Review
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Overview of effective herbal and antioxidant compounds on diabetes

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Objectives The aim of the present study was to review the effect of herbal medicine and antioxidant compounds on diabetes.
Methods We searched PubMed, Science Direct, Scopus, and Medline for studies published from 2000 to 2017 with using keywords of diabetes, herbal medicine, and antioxidant compounds.
Results Various herbal medicines have been introduced to cure the diabetes. The most common types of effective compounds include flavonoids, terpenoid, carotenoids and alkaloids which are able to reduce the levels of blood sugar through increase insulin levels or reduction of intestinal uptake of glucose and regenerate pancreatic tissue through different mechanisms.
Conclusion Herbal medicines with antidiabetic effects can give raise a field to discover drugs with herbal origin for treating the diabetes. Different herbal remedies have been known and proved that mechanism of action.
Keywords diabetes, herbal medicine, herbal antioxidant compounds

Introduction

Diabetes is the most common form of endocrine disorders with increasing prevalence within human population.[1] According to WHO reports, diabetic patients account to 366 million up to 2030.[2] Diabetes is accompanied with loss of quality of life and appearance of risk factors related to mortality. Diabetes outbreak seems to be due to disturbance of carbohydrates, fats and proteins metabolism.[3] Following the relative insulin decrease, acute metabolic consequences are detected including ketoacidosis, hyperosmolar coma and different chronic disorders such as retinopathy, nephropathy, neuropathy and cardiovascular ailment.[4]

Long periods of hyperglycemia in diabetic patient may produce free radicals, especially reactive oxygen species (ROS). Increased generation of ROS may be due to glucose oxidation and protein glycosylation, and inappropriate conditions of tissue could disturb the balance between ROS production and defense mechanisms of cells. This imbalance leads to change of function, cell destruction and finally tissue damage, especially in pancreatic tissue damage.[5] Evidences suggested that free radicals play important role to make changes at molecular level, in turn leads to wide range of human diseases including atherosclerosis, Alzheimer's disease, Parkinson's disease, cancer, arthritis, asthma, immune system deficiency and diabetes.[6]

Three Main Type of Diabetes

Type 1 diabetes

This type of diabetes is due to immune-destruction of beta cells within pancreatic islands, associates with apparent loss of insulin production. Type 1 diabetes (insulin-dependent) develops among young adults and is known as juvenile diabetes or insulin-dependent diabetes. In addition to autoimmune disorders, diseases caused by insulin production result in insulin-dependent diabetes. Also, viral infections may involve in disruption of beta cells. In some cases, inheritance serves as a factor of beta cells destruction.[7] Decreased level of blood insulin as well as increased level of blood glucose of diabetic patients makes it equisetic to receive exogenous insulin source. Recent studies demonstrate that immune system is the key factor of type 1 diabetes pathogenesis, so that immune-suppressor medications like cyclosporine decrease the rate of beta cells destruction during early development of clinical manifestations.[8]

Type 2 diabetes

Type 2 diabetes (insulin independent) is the most common type of diabetes accounting in 90–95% of patients. This type of diabetes is observed among adults with age more than 40 years due to reduced/inadequate production of insulin or low sensitivity to it (insulin resistance) in which cells fail to use insulin properly.[9] Also, insulin resistance is associated with gradual dysfunction of beta cells which leads to metabolism disturbance.[10] It is necessary to note that endogenous insulin is produced but in lower quantities or because of tissue insensitivity of insulin, its level remains insufficient.[11] Given that majority of patients are obese, it is seeming that obesity is the key factor of reduced insulin sensitivity; therefore, obese patients suffer from insulin resistance syndrome related metabolic disorders. Appropriate diet regimen, weight loss before prescription and life style are important factors to treat type 2 diabetes.[12]

Gestational diabetes mellitus

Gestational diabetes mellitus is defined as glucose intolerance during second or third trimesters of pregnancy and it occurs in 4% of all pregnancies. About 30–50% of patients face to suffer from diabetes mellitus, especially type 2 ones.[13]

