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AN OVERVIEW ON ANTI-DIABETIC ACTIVITY OF CERTAIN MEDICINAL PLANTS

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ABSTRACT

Diabetes mellitus is not a single disease but is a group of metabolic disorders affecting a huge number of populations in the world. It was mainly characterized by chronic hyperglycemia, resulting from defects in insulin secretion or insulin action. Even though the cases of diabetes are increasing by except insulin and oral hypoglycemic drugs no other way of treatment has been successfully developed so far. The review also contains brief idea about diabetes mellitus and the experimental screening model with their relevant mechanism and significance mainly used now days. Streptozotocin and alloxan are mainly used for evaluating the ant diabetic activity of a particular drug. This review contain list of medicinal plants which have been tested for their ant diabetic activity in the streptozotocin induced diabetic rat model. Thus, the information provided in this review with help of researchers for the development of an alternative methods rather than insulin and oral hypoglycemic agents for the treatment of diabetes mellitus, which will minimize the complication associated with the diabetes and related disorder.

KEYWORDS

Aldose reductase, Streptozotocin, Antioxidant, Diabetes mellitus, Insulin, Phytoconstituents, Alloxan and Oral hypoglycemic agents.

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INTRODUCTION

Diabetes is a metabolic disorder of carbohydrate, fat and protein, affecting in a large number of population in the world[1]. Diabetes mellitus is not a single disorder but it is a group of metabolic disorder characterized by chronic hyperglycemia, resulting from defects in insulin secretion, insulin action, or both. Which occur due to the abnormalities in carbohydrate, fat, and protein

metabolism. When ketones body is present in the blood or urine is called ketoacidosis, hence proper treatment should be taken immediately, else it can leads to other diabetic complications[2]. Diabetes mellitus is characterised by significant morbidity and mortality due to microvascular (retinopathy, neuropathy, and nephropathy) and macrovascular (heart attack, stroke and peripheral vascular disease) complications[3]. Hyperglycemia is the main symptom of diabetes mellitus generates reactive oxygen species (ROS) which cause lipid peroxidation and membrane damage. Reactive Oxygen Species is plays an important role in the development of secondary complications in diabetes mellitus such as cataract, neuropathy and nephropathy. Antioxidants protect β-cells from oxidation by inhibiting the peroxidation chain reaction and thus they play an important role in the diabetes. Plants containing natural antioxidants such as tannins, flavonoids, vitamin C and E can preserve β-cell function and prevent diabetes induced ROS formation. Polyphenols one of which are classified into many groups such as flavonoids, tannins and stilbenes have been known as health-beneficial properties, which include free radical scavenging, inhibition of hydrolytic and oxidative enzymes, anti-inflammatory action and antidiabetogenic potentiality[4,5]. Aldose Reductase as a key enzyme, catalyze the reduction of glucose to sorbitol and is associated in the chronic complications of diabetes such as peripheral neuropathy and retinopathy. Use of aldose reductase inhibitors and α-glucosidase inhibitors has been reported for the treatment of diabetic complications[6].

Types of diabetes mellitus

Diabetes mellitus can be divided into two types, Type 1, "Juvenile Diabetes Mellitus" (Insulin Dependent Diabetes Mellitus) Type II, "Adult type" (Non-Insulin Dependent Diabetes Mellitus). Type 1 are associated occurs in childhood, mainly due to destruction of pancreatic β-cell islets through autoimmune-mediated, resulting in absolute insulin deficiency. Type II occurs in adulthood and elderly people, which are mainly due to insulin resistance or abnormal insulin secretion. The exact causes of pancreatic failure and insulin resistance are unknown i.e they are associated with disease state, environmental impact and food habit. Diabetic patients are more susceptible to various type of infection skin diseases and carbuncles[2]. With other type of diabetes is gestational diabetes which is mainly associated with pregnancy. Genetic defects of β-cell function or insulin action is also a type of diabetes mellitus commonly called maturity onset diabetes[3]. Neonatal diabetes mellitus is also a type of disorder in which Insulin is required for the maintenance of blood glucose level in the first three months of life. Mitochondrial diabetes is commonly associated with sensorineural deafness and is characterized by progressive non-autoimmune beta-cell failure[3]. Cystic fibrosis are related diabetes is primarily due to insulin deficiency, but insulin resistance during acute illness, secondary to infections and medications, may also contribute to impaired glucose tolerance and diabetes. Sometimes diabetes can also occurs by other factors like stress or in other uses of medication such as dexamethasone, L-asparaginase, glucocorticoids, cyclosporin or tacrolimus, olanzapine, risperidol, quetiapine and ziprasidone[2].

Medicinal Plants with Potential Antidiabetic Activity

Natural products are the major for discovering promising lead candidates, which play an important role in future drug development programs. Ease of availability, least side effects and low cost make the herbal preparations are the main key player of all available therapies, especially in rural areas[7]. Since centuries, so many plants are considered a fundamental source of potent anti-diabetic drugs. Although, synthetic oral hypoglycemics together with insulin are the main route for controlling diabetes. This constitutes the major force for finding alternatives, mainly from plant kingdom that are of less severe or even no side effects[8]. In the following section are compilation of the most famous plants widely used in folk medicine will be discussed. But we will shed light on the most

relevant data related to these popular plants. The most widely used antidiabetic herbs[9].

