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THE POTENTIAL HYPOGLYCEMIC EFFECTS OF BIOACTIVE COMPOUNDS OF SELECTIVE MEDICINAL PLANTS

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ABSTRACT
Medicinal plants have been proposed as rich yet unexploited potential sources for anti-diabetic drugs, even though used since ancient times for the treatment of diabetes mellitus. Many of the synthetic drugs were discovered either directly or indirectly from the plant source. The present study reviews of plants having anti diabetic property. Although many plants are recommendation, further pharmacological and chemical research should be done to elucidate the exact mechanism of hypoglycaemic activity

Key words: Diabetes mellitus, Medicinal plants, Bioactive compounds.

INTRODUCTION

Diabetes mellitus is a common and very prevalent disease affecting the citizens of both developed and developing countries. It is estimated that 25% of the world population is affected by this disease. Diabetes mellitus is caused by the abnormality of carbohydrate metabolism which is linked to low blood insulin level or insensitivity of target organs to insulin [1]. Despite considerable progress in the treatment of diabetes by oral hypoglycemic agents, search for newer drugs continues because the existing synthetic drugs have several limitations. The herbal drugs with antidiabetic activity are yet to be commercially formulated as modern medicines, even though they have been acclaimed for their therapeutic properties in the traditional systems of medicine[2]. Type 2 diabetes usually occurs in obese individuals and is associated with hypertension and dyslipidemia. Thus the treatment aims to reduce insulin resistance and to stimulate insulin secretion. Diabetes is a metabolic disorder where in human body does not produce or properly us insulin, a hormone that is required to convert sugar, starches, and other food into energy.

Diabetes mellitus is characterized by constant high levels of blood glucose (sugar). Human body has to maintain the blood glucose levels at a very narrow range which is done with insulin and glucagon. The function of glucagon is causing the liver to release glucose from its cells into the blood for the production of energy. Type 1 Diabetes leads to inability to release insulin results in low rates of glucose uptake into muscles and adipose tissue [3]. Traditional medicine (herbal) is used for treatment of diabetes in developing countries where the cost of conventional medicines is a burden to the population [4]. Despite the introduction of hypoglycemic agents from natural and synthetic sources, diabetes and its secondary complications continue to be a major medical problem. Many indigenous Indian medicinal plants have been found to be useful to successfully manage diabetes. One of the great advantages of medicinal plants is that these are readily available and have very low side effects.

Plants have always been an exemplary source of drugs and many of the currently available drugs have been derived directly or indirectly from them. The ethno botanical information reports about 800 plants that may possess antidiabetic potential [5]. Several herbs have shown antidiabetic activity when assessed using presently available experimental techniques.

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This review article enumerates some medicinal plants possessing antidiabetic activity such as Acacia tortilis, Andrographis paniculata, Anethum graveolens, Argyriea speciosa, Barleria prionitis, Capparis deciduas, Cassia grandis, Ceriops decandra, Colocasia esculenta, Costus igneus, Eucalyptus citriodora, Ficus bengalensis, Heinsia crinata, Helicteres isora, Icacina trichantha, Ipomoea reniformis, Jatropha curcus, Julgans regia, Lantana aculeate, Limonia acdissima, Mallotus philippensis, Melia azedarach, Mentha piperita, Morus alba, Nicotiana tobacum, Ocimum gratissimum, Plantago ovata,, Phoenix dactylifera, Phyllanthus niruri,Prunus dulcis, Salacia oblonga, Solanum nigrum, Stevia rebaudiana, Sutherlandia frutescens, Tephrosia purpurea, Trigonella foenum graecum, Vaccinium myrtillus, Vaccinium vitis-idaea, Vernonia amygdalina, Zaleya pentandra and Zizyphus spina-christi and bioactive compounds responsible for antidiabetic activity of plant extracts were exploited (Table 1).

Table 01: Bioactive compounds having antidiabetic activity from some medicinal plants