Other types of diabetes

Additional factors including genetic disorders in insulin secretion of pancreas beta cells as well as different types of exocrine glands diseases such as chronic pancreatitis, cystic fibrosis and even high levels of glucocorticoids strongly damaging pancreas, could dispose one to diabetes.[14] In 80% of cases, women suffering from polycystic ovary syndrome, have face to insulin resistance, so that long-term consequences will progress to diabetes mellitus.[15]

Table 1. **Medicinal plants with anti-diabetes activity used in traditional medicine**

Scientific plant	Family name	References	Active constituent	Effect
Zingiber officinale Roscoe	Zingiberaceae	48	Phenolic compounds such as ginjervals, shogwaves, paradoxes and zainjorns. Terpinaid	Reduced glucose levels, increased serum levels of insulin, inhibition of glucosidase and amylase enzymes in the intestines
Trigonella foenumgraecum	Laguminosae	51–55	Alkaloids, saponins, flavonoids and mucilages	Reduced glucose and cholesterol
Thymus vulgaris	Lamiaceae	56–58	Tannin, saponin, flavonoids, a phenol compound (thiomol), linalol, cineol, terpenoid, glycoside, caffeic acid, and rhizmarnin acid	Reduced blood lipids and inhibit LDL oxidation hypoglycemic
Tribulus terrestris		59–62	Saponin	Gluconeogenstic acid inhibition and hypoglycemic and hypolipidemic serum glucose
Berberis vulgaris	Berberidaceae	63–65	Berberine alkaloids, oxycetin, berbamine, palmatine, braltlin, berbromine, columbemin, jaterurine	Increased insulin sensitivity, decreased blood glucose, hypolipidemia, activation of protein kinase B, decreased serum MDA and HbA1c levels
Juglans regia	Juglandaceae	66–70	Phenolic compounds, flavonoids quercetin	Decreased plasma blood glucose
Camellia sinensis	Theaceae	71–75	Catechin polyphenols, caffeine, teinin, epigallocatechin	Inhibition of glucose intestinal absorption, increased insulin levels, decreased glucose. triglyceride and fatty acids
Amygdalus lycioides	Rosaceae	76–78	Amygdalin	Increased production and release of insulin
Punica granatum	Punicaceae	79–84	Polyphenols. alkaloids anthocyanin, catechin, quercetin, rutin, alajic acid	Decreased glucose levels, triglycerides, total cholesterol in the bloodstream
Olea europaea L	Oleaceae	85–87	Tannin, saponins, glycolic acid, olropin, hydroxy thirozole, ultropeosis	Enhancing insulin release and increasing glucose uptake
Urtica dioica	Urticaceae	88–90	Flavonoids, lectins, polysaccharides, salicylic acid, histamine, serotonin, acetylcholine, formic acid and leukotrienes	Stimulation of beta cells and increased serum insulin, increased glucose uptake by muscle fibroblast cells, inhibition of alpha-amylase activity in serum FBS, cholesterol, TG, LDL reduction
Rhus coriaria	Anacardiaceae	91–94	Flavonoids quercetin, tannin, quercetin, miristin and anthocyanins	Inhibition of intake of glucose in the intestine decreases in serum cholesterol levels
Cannabis sativa	Cannabaceae	95–101	Delta 9 tetrahydrocannabinol, cannabinoid	Reduced glucose levels
Panax ginseng	Araliaceae	102–104	A steroid glycoside called panacillin, a saponin called panoxoside	Increased insulin production, reduced degradation of beta-pancreatic cells
Aloe vera	Liliaceae	105–107	Barbaloin, isobarboline, aloenin	Antioxidant and antidiabetic effects