Aegle marmelos

It is commonly known as the Holy Fruit tree of (family: Rutaceae). The oral administration of aqueous leaf extract to STZ diabetic rats was proven to be equally potent as insulin in normalizing blood glucose and insulin levels[10]. Its mode of action may be either due to stimulating glucose uptake or enhancing insulin secretion or both. In addition, it improved the functional state of the beta cells, regenerating the damaged pancreatic parts[11]. Moreover, the oral administration of its seeds aqueous extract showed a significant reduction in FBG level. Besides, it decreased total cholesterol level, LDL and triglyceride with concomitant elevation in HDL[12]. However, oral and intraperitoneal administration of the fruit aqueous extract showed antidiabetic activity in STZ induced diabetic rats. It significantly reduced the blood-glucose level as well as glycosylated hemoglobin, while elevating both serum insulin and liver glycogen. The fruit extract at a dose of 250 mg/kg was found to be more potent than glibenclamide[11].

On the other hand, *A. marmelos* methanol extract is decreased blood sugar in alloxan induced diabetic rats, lowering its oxidative stress evidenced by reducing serum and liver lipid peroxidation, conjugated diene and hydroperoxide levels, elevating catalase, glutathione peroxidase, superoxide dismutase and reduced glutathione levels[13]. This relevant hypoglycemic effect is probably attributed to coumarins that stimulate insulin secretion from the pancreatic beta cells in the islets of Langerhans.

***Allium cepa* (Onion) and *Allium sativum* (Garlic)**

They are important play dietary supplements belonging to family Liliaceae that involved in the eastern kitchen. Studies has showed that oral administration of the ethanol extract of garlic regulated the blood-sugar level, normalizing the activity of both liver hexokinase and glucose-6-phosphatase. In addition, it elevated liver glycogen, serum insulin as well as free amino acids, causing significant reduction in FBG, serum triglycerides, total cholesterol, urea, creatinine, AST and ALT levels[14]. The antidiabetic activity of the extract was more potent than glibenclamide, the commonly known antidiabetic drug[15]. Many onion bulbs ether fractions showed significant hypoglycemic effects by decreasing the glucose peak in subcutaneous glucose tolerance tests[10]. Among them, *A.cepa* increases the fasting serum high-density lipoprotein values, exhibiting alleviation of hyperglycemia in streptozotocin (STZ) diabetic rats. The hypoglycemic and hypolipidemic effects of onion was usually associated with a relevant antioxidant activity, as indicated by the increase in superoxide dismutase activity. No effects were observed on both lipid hydroperoxide and lipoperoxide levels[16]. The potent antidiabetic activity of both plants may be attributed to the presence of these volatile decomposed products that predominate in their oils in addition to other nonvolatile sulfur-containing peptides and proteins[17].

Aralia elata

It is a woody plant belonging to the family Araliaceae, known also by Japanese angelica tree. The antidiabetic activity of its root cortex may be attributed to the presence of elatosides E together with oleanolic acid and its derivatives. These secondary metabolites lower the serum glucose level as shown by oral sugar tolerance test in rats[18]. The hypoglycemic activity of *A. elata* is mainly mediated through inhibition of aldose reductase activity[19].

Azadirachta indica

It belongs to the family Meliaceae and has been used for a long time in traditional medicine in treating several ailments including diabetes. Its leaves stem bark and seeds possess hypoglycemic activity via increasing insulin secretion from the beta cells of the pancreas[20]. The leaves are characterized by the presence of high fiber content that is potent in diabetes management and controlling of post-prandial hyperglycemia through delaying gastric emptying, increasing viscosity of GIT content thus, suppressing digestion and absorption of carbohydrate with no risk of

hypoglycemia, hyper insulinemia and undesirable weight gain[21].

Bauhinia candicans* and *B. forficate

They are medicinal plants native to Peru, Brazil and Argentina sub-tropical regions, belonging to family Caesalpinaceae the methanol extract of B. candicans leaves, together with its butanol exerted a potent antidiabetic activity reducing the plasma glucose level as well as urinary glucose excretion through enhancing peripheral glucose metabolism[22]. Administration of *B. forficata* leaves various extracts to alloxan induced diabetic rats resulted in an obvious suppression in serum glucose, triglycerides and total cholesterol. Moreover, chromatographic purification of *B. forficata* leaves n-butanol fraction, resulted in the isolation of kaempferilrin, a flavonoid, which showed a potent hypoglycemic activity upon oral administration in alloxan-induced diabetic rats[23].

Biophytum sensitivum

It is an herbaceous plant are available in Nepal widely reputed in folk medicine belonging to family Oxalidaceae. Its leaf extract exhibited a potent antidiabetic activity affecting glucose homeostasis. It caused a significant rise in serum insulin together with reduction in bloodglucose levels suggesting an insulinotropic effect mediated through enhancing the synthesis and/ or release of insulin from the pancreatic beta cells[23].

Brassica nigra

It belongs to family Brassicaceae and endogenously grows in the Mediterranean regions. The aqueous *B. nigra* seeds has extract exhibited a potent antidiabetic activity in STZ induced diabetic rats manifested by significant reduction in fasting serum glucose, glycosylated hemoglobin and serum lipids exceeding that of ethanol, acetone and chloroform extracts[24]. The mode of action are mainly attributed to stimulating insulin release from pancreas and normalizing the effects of glucose metabolizing enzyme, therefore, improving glucose homeostasis in both liver and kidney[25].

