 80% of the sphere's population is using natural remedies for major healthcare services. Medicinal and aromatic plants are the promising agents in antidiabetic, antimicrobial, anti-inflammatory, antifertility, antianxiety, antiageing, antiarthritic, antidepressant, analgesic, antispasmodic, etc. There are several therapeutic plants are reported for its anti-diabetes activity. The best approach to use herbal medicines provides efficacious and fruitful for many diseases. The effectiveness of herbal medicine is usually subjective to the patient.The strength of phytomedicine varies depending on the growing conditions, genetic alteration, timing and process of harvesting, exposure of the plants to light, air, and dampness, and herb preservation type.Medicinal and aromatic plants are the most potent and the most frequently studied for diabetes and its complications are *Allium cepa, Allium sativum, Zingiber officinale. Curcuma longa.Ginkgo biloba, Aloe vera, Panax ginseng, Momordica charantia, Azadirachta indica, Phaseolus vulgaris*, etc.

With continuously rising rates of prevalence and mortality, diabetes mellitus is a severe health concern. Diabetes mellitus is characterized by excessive amounts of plasma glucose due to deficiency of insulin and insulin resistance, or both, leading to metabolic deformity in lipids, carbohydrates, and proteins. These lead to many secondary complications including ketosis, polyurea,retinopathy, polyphasia, and cardiovascular disorder.Despite the advent of hypoglycemic agents and their widespread use, diabetes and associated problems appear to be a global health concern, affecting almost 10% of the world's population and perceived to be a major source of high economic losses that can obstruct nations' growth in turn. Insulin and many oral hypoglycemic drugs, such as metformin, sulfonylureas, troglitazone, glucosidase inhibitors, etc., are a commercially available treatment for diabetes. However, serious adverse side effects are reported to occur, such as lactic acidosis, diarrhea as well asliver problems. By enhancing insulin sensitivity, rising the production of insulin, and reducing the amount of glucose in the blood, traditional medications are used to treat diabetes **(Figure 1)**. In maintaining normal blood glucose levels, the adverse effect of drug therapy is not always satisfactory, and this observation has been granted to many medicinal and aromatic plants as a promising source of antidiabetic agents that is commonly used in different conventional medicine systems worldwide for the treatment of diabetes mellitus, and many of them are considered to be successful against diabetes.In the last few decades, there has been anincreasing interest in herbal medicine in the maintenance and diagnosis of diabetes both in developing and developed countries, due to their natural source and minimum side effects. The present study review is focusing on the use of the herbal drug for the treatment of diabetic mellitus.

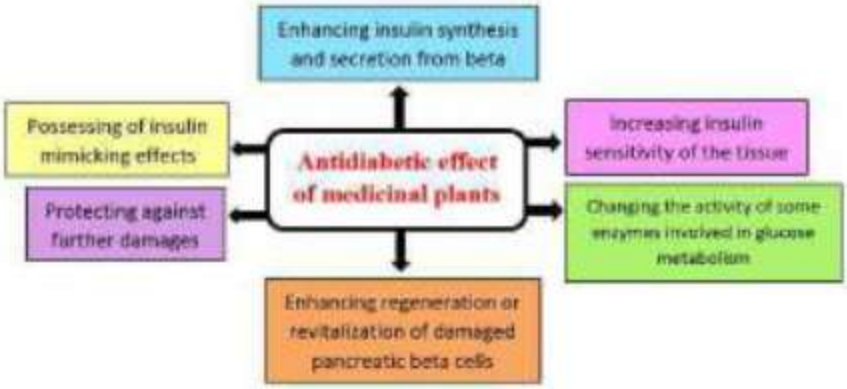

Figure 1: Antidiabetic effect of medicinal and aromatic plants

Diabetes mellitus

Diabetes mellitus is recognized as one of the world's five leading causes of death.According to the WHO, diabetes mellitus is defined as a metabolic condition of multiple etiologycharacterized by chronic hyperglycemia with fat, carbohydrate, and protein metabolism disruptions arising from deficiencies in insulin release, insulin action, or both. Long-term impairment, dysfunction, and malfunction of multiple organs are the symptoms of diabetes mellitus. The distinctive symptoms of diabetes mellitus include polyuria, thirst, weight loss, and blurred vision. There are four main types of diabetes mellitus viz. type 1 diabetes, type 2 diabetes, other specific types of diabetes and gestational diabetes **(Figure 2 & Table 1)**.