Diabetes Treatment in Traditional Medicine

Herbal therapy is an old field with historical origin and serves as a major base of medicine within ancient civilization including Egypt, India, China, Greek, Iran and Islamic medicine. Medicinal herbs are so important that pharmacist researchers who explore 21st century medications into traditional medicine believe that medicinal herbs solve issues related to drug discovery in future.[16] Plants serve as bioactive source of traditional medicine. Current century, wide investigations are conducted on medicinal herbs and their effective components which open new way to researchers so that nowadays, plant-derived medications comprise third of those.[17] Many well-known plants in the world play an important role in treating diabetes. New research suggests that re-attention to old drugs and natural treatments have triggered a new wave of research into the traditional ways diabetes has been treated. Traditional anti-diabetic herbs can be a useful source of oral glucose-reducing compounds that can be used as medicines or dietary supplements.[18] However, adverse and side effects of chemically-based medications, medicinal herbs with natural components have confirmed harmless or negligible side effects make researchers insist to expand their investigations.[19]

Natural Antioxidant Agents

Antioxidant agents play important role in human life. Use of antioxidant components is accompanied with reduced risk of

cancer, diabetes and cardiovascular diseases. Plants are the potential sources of antioxidants and many attempts have been performed to replace synthetic antioxidants by natural products. The most common antioxidant compounds of fruits, vegetables and medicinal herbs include flavonoids, alkaloids, terpenoids, carotenoids and vitamins.[20]

Chemical compounds found in plants (also called phytochemicals) have different preventive as well as protective properties,[21] which well-known types are phenols, alkaloids and terpenes. Also triterpenoids, glycopeptides, various amino acids (hypoglycin, arginin, leucin, isoleucine, lysine, phenylalanine, tryptophan), flavonoids, phenols, coumarins (e.g. scopoletin), guanidines (e.g. galegine), vitamins (E, B, C), polysaccharides (e.g. saccharin), peptides (P peptide with insulin-like properties), Anemaran A, aconitan A, galactomannan and sulfur derivatives in onion and garlic were found to have antidiabetic properties.[22]

Flavonoids

Flavonoids serve as an important compound found in fruits, vegetables and medicinal herbs. Major types of flavonoids include flavones, flavanone, flavonols, and anthocyanin[23] with antimicrobial, antiviral, antidiabetic, antioxidant and anti-inflammatory effects.[24] Flavonoids are able to reduce the levels of blood glucose while insulin secretion and sensitivity increases.[25] Examples of important flavonoids include quercetin, rutin also called rutoside, lycopene, catechin, cinnamic acid, luteolin.[26] In general, flavonoids suppress production of ROS through inhibition of related enzymes, removing ROS, regulation and protection of antioxidant defense system.[27]

Chitin and Chitosan

After cellulose, chitin is the natural polysaccharide and second biopolymer which is found within crustacean shell such as crab, shrimp, and insect cuticles as well as fungi cell wall.[28] Chitosan is the deacetylated derivative of chitin and solves into hydro-acidic solutions. Chitin and chitosan have low toxicity, antimicrobial and antiallergy characteristics which gain more attention in industrial, medical and pharmaceutical applications.[29] Chitin and chitosan are novel antioxidant compounds to control diabetes.

Also, chito-oligosaccharides obtaining from chemical hydrolysis of chitosan[30] have several biological effects such as antimicrobial, antioxidant, antidiabetic and immune system improving activities.[31] Various concentrations of chito-oligosaccharides could increase total antioxidant capacity as well as superoxide dismutase activity. Also, they can prevent pancreatic island cells to apoptosis, leading to decrease the levels of malondialdehyde, definite product of lipid peroxidation which leads to diabetic keto-acidosis.[32]

Chitosan, chito-oligosaccharides, and their derivatives apply their protective and preventive effects thorough the decrease of oxidative stress and low-density lipoprotein, decrease the inflammation as well as increase of muscular stiffness in age-dependent diseases such as diabetes, atherosclerosis, cancer, etc.[33] Chito-oligosaccharides have long-term antidiabetic effects in streptozotocin-induced diabetic rats through improve of glucose metabolism and increase of secretory capacity of pancreatic cells.[34] Chito-oligosaccharides have protective effect for type 2 diabetes which was demonstrated by improving insulin resistance and increasing insulin secretion.[35]