Cinnamomum zeylanicum

It is commonly known as Cinnamon belongs to the (family: Lauraceae) and widely used in East Asia and Europe. It is extensively used in folk medicine to treat diabetes. It contains volatile oils, mainly cinnamaldehyde. Cinnamon ingestion decreased total plasma sugar level with insulin sensitivity improvement. It also significantly reduced gastric emptying and profoundly decreasing postprandial glycemic response[14]. In addition, cinnamon aqueous extract revealed a potent antidiabetic effect through its up regulation of uncoupling protein-1 (UCP-1) and enhancing the translocation of GLUT4 in the muscle and adipose tissues[26]. Oral administration of cinnamaldehyde is a chief active constituent, resulted in significant reduction in serum glucose, glycosylated hemoglobin, total cholesterol and triglyceride levels accompanied by a marked increase in serum insulin, hepatic glycogen and high-density lipoprotein in a dose-dependent manner[27].

***Coptis chinensis* (Huanglian)**

It belongs to the family Ranunculaceae and popularly used to alleviate diabetes in traditional Chinese medicine. The anti diabetic activity is likely due to the presence of berberine, an isoquinoline alkaloid that predominates in plant roots, rhizomes, stems and barks. Studies has showed that berberine produced significant reduction in blood-glucose level, plasma total cholesterol, triglycerides, and markedly decrease disaccharidases and β-glucuronidase activities in STZ-induced diabetic rats.

They are successfully reduced body weight, increasing insulin response, enhancing glucose's uptake by adipocytes via GLUT1, acetylcoenzyme a carboxylase phosphorylation, adenosine monophosphate-activated protein kinase. Moreover, it is increased in the PPAR α/δ/γ protein expression in liver thus it potentiates insulin receptor expression in liver and skeletal muscle cells with concomitant improvement in glucose consumption, relieving some diabetic complications through marked regeneration in the damaged pancreas[28].

Cyamopsis tetragonoloba

C. tetragonoloba (Fabaceae) beans ethanol extract administered to alloxan-induced diabetic rats caused significant reduction in blood glucose levels which can be mediated through reduction of glucose absorption from gastrointestinal tract together with enhancing glucose utilization[29].

Eugenia jambolana

It is commonly by Jamun or black plum or *Syzygium cumini* belonging to family Myrtaceae and is widely being used over many centuries for the treatment of diabetes by the traditional practitioners. Oral administration of the pulp extract of the fruit resulted in the enhancement of insulinemia through insulin secretion stimulation and insulinase activity suppression from liver and kidney[10]. While, administration of the seeds dried alcohol extract resulted in hypoglycemia and decreased glycosuria, partially restoring the altered hepatic and skeletal muscle glycogen content as well as hexokinase, glucose-6-phosphatase, phosphofructokinase and glucokinase[30].

Its mechanism of action is probably due to up regulation of both PPARα and PPARγ in addition to its ability to differentiate 3T3-L1 preadipocytes[31]. Besides, seed kernel extracts were found effective in inhibiting α-glucosidase accounting for the mode by which this herb exerts its anti-diabetic effect[32].

Ficus bengalenesis

Oral administration of bark aqueous extract exerted significant hypolipidemic, hypoglycemic and serum insulin increasing effects with intimate similarities to that exerted by a minimal dose of glibenclamide in STZ induced diabetic rats. It is effectively reduced serum glucose level, normalizing serum electrolytes levels, glycolytic enzymes and hepatic cytochrome P-450 dependent enzyme systems accompanied by reduction in liver and kidney lipid peroxides. This was further confirmed by histological studies of the dissected pancreatic sections[33].

Grewia asiatica

It is known as Phalsa or Falsa (family: Malvaceae), native to southern Asia, and commonly cultivated in tropical countries. Ethanol extracts of its fruit, stem, bark and leaves are orally administered elicited an observable reduction in serum glucose level of alloxan induced diabetic rabbits. This anti-hyperglycemic may be mediated by its antioxidant and radical scavenging activity rather than by stimulating the release of insulin[34].

Gymnema sylvestre

It is a member of family Asclepiadaceae, which is widely known as gurmar. It is a woody, climbing plant; its main constituents are gymnemic acid, gurmarin, a polypeptide of 35 amino acids and saponins[15]. *G. sylvestre* leaves extract exhibited a potent antidiabetic activity in type 2 diabetes, as evidenced by causing a prominent suppression in blood glucose, glycosylated hemoglobin and glycosylated plasma proteins together with restoring blood glucose homeostasis in type 2 diabetic patients. These results postulated that the beta pancreatic cells may be regenerated by *G. sylvestre* leaves extract supplementation and further confirmed by insulin levels elevation in patients serum[35].

Lawsonia inermis

Which is commonly known as Henna. It is a popular member of family Lythraceae, its leaves is found to constitute carbohydrates, flavonoids, proteins, phenolic compounds, tannins, terpenoids, alkaloids, quinones, xanthones, coumarins, as well as fatty acids[36]. Oral administration of 70% ethanol as well as 95% methanol extracts of the whole plant exhibited potent hypoglycemic and hypolipidaemic activities in alloxan induced diabetic mice causing significant reduction in serum glucose, cholesterol and triglycerides levels exceeding the effect of glibenclamide[37,38].