Plant name / Family	Plant part/Extraction	Bioactive compounds	Biological activities	Ref.
Acacia tortilis/ Fabaceae	Gum exudates of stem and branches/ Aqueous extract	Polysaccharide - D-Glucuronic acid	Antidiabetic activity	[6]
Andrographis paniculata/ Acanthaceae	Aerial parts / Ethanolic extract	Terpenoid- Andrographolide	Hypoglycaemic activity	[7, 8]
Anethum graveolens/ Apiaceae	Seeds/ Aqueous extract	Essential oil - D -Carvone	Antidiabetic activity	[9]
Argyreia speciosa/ Convolvulaceae	Aerial parts/Ethanolic extract	Coumarins - Scopoletin	Antidiabetic & antioxidant activity	[10, 11]
Barleria prionitis/ Acanthaceae	Whole plant/ Alcoholic extract	Phenylethanoid glycoside - Barlerinoside	Antidiabetic activity	[12, 13]
Capparis deciduas/ Capparidaceae	Stem/Aqueous and Ethanolic extract	Phenolic compounds - Glucosinolates	antidiabetic activity	[14, 15]
Cassia grandis/ Leguminosae	Stem /Aqueous and Ethanolic extracts	Carbohydrate -Lyoniresinol	antidiabetic activity	[16, 17]
Ceriops decandra/ Rhizophoraceae	Leaves/Ethanolic extract	Diterpenoids - Ceriopsins F and G(1-2)	Antidiabetic & antioxidant activity	[18, 19]
Cissampelos pareira/ Menispermaceae	Climber/Whole plant	Alkaloid - Berberine	Antidiabetic activity	[20, 21]
Costus igneus/ Costaceae	Leaves/Ethanolic extract	Flavonoids - Quercetin	Antidiabetic activity	[22, 23]
Eucalyptus citriodora/ Myrtaceae	Leaves/Aqueous extract	Monoterpenoid - Citronellal	Antidiabetic activity	[24, 25]
Ficus bengalensis/ Moraceae	Aerial roots/Aqueous extract	Linear copmpound-6-heptatriacontene-10-one	Antidiabetic activity	[26, 27]
Heinsia crinata/ Rubiaceae	Leaf /Aqueous extract	Fatty acid - Heptacosanoic acid	Antidiabetic activity	[28, 29]
Helicteres isora/ Malvaceae	Fruit/Hot water extract	Alkaloid - Berberine	Antioxidant and Antidiabetic activity	[30, 31]
Icacina trichantha/ Icacinaceae	Tuber/Methanolic extract	Diterpene - Icacinol	Hypoglycaemic and Hypolipidaemic activity	[32, 7]
Ipomoea reniformis/ Convolvulaceae	Stem/Leaf /Ethanolic extract	Monocarboxylic acid - P-Coumaric acid	Antihyperglycemic antihyperlipidemic activity	[33, 34, 35]
Jatropha curcus/ Euphorbiaceae	Leaf/Methanolic extract	Flavanoid glycoside - Apigenin-7-O-β-rhamnoglucoside	Antidiabetic and Antihyperlipidemic activity	[36, 37, 38]
Juglans regia/ Juglandaceae	Leaves/Alcoholic extract	Omega-6-Fatty acid -Linoleic acid	Antidiabetic Antioxidant Antibacterial activity	[39, 34]

Lantana aculeata/ Verbenaceae	Matured roots/Ethanolic extract	Pentacyclic triterpenoid - Oleanolic acid	Antidiabetic activity	[40]
Limonia acidissima/ Rutaceae	Fruit pulp/Methanolic extract	Amino acid - Tyramine	Antidiabetic, antioxidant and antihyperlipidemic activity	[41, 42, 43]
Mallotus philippensis/ Euphorbiaceae	Bark/Hydro-ethanolic extract	C-glycoside - Bergenin	Antidiabetic activity	[44, 45]
Melia azedarach/ Meliaceae	Leaf/Aqueous extract	Euphane-type triterpene - Azedarachic acid	Antidiabetic activity	[46, 47]
Mentha piperita/ *Lamiacea*	Leaf/ Aqueous extract	Essential oil - Menthol	Antidiabetic activity	[48, 49]
Morus alba/Moraceae	Leaf/Ethanolic extract	Flavanoid - Rutin	Antidiabetic activity	[50, 51]
Nicotiana tabacum/ Solanaceae	Leaf/Aqueous extract	Alkaloid - Nicotine	Antidiabetic activity	[52,53]
Ocimum gratissimum/ Lamiaceae	Leaf/Aqueous extract	Phenolic compound - Chicoric acid	Hypoglycaemic activity	[54]
Plantago ovata/ Plantaginaceae	Husk/Aqueous extract	Sugar acid - Galactouronic acid	Antidiabetic activity	[55, 56]
Phoenix dactylifera/ Arecaceae	Seed/Hot water extract	Polyphenols - Quercetin	Antidiabetic activity	[57]
Phyllanthus niruri/ Euphorbiaceae	Aerial parts/Methanolic extract	Polyphenol - Ellagic acid	Hypoglycaemic activity	[58]
Prunus dulcis/ Rosaceae	Fruits/Methanolic extract	Flavanol - Morin	Antidiabetic activity	[59, 60, 7]
Salacia oblonga/ Celastraceae	Roots/Aqueous & Methanolic extract	Diterpenes- Kotalagenin 16-acetate	Antidiabetic activity	[61]
Solanum nigrum/ Solanaceae	Leaves/Hydroalcoholic extract	Polyphenol - P-coumaric acid	Antidiabetic activity	[62]
Stevia rebaudiana/ Asteraceae	Leaf/Methanolic extract	Diterpenes - Stevioside	Antidiabetic activity	[63]
Sutherlandia frutescens/Fabaceae	Whole plant/Aqueous-formic acid extract	Sugar alcohol - Pinitol	Antidiabetic activity	[64, 65]
Tephrosia purpurea/ Fabaceae	Whole plant/Ethanolic extract	Flavanoid - Quercetin	Antidiabetic activity	[66]
Trigonella foenum-graecum / Leguminosae	Seeds/Alcoholic extract	Polysaccharide - Glucomannan	Antidiabetic activity	[67]
Vaccinium myrtillus/ Ericaceae	Leaves/Aqueous extract	Glycosides - Neomyrtillin	Antidiabetic activity	[68]
Vaccinium vitis-idaea/ Ericaceae	Berries/Ethanol extract	Flavanoid - Quercetin	Hypoglycaemic activity	[69]
Vernonia amygdalina/ Asteraceae	Leaves / Chloroform extract	Fatty acids - Linoleic acid	Antidiabetic activity	[70]
Zaleya pentandra/ Aizoaceae	Aerial parts / Methanolic extract	Pentandradiol	Antidiabetic activity	[71]
Zizyphus spina-christi/ Rhamnaceae	Leaves / Butanol extract	Saponin glycoside - Christinin	Antidiabetic activity	[72]