Royal Jelly

Royal jelly (RJ) is a slimy, creamy compound that slightly has a spicy taste was secreted from maxillary and subpharyngeal glands of *Apis mellifera* bees. RJ has several biological activities on cells and tissues of animal models such as antioxidant, neurotrophic, anti-inflammatory, antitumor, antimicrobial, vasoconstriction, immune-modulatory and regulatory properties, and decrease the levels of blood glucose, cholesterol and hypertension.[36] RJ applies its antioxidant activity through decrease of lipid peroxidation of rats.[37]

Administration of RJ seems to decrease the blood glucose in patients and in contrast, increases serum concentration of insulin[38] which may be due to insulin-like activities of RJ peptides and presumably, decrease of insulin resistance.[38] Identification of antioxidant compounds with pharmacologic view has raised; those which not only use in medicine and food industry, but also have minimal side effects to treat diabetes.[39] Medicinal herbs contain natural products with fewer side effects; therefore, their antioxidant content could improve damages caused by oxidative agents or diseases.[40] Before the invention of insulin and other antidiabetic medications, patients were treated using traditional medicine. So far, more than 1200 medicinal herbs have been introduced to decrease the blood glucose or its complications.[14] In recent years, various experimental and clinical investigations have been conducted based on the medicinal herbs among which significant decrease in patients' blood glucose has been observed.

Overall Functional Mechanisms of Antidiabetic Herbs

Different antidiabetic mechanisms of herbs are included into one of following groups:

1. Blocking calcium channels of pancreas beta cells.
2. Stimulation of cAMP and inhibition of renal glucose uptake.
3. Exciting insulin secretion and inhibiting mechanisms involved into decreased insulin secretion.
4. Decreasing insulin resistance.
5. Providing essential elements to beta cells including calcium, zinc, magnesium and copper.
6. Improving regeneration of beta cells.
7. Increasing number and size of cells within pancreas islands.
8. Stimulating glycogenesis and hepatic glycolysis.
9. Inhibiting activity of α- and β-galactosidase.
10. Cortisol reducing activities.
11. Inhibiting α-amylase activity.
12. Prevention of oxidative stress.[41–44]

To date, wide range of medicinal herbs has been studied to treat diabetes, some of which are discussed as follows.

Ginger

Ginger (*Zingiber officinale*) from Zingiberaceae family, is one of the most applicable medicinal herb used in Iran, China and

Greek traditional medicine to treat several diseases such as catch cold, rheumatism, neural disorders, gingivitis, asthma, constipation, diabetes, as well as in food industry as flavoring.[45] Effective compounds of ginger root differ depending upon implant site, and whether the root is dry, or wet. The odor of ginger is due to its volatile oil component. More than 50 effective compound including monoterpenes and sesquiterpene and beta-sesquiphellandrene exists in volatile oil.[46]

Ginger has different pharmaceutical effects, for example, dry root extract of ginger may inhibit the increase of lipid levels, increase of body weight, and fructose-induced hyperglycemia.[47] Hypo-glycemic, hypo-cholesterolemic, and hypolipidemic effects of ginger, as well as its antagonist effect on proteinuria and weight loss due to streptozotocin-induced diabetes in rats was demonstrated, suggesting the effectiveness of ginger in diabetic patients. Ginger reduces blood sugar with antagonistic activity against serotonin-receptors and blocking them, it also probably inhibits the activity of glucosidase and amylase enzymes in the intestine and thereby reduces glucose uptake in the body.[48]