Lythrum salicaria

It is a member of family Lythraceae, which is commonly found in Europe, Asia, southeastern Australia and northwest Africa. It is also known as Purple loosestrife. *L. salicaria* stem and flower ether extracts caused a significant depression in serum glucose upon oral administration accompanied by an elevation in circulating insulin levels[39]. It is having a promising antidiabetic activity, mostly due to its richness in phenolic compounds, mainly tannins[40].

Medicago sutivu

Known by Alfalfa and also called Lucerne. It is a perennial flowering plant belonging to family Fabaceae. It is commonly used in traditional medicine to treat diabetes mellitus. Administration of its aqueous extract in hyperglycemia in STZ-diabetic mice via stimulating 2-deoxy-glucose transport in addition to glucose oxidation, and conversion of glucose to glycogen in mouse abdominal muscle. It also potentiated insulin secretion from the pancreatic β-cells. This insulin releasing effect was also observed in both methanol and water fractions suggesting the synergistic effect of various extract constituents[41].

Momordica charantia

An well-known plant (bitter melon) belonging to family Cucurbitaceae that widely used in folk therapy for the treatment of diabetes. Oral administration of the fruit juice or seed powder resulted in a significant decline in FBG and pronounced amelioration of glucose tolerance exerting both insulin secretagogue and insulinomimetic activities[42]. This potent antidiabetic activity are mainly attributed to the presence of an insulin-like polypeptide known by polypeptide- P, similar in structure to the bovine insulin, which reduces plasma sugar levels when injected subcutaneously into type I diabetic patients and appears to inhibit gluconeogenesis. In addition, it improves glucose tolerance in type II diabetes[10]. Other reported hypoglycemic agents isolated from *M. charantia* comprise the sterol glucoside mixture charantin isolated from fruit and the pyrimidine nucleoside vicine abundant in the seeds[43].

Morus alba

Iit is known as mulberry. It is a member in family Moraceae, The flavonoids in rich fraction of the Egyptian Morus alba root bark 70% alcohol extract exhibited hypoglycemic activity in STZ diabetic rats upon oral administration. It has significantly decreased the value of the blood-sugar level through protection of pancreatic beta cells from being degenerated and diminishing lipid peroxidation through reduction of lipid peroxides. It is detailed phytochemical investigation revealed the presence of four hydrophobic flavonoids namely morusin, cyclomorusin, neocyclomorusin, and kuwanon E, a 2-arylbenzofuran, moracin M, and two triterpenes, betulinic acid and methyl ursolate that may account for its antidiabetic potency[44].

Murraya koeingii

The curry leaf tree belonging to family Rutaceae is widely cultivated for its aromatic leaves, which are used as a flavoring agent. It was reported that an oral administration of *M. koeingii* leaves showed that potent hypoglycemic effect associated with an increase in hepatic glycogen content due to stimulated glycogenesis and suppressed glycogenolysis as well as gluconeogenesis[10]. It also prevented the β cells from damage, exhibiting antioxidant and free radical scavenging activity showing more efficacy than glibenclamide[45]. It effectively reverted serum urea, uric acid and creatinine to the normal levels, reflecting its protective effects on kidney in STZ-induced diabetic rats[46].

Another studies as showed that single oral administration of variable doses of *M. koeingii* leaves aqueous extract exerted a pronounced antidiabetic activity in alloxan induced diabetic rabbits as evidenced by marked lowering in blood-glucose level and improvement in glucose tolerance suggesting the tendency of its usage as an adjunct to dietary supplement and drug therapy for adequate control of diabetes mellitus[47]. Moreover, it should be given intraperitoneal of mahanimbine, carbazole alkaloid isolated from its leaves, at doses of 50 and 100 mg/kg showed a marked hypoglycemic activity reducing fasting blood sugar, triglycerides, low-density lipoprotein, VLDL levels increasing HDL level[47].

Ocimum sanctum

It is commonly known as Holy basil belong to the family (Labiateae). Administration of *O. sanctum* leaves alcohol extract, orally, significantly reduced glycemia and enhanced exogenous insulin action. Administration of leaf powder to healthy and diabetic rats resulted in reduction of FBG after one month[19]. Its pronounced that the therapeutic potential as antidiabetic agent can be attributed to

the presence of eugenol, its chief active constituent, reducing elevated serum sugar, cholesterol triglyceride levels as well as lactate dehydrogenase, alanine transaminase, aspartate transaminase and alkaline phosphatase[48].

Panax ginseng

It is a Ginseng root (Araliaceae) has been used for over 2,000 years in the Far East for its health-promoting activities. It contained triterpene glycosides (saponins), commonly referred to as ginsenosides, peptides, polysaccharides, fatty acids and polyacetylene alcohol[49]. The hypoglycemic effect of ginseng root may be attributed to blocking intestinal glucose absorption and inhibiting hepatic glucose- 6-phosphatase activity resulting in delaying of food digestion and carbohydrate absorption rate[49]. Ginseng polypeptide, isolated from the root was effective in decreasing liver glycogen and blood-sugar levels while, its aqueous extract showed a remarkable hypoglycemic activity, increasing insulin production, reducing pancreatic β-cells death and resistance to insulin, thus improving postprandial glycemia in diabetic patients[50]. Additional site of action for ginseng berry is the gastrointestinal tract, it exerts postprandial hypoglycemia via gastric vagal afferents, inhibited brain stem neuronal activity[51].