DISCUSSION:

Diabetes is considered to be a metabolic disorder that mainly occurs due to defects in either insulin secretion, insulin action, or both. Diabetes is a disease that can lead to serious problems affecting human health. In the long term, effects can cause micro and macro vascular problems[73]. In addition, uncontrolled diabetes can cause many chronic complications, including blindness, heart disease, and renal failure[74]. A significant change occurs in the structure and metabolism of lipid in diabetes. Lipid

peroxidation is associated with hyperlipidemia. The liver plays a critical role in glucose, lipid homeostasis, and has an important effect on diabetes. The liver and kidneys participate in the absorption, oxidation, and metabolism of free fatty acids and synthesize cholesterol, phospholipids, and triglycerides. Despite the presence of anti-diabetic drugs in the pharmaceutical market, the treatment of diabetes with medicinal plants is often successful. Herbal medicines and plant components with insignificant toxicity and no side effects are notable therapeutic options for the treatment of this disease around the world[75]. Most tests have demonstrated the benefits of medicinal plants containing hypoglycemic properties in diabetes management. The most common herbal active ingredients used in treating diabetes are flavonoids, tannins, phenolic, and alkaloids. The existence of these compounds implies the importance of the anti-diabetic properties of these plants. Numerous mechanisms of actions have been proposed for these plant extracts. Some hypotheses relate to their effects on the activity of pancreatic ß cells (synthesis, release, cell regeneration/revitalization) or the increase in the protective/inhibitory effect against insulinase and the increase of the insulin sensitivity or the insulin-like activity of the plant extracts. Other mechanisms may involve improved glucose homeostasis (increase of peripheral utilization of glucose, increase of synthesis of hepatic glycogen and/or decrease of glycogenolysis acting on enzymes, inhibition of intestinal glucose absorption, reduction of glycaemic index of carbohydrates, reduction of the effect of glutathione. All of these actions may be responsible for the reduction and or abolition of diabetic complications. For example, tannin improves the function of pancreatic Beta-cells and increases insulin secretion. Quercetin is an antioxidant that acts in several mechanisms related with the removal of oxygen radicals, so prevents lipid peroxidation and metal ion chelation. In fact, the mechanisms of actions for hypoglycemic plants include: increasing of insulin secretion, increasing of glucoses absorption by muscle and fat tissues, prevention of glucose absorption from the intestine, and prevention of glucose production from liver cells [76]. These factors are mostly responsible for the reduction or elimination of diabetes complications. It is worth noting that in this study, STZ rats are the most common animal model used to investigate anti-diabetic activity of plant extracts.

CONCLUSION:

Plants are natural antioxidants and effective herbal medicines, in part due to their anti-diabetic compounds, such as flavonoids, tannins, phenolic, and alkaloids that improve the performance of pancreatic tissues by increasing the insulin secretion or decreasing the intestinal absorption of glucose. Phytoconstituents can be used as alternatives to antidiabetic drugs in diabetes medications because they have no proven side effects and may help reduce the costs associated with treatment of diabetes mellitus. More researches are needed in order to separate the active components of plants and molecular interactions of their compounds for analysis of their curative properties.

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