Fenugreek

Trigonella foenum-graecum of Fabaceae, is one of the most effective antidiabetic herbs used in traditional medicine.[49] Trigonella has shown to decrease blood glucose levels as a dose-dependent state, in both healthy and diabetic animal models.[50] Also, *in vitro* studies demonstrated that 4-hydroxyl lysine, a component of Trigonella leads to increase in insulin secretion of pancreatic island cells in response to glucose, both in human and mice. As an interesting result, number of insulin receptors was increased, while alpha-amylase and sucrase (intestinal enzymes involving carbohydrate metabolism) activities were inhibited.[51] The compounds in the fenugreek seeds include volatile alkaloids, saponins, flavonoids and mucilages.[52] The therapeutic effect of fenugreek seed on diabetes is due to the direct stimulation of an amino acid called 4-hydroxyisoleucine on insulin secretion from beta cells.[53]

Thyme

Thyme (*Thymus vulgaris*) of lamiaceae family is one of the oldest medicinal herbs containing several compounds such as tannin, flavonoids, saponin, thymol, linalool, cineol, terpenoid, glycosides, caffeic acid, and rosmarinic acid.[54] This herb has a wide range of pharmaceutical properties including tonic, digestive, anti-spasmodic, carminative, antifungal, antibacterial, antiseptic, and anti-rheumatoid and antioxidant properties, also the effect of thyme extract on the pancreatic beta cells is shown in experimental model of induced diabetes mellitus.[55] Both chronic and acute hyperglycemias lead to induction of oxidative stress and increase of lipid peroxidation. Thyme extract seems to be effective in oxidative stress prevention.[56]

Tribulus terrestris

Tribulus terrestris is a plant that contains various types of compounds such as flavonoids, alkaloids, vitamins, tannin and saponin. Antioxidant properties of *Tribulus terrestris* seem to be effective to treat cardiovascular diseases, diabetes, and tumors; also it is effective to decrease the inflammation of urinary tract and lower the hypertension.[57,58] Animal studies show that saponin content could significantly decrease blood glucose and inhibit gluconeogenesis. Oral administration of saponin seems to inhibit intestinal alpha-glucosidase, delaying glucose uptake and decrease blood glucose following the feeding.[59] Antioxidant properties of *Tribulus terrestris* could improve disorders associating with significantly increase in oxidative stress levels, for example diabetes.[60]

Barberry

Barberry (*Berberis vulgaris*) grows as 1 m spiny shrubs with fragile branches from 0.5 to 3 m height. Root of barberry shrub contains several alkaloids such as berberine, berbamine, palmatine, oxycanthine, berberomine, beroulicine, clombamine, jatrorrhizine. In addition to alkaloids, inorganic acids, citric acid, malic acid, resin, tannin, mucilage and pectin exist within the root.[61] Berberine has several biologic effects such as anti-inflammatory, antioxidant, decreasing the blood glucose and blood pressure.[62] Since type 1 diabetes is due to the destruction of beta cells by T lymphocytes, therefore it is suggested that barberry may improve type 1 diabetes through its immune-modulatory properties.[63]

Walnut

Walnut (*Juglans regia*) from Juglandaceae family is widely used in traditional medicine.[64] Walnut leaves are administered to treat diabetes, fever, rheumatic pains, dermal diseases, and its flowers are used to treat malaria and rheumatic pains.[65] Also, it has been demonstrated that brewed leaf of walnut may be effective to decrease blood glucose of diabetic patients. In Iranian traditional medicine, walnut leaves and the pulp of its unripe fruit are used to decrease blood glucose.[66] Also, walnut leaves extract riches in different antioxidants such as phenolic compounds,[67] especially phenolic acids and flavonoids. Its main flavonoid is quercetin. Studies suggest that flavonoids decrease the blood plasma glucose.[68]

Green tea

Green tea (*Camellia sinensis*) from Theaceae family, contains polyphenol compounds such as catechin, caffeine, theanine, and epigallocatechin.[69] Green tea serves as an anti-inflammatory, antioxidant and anticancer agent[70] and it is rich of poly-phenols, justifying its role to treat diabetes-induced retinopathy.[71] Administration of green tea powder into animal models of hyperglycemia improves insulin resistance.[72] Also, human studies have shown that daily administration of 1.5 g of green tea powder increases the glucose tolerance and metabolism of patients.[73]