Picrorrhiza kurroa

It is commonly known as Kutki. It belongs to family Scrophulariaceae, Its alcohol extract reduced the sugar level in alloxan-induced diabetic rats through acting as a free radical scavenger. It can also decrease elevated blood urea nitrogen, serum lipid peroxides levels as well as ameliorating white blood cells destruction, protecting vital tissues including the pancreas and inhibiting undesirable body weight loss thus reducing the causation of diabetes[29,43]. Picrosides from Katuki constituted the major active ingredient responsible for its potent hypoglycemic activity presenting a natural and safe remedy for prevention or delaying of diabetic complications[52].

Polygonati Odorati

It belongs to family Liliaceae, of its aqueous extract showed potent antidiabetic activity influencing glucose or carbohydrate metabolism through inhibiting α-glucosidase activity in the digestive canal and thus improving glucose and triglyceride metabolism[53].

Psidium guajava

It is known as Guava belonging to family Myrtaceae. It was contains a high percentage of vitamins B1, B2, B6, vitamin C, free sugars (glucose, fructose and sucrose) and carotenes. Oral administration as well as intraperitoneal injection of aqueous leaves extract to alloxan-induced hyperglycemic rats has shown beneficial effect not only on blood glucose but also on body weight, glucose and ketone level of urine and tissue of pancreas showing a marked inhibitory activity on protein tyrosine phosphatase1B[54]. While, the methanol extract was that showed hypoglycemic effect in type II diabetes. Flavonoid glycosides are exemplified by pedunculagin, isostrictinin and strictinin are the potent constituents, that have been used in clinical treatment of diabetes to improve insulin sensitivity. Additionally, *P. guajava* of stem bark ethanol extract showed a marked hypoglycemic effect, which may not be due to stimulating insulin release from pancreatic β-cells, but may be attributed to extra pancreatic mechanism exemplified by enhancing peripheral glucose metabolism[55].

Pterocarpus marsupium

It is also known as Vijayasar or the Indian Kino Tree belonging to family Fabaceae. The hypoglycemic effect of various extracts from P. marsupium bark was obvious in alloxan-induced diabetic rats. The results was confirmed their efficacy on plasma glucose, total protein, cholesterol, triglycerides, alkaline phosphatase, alanine transaminase and aspartate transaminase. Moreover, butanol sub-fraction a marked hypoglycemic effect by adjusting body metabolism similar to insulin properties[56]. Marsupsin, pterostilbene, phenolic constituents of the heartwood of *P. marsupium*, significantly reduced blood-glucose level of approaching that of metformin[57].

***Tecoma stans* (Bignoniaceae) and *Teucrium cubense* (Lamiaceae)**

These plants were mainly used as a diabetes mellitus .Their aqueous extracts exert a potent antidiabetic activity via enhancing glucose uptake in both insulin-sensitive and insulin-resistant murine and human adipocytes with no marked proadipogenic or antiadipogenic adverse effects[58].

Tinospora cordifolia

It is commonly known as Gaduchi belongs of family Menispermaceae. It is widely used as tonic and its for treatment of endocrine metabolic disorders, including diabetes. The major phytochemical constituents are diterpenoids, alkaloids, steroids, lactones, glycosides, phenolics, aliphatic compounds, sesquiterpenoid, and polysaccharides. Oral administration of *T. cordifolia* root aqueous or alcohol extracts to alloxan diabetic rats produced a significant antidiabetic effect through enhancing the glucose metabolism as evidenced by an obvious suppression in plasma glucose, brain lipid values, serum acid phosphatase, alkaline and lactate dehydrogenase and hepatic glucose- 6-phosphatase, with consequent elevation in body weight, hepatic hexokinase and total hemoglobin[59].

Trigonella foenumgraecum

It is commonly known as Fenugreek seeds and is belonging to family Fabaceae. It is famous for the presence of mucilage, proteins, proteinase inhibitors, steroid saponins and saponin-peptide esters, sterols, flavonoids, nicotinic acid, coumarin, trigonelline and volatile oil[60]. Administration of the defatted seeds is decreased fasting and postprandial blood levels of glucagon, glucose, insulin, somatostatin, triglycerides, total cholesterol, while increased HDL-cholesterol levels. The intake of seed fiber of *T. foenumgraecum* decreases sugar absorption rate, delaying gastric emptying, thus inhibiting the increase in blood glucose levels after meals. It also stimulates insulin receptor sites to burn cellular glucose at high-fiber diet. Its chemical analysis revealed that galactomannan constituted the major ingredient that of the seed fiber to which the antidiabetic activity may be attributed[61,62].

Zingiber officinale

It is commonly known as ginger, belonging to family Zingiberaceae. The juice of *Z. officinale* rhizome exhibited a pronounced increase in serum insulin together with a marked decrease in FBG levels in STZ induced diabetic rats. It also exerted suppression in serum cholesterol, triglyceride and blood pressure in diabetic rats. This glycemic control particularly involves serotonin (5-HT) receptors[63]. Ginger extracts stimulate the 3T3-L1 preadipocytes differentiation. Recent studies showed that gingerol, its chief active constituent, enhanced cell-mediated glucose uptake via increasing insulin-sensitivity, thus improving chronic disease, as diabetes[64].