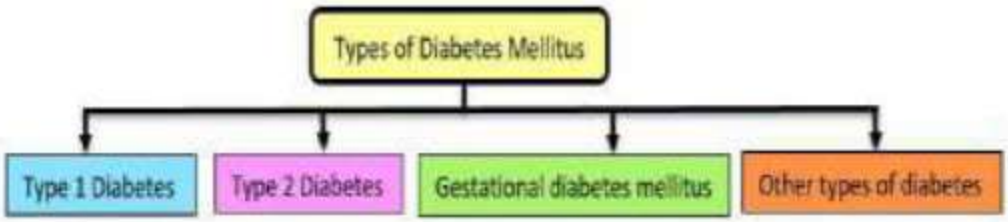

Figure 2: Types of Diabetes Mellitus

- **Type 1 Diabetes Mellitus:**Type 1 diabetes mellitus (also known as juvenile diabetes) is characterized by an autoimmune mechanism causing the loss of beta cells, usually leading to complete insulin deficiency. Type 1 is generallyconsidered by the existence of anti–glutamic acid decarboxylase, islet cell or insulin antibodies that recognize the autoimmune processes contributing to the death of beta cells. In order to uphold normglycemia, all type 1 diabetic patients will eventually undergo insulin therapy.
- **Type 2 Diabetes Mellitus:** There is intra-abdominal (visceral) obesity in most people with type 2 diabetes, which is closely linked to the presence of insulin resistance. In addition, in these

people, hypertension and dyslipidemia (high triglycerides and low levels of HDL-cholesterol; postprandial hyperlipidemia) are sometimes present. This is the most prevalent type of diabetes mellitus and is closely related to a history of diabetes in the family, older age, obesity and lack of exercise. In women especially women with a history of gestational diabetes, and in Blacks, Hispanics and Native Americans, it is more common.

- **Gestational Diabetes Mellitus:**Gestational diabetes mellitus is an operational classification that describes women who experience diabetes mellitus during gestation (instead of a pathophysiologic condition). Women who develop type 1 diabetes mellitus during pregnancy and women with undiagnosed asymptomatic type 2 diabetes mellitus detected during pregnancy are known as gestational diabetes mellitus (GDM). The condition develops in the third trimester of pregnancy in most people who experience GDM.
- **Other types of Diabetes:** Diabetes mellitus types in different recognized etiologies are clustered together to form the other specific types of diabetes. The category includes individuals with genetic defects in beta-cell function (this type of diabetes was previously referred to as MODY or maturity-onset diabetes in youth) or with insulin defects; individuals with exocrine pancreatic disorders such as pancreatitis or cystic fibrosis: individuals with disorder associated with other endocrinopathies (e.g. acromegaly); and individuals with pancreatic dysfunction caused by chemicals, drugs or infections.

Table 1: Different types of Diabetes mellitus with definition

Sl No.	Types	Definition
1	Type 1 Diabetes	Type 1 diabetes is a disorder in which immune system abolishes insulin-making cells in pancreas. These are so-called beta cells. The disorder is usually spotted in children and youngsters, so it used to be termed as juvenile diabetes.
2	Type 2 Diabetes	Type 2 diabetes is a chronic disorder that prohibits insulin from being processed by the body the way it should. It is said that people with type 2 diabetes have insulin resistance.
3	Gestational Diabetes Mellitus	Gestational diabetes is a disease in which, during pregnancy, the blood sugar levels get elevated. Per year it affects up to 10% of women who are pregnant in the U.S. It effects pregnant women who are not diagnosed with diabetes ever.
4	Other types of Diabetes	Other types of diabetes comprise those caused by genetic abnormalities of the beta cells, the insulin-producingpart of the pancreas such as neonatal diabetes

		mellitus (NDM) or maturity-onset diabetes of the young (MODY), excess levels of certain hormones arising from some medical circumstances such as cortisol in Cushing's syndrome which acts against insulin regulation, pancreatic disorders, or destruction of pancreas, such as cystic fibrosis and pancreatitis.