Peanuts

Peanut (*Amygdalus lycioides*) is a plant from Rosaceae family. It differs from almond because of the presence of amygdalin. Also, amygdalin is found within seeds of apricot, cherry, and plum. Amygdalin is a cyanogens glycoside with anticancer activity which hydrolyzes into glucose, benzaldehyde, and hydrosyanic acid. Amygdalin accelerates pancreatic enzymes activity and enables the pancreas to increase the production and release of insulin. Insulin prevents the glycogen breakdown, blocking the increase of blood glucose, as well as facilitates the entrance of glucose into cells. Chemical structure of amygdalin consists of two molecules of glucose, one hydrocyanic acid and benzaldehyde with anticancer and anesthesia properties, respectively. Oral administration of peanut extract into animal models decreases the blood glucose. Amygdalin is used to relief pain caused by cancer, decrease the hypertension, asthma and emphysema.[74–76]

Pomegranate

Pomegranate (*Punica granatum*) is a plant from Punicaceae family. Different parts of pomegranate contain poly-phenols, alkaloids, B1, B2, and folic acid vitamins.[77] Some of the components of pomegranate juice include anthocyanins, glucose, vitamin C, ellagic acid, gallic acid, caffeic acid, catechin, quercetin, rutin also called rutoside, organic compounds of phosphorus, magnesium, potassium, and iron.[78] Flavonoids of pomegranate prevents both hypertension and cancer cell growth.[79] Pomegranate juice and its flower extracts are effective to control diabetes, so they decrease the blood glucose, triglyceride, and total cholesterol in animal models of diabetes.[80] Human studies showed that the pomegranate juice decreases the blood fatty acids, hypertension and increase antioxidant effects, rather than blood glucose; therefore, pomegranate may decrease the diabetes consequences.[81,82]

Olive

Olive (*Olea europaea*) is a species of small tree in the family Oleaceae with constantly green leaves, which can live more than 1000 years under favorable conditions. Different compounds have been identified within the olea leaves such as sugar and resin, wax, chlorophyll, tannin, saponins, gallic acid, oleuropein, oleuropeoside, and hydroxytyrosol.[83] The most effective part of olea to treat diabetes is its leaves. The experimental studies of diabetes have shown that olea leaves not only decrease the levels of blood glucose and fatty acids,[84] but also prevent auto-immune dependent type 1 diabetes to progress.[85]

Nettle

Nettle (*Urtica dioica*) from Utricaceae family, encompasses plants which are generally perennial herb, and most of its aerial parts are covered with hook- or cone-shaped piles. In Iran, nettle has been introduced as an adjuvant agent to treat diabetes.[86] Also, nettle is used as anti-inflammatory, lowering the blood glucose, diuretic, analgesic, local anesthetic, and prostatic inflammation.[87] Its compounds include flavonoids, hydrophilic compounds such as lectins and polysaccharides, substances such as histamine, formic acid, acetylcholine, acetic acid, butyric acid, leukotriene and 5-hydroxy-tryptamine.[88]

Sumac

Sumac (*Rhus coriaria*) from Anacardiaceae family is a shrub plant with long history in traditional medicine. Sumac is regarded to prevent cardiovascular diseases, also used as spices.[89] Phytochemical analyses propose the sumac as rich source of phenolic compounds such as tannin, quercetin, myricetin and anthocyanins.[90] Tannin has both preventive and anti-cancer properties.[91] Hypoglycemic activity of quercetin is applied using inhibition of intestinal glucose uptake; therefore, sumac hypoglycemic activity may be attributed to the presence of quercetin.[92]