CONCLUSION

Natural resources are still considered as potent candidates for drug discovery and are playing important role in drug development programs. Moreover, many medicinal herbs has provide that a rich mine for bioactive chemicals that are markedly free from undesirable side effects and of powerful pharmacological actions. Now a days, the data on biological activities of many medicinal herbs are tremendously increasing. However, it is impractical to specify the performance of a multi-component mixture, as that present in plant extracts comprising a wide range of phytochemical constituents, to only a single component from that extract Secondary metabolites could act as lead compounds for the discovery of different new classes of possibly potent and safe ant diabetic agents. Further, should be given for the identification of the typical modes of action of their extracts and the isolated pure compounds. However, the variable molecular biological reports, the field of speculations and interpretation seem to be infinite. Consequently, much effort should be afforded to optimize a procedure for antidiabetic screening of different plants' extracts as well as isolated bioactive compounds for the discovery of new natural herbal antidiabetic drugs. That can be used as alternatives

to synthetic oral hypoglycemic drugs with less or even no prominent side effects.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

BIBLIOGRAPHY

1. Pareek H, Sharma S, Khajja B S, Jain K, Jain G C. Evaluation of hypoglycemic and anti hyperglycemic potential of *Tridax procumbens* (Linn.), *BMC Complement Altern Med,* 29(9), 2009, 48-54.
2. Craig M E, Hattersley A, Donaghue K C. Definition, epidemiology and classification of diabetes in children and adolescents, *Pediatr Diabetes,* 10(Supply12), 2009, 3-12.
3. Thévenod F. Pathophysiology of diabetes mellitus type 2: Roles of obesity, insulin resistance and β-cell dysfunction, *Front Diabetes Basel Karger,* 19, 2008, 1-18.
4. Patel D K, Kumar R, Prasad S K, Sairam K, Hemalatha S. Antidiabetic and *in vitro* antioxidant potential of *Hybanthus enneaspermus* (Linn) F. Muell in streptozotocin-induced diabetic rats, *Asian Pac J Trop Biomed,* 1(4), 2011, 316-322.
5. Patel D K, Kumar R, Prasad S K, Hemalatha S. *Pedalium murex* Linn (Pedaliaceae) fruits: A comparative antioxidant activity of its different fractions, Asian Pac J Trop Biomed, 1(5), 2011, 395-400.
6. Jung H A, Islam M D, Kwon Y S, Jin S E, Son Y K, Park J J, *et al.* Extraction and identification of three major aldose reductase inhibitors from *Artemisia Montana*, *Food Chem Toxicol,* 49(2), 2011, 376-384.
7. Warjeet Singh L. Traditional medicinal plants of Manipur as anti-diabetics, *J Med Plants Res,* 5(5), 2011, 677–687.
8. Arya V, Gupta V K, Ranjeet K. A review on fruits having anti-diabetic potential, *J Chem Pharmace Res,* 3(2), 2011, 204-212.
9. Upendra Rao M, Sreenivasulu M, Chengaiah B, Jaganmohan Reddy K, Madhusudhana Chetty C. Herbal medicines for diabetes mellitus: a review, *Int J Pharm Tech Res,* 2(3), 2010, 1883-1892.
10. Soumyanath A. Traditional medicines for modern times antidiabetic plants, *Taylor and Francis, Boca Raton, USA.* 1st Edition, 2005, 336.
11. Grover J, Yadav S, Vats V. Medicinal plants of India with anti-diabetic potential, *J Ethnopharmacol,* 81(1), 2002, 81-100.
12. Maity P, Hansda D, Bandyopadhyay U, Mishra D K. Biological activities of crude extracts and chemical constituents of Bael, Aegle marmelos (L.) Corr, *Indian J Exper Biol,* 47(11), 2009, 849-861.
13. Kesari A N, Gupta R K, Singh S K, Diwalar S, Watal G. Hypoglycemic and antihyperglycemic activity of Aegle marmelos seed extract in normal and diabetic rats, *J Ethnopharmacol,* 107(3), 2006, 374-379.
14. Sabu M, Kuttan R. Antidiabetic activity of Aegle marmelos and its relationship with its antioxidant properties, *Indian J Physiol Pharmacol,* 48(1), 2004, 81-88.
15. Goel R, Bhatia D, Gilani S J, Katiyar D. Medicinal plants as antidiabetics: A review, *Int Bull Drug Res,* 1(2), 2012, 100-107.
16. Eidi A, Eidi M, Esmaeili E. Antidiabetic effect of garlic (Allium sativum L.) in normal and streptozotocin-induced diabetic rats, *Phytomed,* 13(9-10), 2006, 624-629.
17. Dey L, Attele A S, Yuan C S. Alternative therapies for type 2 diabetes, *Altern Med Rev,* 7(1), 2002, 45-58.
18. Augusti K. Therapeutic values of onion (Allium cepa L.) and garlic (Allium sativum

L.), *Indian J Exper Biol,* 34(7), 1996, 634-640.