Pathophysiology

Insulin is the key hormone that controls the absorption of blood glucose into most cells of the body, especially the muscle, liver, and adipose tissue. Therefore, in the entire kind of diabetes mellitus, its lack or the inconsiderateness of its receptors reflects a critical task. β-cells, which are found in the pancreatic islets of Langerhans, release insulin into the blood in response to increasing blood glucose levels, usually after intake of food. Approximately two-thirds of the body's cells use insulin for absorption of blood glucose for use as energy, for conversion to other molecules required, or for storage. The effect of lower glucose levels is a reduction in insulin release from the beta cells and the breakdown of glycogen into glucose. The hormone glucagon is mainly regulates this process, which works in the opposite manner to insulin. If the quantity of insulin available is inadequate, if the cells respond poorly to the effects of insulin (insulin insensitivity or insulin resistance) or if the insulin itself is deficient, glucose will not be properly absorbed and processed in the liver and muscles by the body cells which require it. The net effect is gradually increased blood glucose level, decreased synthesis of proteins, and additional metabolic derangements, such as acidosis. Although the glucose content in the blood vestiges has risen with time, the kidneys can reach a reabsorption portal, urinary excretion (glycosuria) (**Figure 3**).

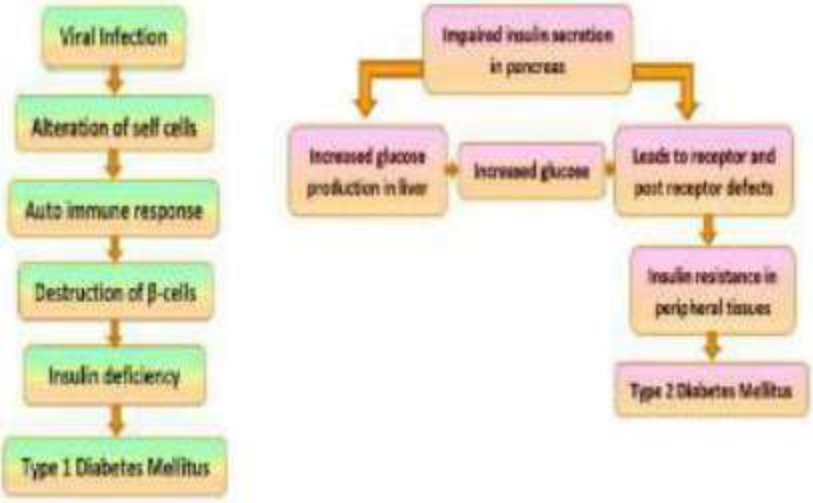

Figure 3: Pathophysiology of Type 1 & 2 Diabetes Mellitus

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Herbal treatment for diabetes mellitus

Since the advent of human beings on this planet, natural herbal medicines have been used and are thus roughly as ancient as time itself. While there are various pharmaceutical treatments developed for patients here, it is still the fact that someone has healed from diabetes in no way. Adverse effects are produced by current oral hypoglycemic agents. Therefore the antidiabetic potentiality of medicinal foliage plus its herbal preparation in the treatment of disease has been highly considered in recent times. Different medicinal plants with hypoglycemic assets are recognized as a substitute to synthetic agents. The World Health Organisation (WHO) has identified approximately 21,000 plants which are used around the world for medicinal purposes.

Some of the significant anti-diabetic prospective medicinal plants sources with their promising mode of action are summarized in Table 2.

Table 2: Antidiabetic medicinal plants with their isolated bioactive principles

Sl No.	Medicinal plants	Family	Bioactive constituents	Mechanism of action	Figure
1	*Allium cepa*	Amaryllidaceae	S-methyl cysteine sulfoxide	Lowering blood glucose level, Regulation of the enzyme hexokinase/ glucokinase	
2	*Allium sativum*	Amaryllidaceae	S-allyl-cysteine sulfoxide (alliin)	Inhibition glycogen-metabolizing enzymes	
3	*Aloe vera*	Asphodelaceae	Isobarbaloin,Lophenol, aloin, 24- ethylphenol 24-methyl-lophenol,	Maintain glucose homeostasis, Stimulates insulin release from pancreatic β-cells	
4	*Zingiber officinale*	Zingiberaceae	Gingerol, Ethanol, Tannins, Triterpenoid	Increase insulin level & decrease fasting glucose level	

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5	*Withania somnifera dunal*	Solanaceae	Withanolide, Alkaloid, withanine, somniferine	Decrease blood sugar level	
6	*Catharanthus roseus*	Apocynaceae	Catharanthine, locherine, vindoline, luerosine, vindolinine	Increase the metabolism of glucose	
7	*Curcuma longa*	Zingiberaceae	Curcuminoid	Reduces blood glucose	
8	*Psidium guajava*	Myrtaceae	Terpene, Flavonoid, Strictinin, Isostrictinin, Pedunculagin, Polysaccharide	Lower blood glucose	
9	*Panax ginseng*	Araliaceae	Saponin	Increasing insulin secretion from beta cells of the pancreas	
10	*Phaseolus vulgaris*	Fabaceae	Kinotennic acid, Kinored,epicathechin	Hypoglycaemic, hypolipidemic,inhibit alpha amylase activity, antioxidant	
11	*Ocimum sanctum*	Labiatae	Volatile oil, terpenoids,eugenol, thymol,estragole, pyridine,pyrrolidine alkaloids	Reduction absorption of glucose from the gastrointestinal tract	
12	*Olea europaea*	Oleaceae	Sugar alcohol, saponin tannin, olive oil	Potentiation of glucose, induced insulin release, & increase peripheral uptake of glucose	