Cannabis

Cannabis sativa belongs to Cannabaceae family. Its seeds contain 3% saturated fatty acids, 28% unsaturated fatty acids and 25% proteins.[93] Main components of cannabis seeds are tetrahydrocannabinol, canabidiols, and cannabinoids.[94] Cannabis extract has several anti-tumors, anti-diabetic, anti-bacterial and antioxidant effects.[95] Chronic inflammation is suggested as a key factor of insulin resistance and type 2 diabetes which is thought to have anti-inflammatory effects of cannabinoid may help to decrease the inflammation and improvement of metabolic state of body. Also, effect of hydro-alcoholic extract of cannabis on diabetic animal models, and patients was studied.[96] One of the most common complications of diabetes is diabetic neuropathy with main sensory disorders of lower extremity. Neurons are unable to regenerate themselves; therefore, destruction of central nervous system is accompanied with irreparable damages. Use of alcoholic extract of cannabis seed as a neural protecting compound prevents hyperglycemia induced neural damages as well as following damages.[97–99]

Ginseng

Ginseng (*Panax ginseng*) an herb from Araliaceae family, regarded as less in medicine. The history of its application as medication for several disorders like diabetes reaches to more than 4000 years.[100] Chemical compounds found in ginseng rhizome include steroid glycoside panakilon, saponin compound named panaxoside and vitamins of B family.[101] Intraperitoneal injection of ginseng in animal models and its reducing effect on blood glucose and hepatic glycogen to treat the hyper-lipidemia was assessed. Hypoglycemic activity of ginseng seems to be through increased insulin production, and decreased destruction of pancreas beta cells.[102]

Aloe vera

Aloe vera belongs to Liliaceae family. The leaves of *Aloe vera* have been used for a long time as medication and contain a clear gel in a central tissue. Some of its properties involve in wound healing, anti-inflammatory, anti-cancer, anti-oxidant and anti-diabetic effects.[103] This herb is rich in oxidase and catalase enzymes and supports the resistance of vitamins E and C against free radicals.[104] Barbaloin, isobarbaloin, and aloenin are isolated effective compounds of *Aloe vera*. Barbaloin protects the beta cells of pancreatic islets from free radical's damages. Animal model studies have used *Aloe vera* for diabetes treatment, wound healing, tumors and intestine inflammatory diseases, in both injection and oral route.[105]

Discussion

Diabetes mellitus is known as a chronic and metabolic disorder of endocrine system with increasing incidence. As clinical and experimental studies show, oxidative stress plays pivotal role in pathogenesis and complications of diabetes. Also, regarding to side effects of chemical medications, researchers pay more attention to medicinal herbs. Herbal medications are considered in diabetes treatment because of less side effects, antioxidant properties and insulin secretion regulatory effects. Mechanisms of herbal compounds to reduce blood glucose level include activation of glucose catabolism, increase insulin secretion, inhibition or inactivation of gluconeogenesis, increase antioxidant capacity, leads glucose into the cell and absorption of free glucose and prevents it to bind proteins.

Animal and human studies have shown beneficial effects of herbs in reducing blood glucose and controlling diabetes. However, more studies are needed to accurately understand the effects of these plants and especially their possible complications in humans.

Major mechanisms of medicinal plants include: increased insulin secretion, activation of the pathway of glucose catabolism, inhibition or inactivation of the gluconeogenesis pathway,

directing of glucose into the cell, absorption of free glucose and prevention of its binding to proteins, increasing the antioxidant capacity, and preventing the harmful effects of oxidants produced in various pathways, which may be due to glucose uptake and the production of ultimate glycemic or other metabolic pathways, which ultimately prevents glucose from absorbing the intestine.

Conclusion

Based on the above studies, it can be said that the use of effective herbs in the treatment of diabetes has less side effects and their antioxidant effects regulatesinsulin secretion in the treatment of this disease. Although it is unlikely that oral herbs will replace insulin, these natural resources are effective in treating diabetes through stimulation of biosynthesis and secretion of insulin as well as enhancing insulin function. However, it seems unlikely those insulin replacement edible plants, but these natural resources by stimulating endogenous insulin biosynthesis and secretion of insulin as well as strengthening performance, are effective in the treatment of diabetes.

Conflict of Interst

None

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