19. Yoshikawa M, Matsuda H, Harada E, Murakami T, Wariishi N, *et al.* Elatoside E, a new hypoglycemic principle from the root cortex of Aralia elata Seem.: structure-related hypoglycemic activity of oleanolic acid glycosides, *Chem Pharmace Bulle,* 42(6), 1994, 1354-1356.
20. Tripathi A K, Bhoyar P K, Baheti J R, Biyani D M, Khalique M, *et al.* Herbal antidiabetics: A review, *Int J Res Pharm Sci,* 2(1), 2011, 30-37.
21. Atangwho I J, Ebong P E, Eyong E U, Williams I O, Eteng M U, *et al.* Comparative chemical composition of leaves of some antidiabetic medicinal plants: Azadirachta indica, Vernonia amygdalina and Gongronema latifolium, *African J Biotech,* 8(18), 2009, 4685-4689.
22. Fuentes O, Arancibia-Avila P, Alarcón J. Hypoglycemic activity of Bauhinia candicans in diabetic induced rabbits, *Fitoterapia,* 75(6), 2004, 527-532.
23. Kavishankar G B, Lakshmidevi N, Mahadeva Murthy S, Prakash H S, Niranjana S R. Diabetes and medicinal plants-A review, *I Int J Pharm Biomed Sci,* 2(3), 2011, 65-80.
24. Puri D. The insulinotropic activity of a Nepalese medicinal plant Biophytum sensitivum: preliminary experimental study, *J Ethnopharmacol,* 78(1), 2001, 89-93.
25. Anand P, Murali K Y, Tandon V, Chandra R, Murthy P S. Preliminary studies on antihyperglycemic effect of aqueous extract of Brassica nigra (L.) Koch in streptozotocin induced diabetic rats, *Indian J Exper Bio,* 45(8), 2007, 696-701.
26. Anand P, Murali Y K, Tandon V, Murthy P S, Chandra R. Insulinotropic effect of aqueous extract of Brassica nigra improves glucose homeostasis in streptozotocin induced diabetic rats, *Exper Clin Endocri Diabetes,* 117(6), 2009, 251-256.
27. Shen Y, Fukushims M, Ito Y, Muraki E, Hosono T, *et al.* Verification of the antidiabetic effects of cinnamon (Cinnamomum zeylanicum) using insulin-uncontrolled type 1 diabetic rats and cultured adipocytes, *Biosci Biotechnol Biochem,* 74(12), 2010, 2418-2425.
28. Subash Babu P, Prabuseenivasan S, Ignacimuthu S. Cinnamaldehyde-A potential antidiabetic agent, *Phytomed,* 14(1), 2007, 15-22.
29. Hui H, Tang G, Go V L. Hypoglycemic herbs and their action mechanisms, *Chinese Medicine,* 4(1), 2009, 1-11.
30. Mukhtar H M, Ansari S H, Bhat Z A, Naved T. Antihyperglycemic activity of Cyamopsis tetragonoloba beans on blood glucose levels in alloxan-induced diabetic rats, *Pharmaceu Bio,* 44(1), 2006, 10-13.
31. Kumar A S, Kavimani S, Jayaveera K. A review on medicinal Plants with potential antidiabetic activity, *Inte J Phytopharmacol,* 2(2), 2011, 53-60.
32. Sharma B, Balomajumder C, Roy P. Hypoglycemic and hypolipidemic effects of flavonoid rich extract from Eugenia jambolana seeds on streptozotocin induced diabetic rats, *Food Chem Toxicol,* 46(7), 2008, 2376-2383.
33. Shinde J, Taldone T, Barletta M, Kunaparaju N, Hu B, *et al.* A-Glucosidase inhibitory activity of Syzygium cumini (Linn.) Skeels seed kernel in vitro and in Goto–Kakizaki (GK) rats, *Carbohydrate Res,* 343(7), 2008, 1278-1281.
34. Gayathri M, Kannabiran K. Antidiabetic and ameliorative potential of Ficus bengalensis bark extract in streptozotocin induced diabetic rats, *Indian J Clin Biochem,* 23(4), 2008, 394-400.
35. Parveen A, Irfan M, Mohammad F. Antihyperglycemic activity in Grewia asiatica, a comparative investigation, *Inte J Pharma Pharmaceut Sci,* 4(1), 2012, 210-213.