13	*Nymphaea nouchali*	Nymphaeaceae	Alkaloids, starch	Increase plasma glucose level	
14	*Musa sapientum*	Musaceae	Flavonoid, Steroid, Glycoside	Reduce blood glucose & glycosylated Hb	
15	*Mangifera indica*	Anacardiaceae	Mangiferin, Phenolics, Flavonoid, gallic acid	Possibly acts through intestinal reduction of the absorption of glucose as well aspancreatic and extrapancreatic mechanism	
16	*Murraya koenigii*	Rutaceae	Carbazole, Alkaloid	Increase glycogenesis, decrease glycogenolysis & gluconeogenesis	
17	*Morus alba*	Moraceae	Morana	Protection of pancreatic beta cells from degeneration and diminish lipid peroxidation	
18	*Momordica charantia*	Cucurbitaceae	Charantin, Momordicin, Galactose-binding lectin, Diosgenin, Cholesterol, lanosterol,β-sitosterol, Cucurbitacin glycoside	Reduce blood glucose Level and acting like insulin	
19	*Lupinus albus*	Fabaceae	Linolinic & palmitic acid	Lower serum glucose level	

20	*Juniperus communis*	Cupressaceae	Isocrupressic acid	Increase peripheral glucose consumption & induce insulin secretion	
21	*Ipomoea batatus*	Convolvulaceae	An acidic glycoprotein	Reduced insulin resistance & blood glucose level	
22	*Gentiana olivieri*	Gentianaceae	Alkaloids and biflavonoid extract of seeds	Lowers plasma glucose level	
23	*Ginkgo biloba*	Ginkgoaceae	Ginkgo-flavone glycoside,fraction – quercetin, kaempferol, isorhamnetin	Inhibit β-amyloid deposition	
24	*Ficus benghalensis*	Moraceae	Leucopelargonidin	Inhibit insulin degradative process	
25	*Eclipta alba*	Asteraceae	Coumestane like eudelolactone, tesmethylecedelol acetone, furanocoumarins oleanane, taraxastane glycosides	Regulation of the enzyme hexokinase/ glucokinase	
26	*Eugenia uniflora*	Myrtaceae	Uniflorin A &B, 2-methylpiperidine3 ,4,5-triol	Regulation of the enzyme hexokinase/ glucokinase	
27	*Dioscorea dumetorum*	Dioscoreaceae	Mucilage, saponin, alkaloids – discoretine, dihydrodiscorine	To posses hypoglycemic effect	

28	*Cajanus cajan*	Fabaceae	Arginine, ascorbic acid	Lowering plasma glucose level	
29	*Camellia sinensis*	Theaceae	Epigallocatechin 3-gallate	Increases insulin secretion	
30	*Azadirachta indica*	Meliaceae	Azadirachtin, nimbin, nimbidin	Increasing insulin secretion from beta cells of the pancreas	

Conclusion

Comprehensive descriptions of traditional medicinal plants used in the treatment of diabetes mellitus have been given in the present study. Folk medicinal plants are mostly used for rural areas; because the availability of extravagant amount of medicinal plants in those areas. Therefore, treating diabetes mellitus with plant derived compounds which are accessible and do not require laborious pharmaceutical synthesis seems highly attractive. Some of these plant-derived drugs provide promise for the cost-effective treatment of diabetes by short-term nutritional interventions, vitamin supplements, and synthetic drug combination treatments, and as the only long-term medication from natural sources. This anti-diabetic activity is mostly due to the presence of bioactive chemicals. However, many other active agents derived from plants were not well characterized. In order to determine the mechanism of action of medicinal plants with antidiabetic effects, further studies must be carried out.In the present review an attempt has been made to investigate the antidiabetic medicinal plants and may be useful to the health professionals, scientists and scholars working in the field of pharmacology and therapeutics to develop antidiabetic drugs.

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