36. Baskaran K, Ahamath B K, Shanmugasundaram K R, Shanmugasundaram E R B. Antidiabetic effect of a leaf extract from Gymnema sylvestre in non-insulin-dependent diabetes mellitus patients, *J Ethnopharmacol,* 30(3), 1990, 295-305.
37. Pritesh P, Pinal H, Jagath P, Nilesh D, Bhagirath P. Antidiabetic herbal drugs a review, *Pharmacophore,* 3(1), 2012, 18-29.
38. Chaudhary G, Goyal S, Poonia P. Lawsonia inermis Linnaeus: A phytopharmacological review, *Inte J Pharmaceu Sci Drug Res,* 2(2), 2010, 91-98.
39. Choubey A, Ojha M, Mishra A, Mishra S, Patil U K. Hypoglycemic and antihyperglycemic effect of ethanolic extract of whole plant of Lawsonia inermis (henna) in streptozotocin induced diabetic rats, *Inte J Pharmaceu Sci Rev Res,* 1(Suppl 8), 2010, 74-77.
40. Lamela M, Cadavid I, Gato A, Calleja J M. Effects of Lythrum salicaria in normoglycemic rats, *J Ethnopharmacol,* 14(1), 1985, 83-91.
41. Humadi S S, Istudor V. Lythrum salicaria (Purple loosestrife). Medicinal use, extraction and identification of its total phenolic compounds, *Farmacia,* 57(2), 2009, 192-200.
42. Gray A M, Flatt P R. Pancreatic and extra-pancreatic effects of the traditional anti-diabetic plant, Medicago sativa (lucerne), *Br J Nut,* 78(2), 1997, 325-334.
43. Raman A, Lau C. Anti-diabetic properties and phytochemistry of Momordica charantia L. (Cucurbitaceae), Phytomed, 2(4), 1996, 349-362.
44. Singab A N B, El-Beshbishy H A, Yonekawa M, Nomura T, Fukai T. Hypoglycemic effect of Egyptian Morus alba root bark extract: Effect on diabetes and lipid peroxidation of streptozotocin-induced diabetic rats, *J Ethnopharmacol,* 100(3), 2005, 333-338.
45. Romila Y, Mazumder P B, Dutta Choudhury M. A Review on antidiabetic plants used by the people of Manipur charactirized by hypoglycemic activity, Assam University, *J Sci Tech,* 6(1), 2010, 167-175.
46. Arulselvan P, Senthilkumar G P, Sathish Kumar D, Subramanian S. Anti-diabetic effect of Murraya koenigii leaves on streptozotocin induced diabetic rats. Die Pharmazie – An, *Int J Pharmaceu Sci,* 61(10), 2006, 874-877.
47. Kesari A N, Gupta R K, Watal G. Hypoglycemic effects of Murraya koenigii on normal and alloxan-diabetic rabbits, *J Ethnopharmacol,* 97(2), 2005, 247-251.
48. Jain V, Momin M, Laddha K. Murraya Koenigii: An Updated Review, *Inte J Ayur Herb Med,* 2(4), 2012, 607-627.
49. Prakash P, Gupta N. Therapeutic uses of Ocimum sanctum Linn (Tulsi) with a note on eugenol and its pharmacological actions: a short review, *Indian J Phys Pharmacol,* 49(2), 2005, 125-131.
50. Painter F. Panax ginseng. Monograph, Alternative Medicine Review, 14(2), 2009, 172-176.
51. Attele A S, Zhou Y P, Xie J T, Wu J A, Zhang L, *et al.* Antidiabetic Effects of Panax ginseng berry extract and the identification of an effective component, *Diabetes,* 51(6), 2002, 1851-1858.
52. Thakkar N V, Patel J A. Pharmacological evaluation of "Glyoherb": A polyherbal formulation on streptozotocin-induced diabetic rats, *Int J Diabetes Dev Ctries,* 30(1), 2010, 1-7.
53. Chen H, Feng R, Guo Y, Sun L, Jiang J. Hypoglycemic effects of aqueous extract of Rhizoma Polygonati Odorati in mice and rats, *J Ethnopharmacol,* 74(3), 2001, 225-229.
54. Oh W K, Lee C H, Lee M S, Bae E Y, Sohn C B, *et al.* Antidiabetic effects of extracts

from Psidium guajava, *J Ethnopharmacol,* 96(3), 2005, 411-415.
55. Mukhtar H M, Ansari S H, Bhat Z A, Naved T, Singh P. Antidiabetic activity of an ethanol extract obtained from the stem bark of Psidium guajava (Myrtaceae), *Die Pharmazie - An Int J Pharmaceu Sci,* 61(8), 2006, 725-727.
56. Dhanabal S P, Kokate C K, Ramanathan, Kumar E P, Suresh B. Hypoglycaemic activity of Pterocarpus marsupium Roxb, *Phytother Res,* 20(1), 2006, 4-8.
57. Manickam M, Ramanathan M, Farboodniay Jahromi M A, Chansouria J P N, Ray A B. Antihyperglycemic activity of phenolics from Pterocarpus marsupium, *J Nat Prod,* 60(6), 1997, 609-610.
58. Alonso-Castro A J, Zapata-Bustos R, Romo-Yañez J, *et al.* The antidiabetic plants Tecoma stans (L.) Juss. ex Kunth (Bignoniaceae) and Teucrium cubense Jacq (Lamiaceae) induce the incorporation of glucose in insulin-sensitive and insulin-resistant murine and human adipocytes, *J Ethnopharmacol,* 127(1), 2010, 1-6.
59. Singh S S, Pandey S C, Srivastava S, Gupta V S, Patro B, *et al.* Chemistry and medicinal properties of Tinospora cordifolia (Guduchi), *Indian J Pharmacol,* 35(2), 2003, 83-91.
60. Bnouham M, Ziyyat A, Mekhfi H, Tahri A, Legssyer A. Medicinal plants with potential antidiabetic activity-A review of ten years of herbal medicine research (1990-2000), *Int Diabetes Metabo,* 14(1), 2006, 1-25.
61. Ali L, Azed Khan A, Hassan Z, Mosihuzzaman M, Nahar N, *et al.* Characterization of the hypoglycemic effects of Trigonella foenumgraecum seed, *Planta Medica,* 61(4), 1995, 358-360.
62. Basch E, Ulbricht C, Kuo G, Szapary P, Smith M. Therapeutic applications of fenugreek, *Alter Med Rev,* 8(1), 2003, 20-27.
63. Akhani S P, Vishwakarma S L, Goyal R K. Anti-diabetic activity of Zingiber officinale in streptozotocin-induced type I diabetic rats, *J Pharmacy Pharmacol,* 56(1), 2004, 101-105.
64. Sekiya K, Ohtani A, Kusano S. Enhancement of insulin sensitivity in adipocytes by ginger, *Biofactors,* 22(1-4), 2004, 153-156.
65. Campos K E, Diniz Y S, Cataneo A C, Faine L A, Alves M J Q F, *et al.* Hypoglycaemic and antioxidant effects of onion, Allium cepa: dietary onion addition, antioxidant activity and hypoglycaemic effects on diabetic rats, *Int J Food sci Nut,* 54(3), 2003, 241-246.

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