MEDICINAL PLANTS OF INDIA EFFECTIVE IN TREATMENT OF DIABETES: A BRIEF REVIEW

Burdwan University

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT FOR THE SEM VI B.SC (GENERAL) DEGREE OF
THE UNIVERSITY OF BURDWAN
BY

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COURSE - DSE DISSERTATION

ROLL NO – 190611610007

REG. NO. – 201901010108OF 2019-20

M.U.C WOMEN'S COLLEGE

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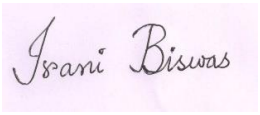
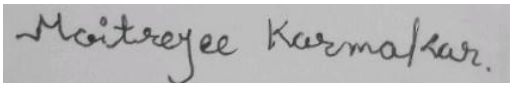


DATE: 16-06-2022

(DR. IRANI BISWAS)

ACKNOWLEDGEMENT

THE DEPARTMENT OF BOTANY OF M.U.C WOMEN'S COLLEGE IS ONE OF THE EFFICIENT DEPARTMENTS IN THE COLLEGE, OCCUPIED WITH POTENTIAL AND AFFECTIONATE TEACHERS WHO HELPED US IN EVERY WAY FOR OUR ACADEMIC ACCOMPLISHMENT. I FELT IMMENSE PLEASURE TO DO THIS INTERESTING DISSERTATION WORK OF SEM VI ON THE TOPIC "MEDICINAL PLANTS OF INDIA EFFECTIVE IN TREATMENT OF DIABETES; A BRIEF REVIEW." I AM ESPECIALLY THANKFUL TO OUR HONOURABLE PRINCIPAL SIR FOR HIS SINCERE CO- OPERATION IN EVERY ASPECT. I AM GARTEFUL TO ALL THE TEACHERS OF BOTANY, ESPECIALLY DR. IRANI BISWAS WHOSE SUPERVISION HAS MADE IT POSSIBLE TO COME OUT OF THIS TOUGH WORK EASILY. SHE HELPED ME IN PREPARING THIS REPORT TO ENNUMERATE SOME MEDICINAL PLANTS OF INDIA HAVING ANTIDIABETIC PROPERTY. I AM AGAIN THANKFUL TO ALL MY TEACHERS WHO HELPED ME IN DOING THIS WORK AND I WOULD ALSO LIKE TO THANK MY FRIENDS WHO HELPED ME A LOT IN FINALIZING THIS PROJECT WITHIN THE LIMITED TIME TO COME OUT WITH SATISFACTORY SUCCESS.



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CONTENTS

INTRODUCTION

In the last few years there has been an exponential growth in the field of herbal medicine and these drugs are gaining popularity both in developing and developed countries because of their natural origin and less side effects. Many traditional medicines in use are derived from medicinal plants, minerals and organic matter. A number of medicinal plants, traditionally used for over 1000 years named Rasayan are present in herbal preparations of Indian traditional health care systems. Among these 2500 species are in India, out of which 150 species are used commercially on a fairly large scale. India is the largest producer of medicinal herbs and is called as botanical garden of the world. The current review focuses on herbal drug preparations and plants used in the treatment of diabetes mellitus, a major crippling disease in the world leading to. The World Health Organization (WHO) has been promoting a movement for "Saving Plants for Saving Lives". This is because of the growing understanding of the pivotal

role medicinal plants play in providing herbal remedies to health remedies. India is the home of several important traditional systems of health care like Ayurveda, Siddha and Unani. All these systems depend heavily on herbal products. In addition, allopathic drugs are also derived from a wide range of plant products. Over 800 medicinal plant species are currently in use by the Indian herbal industry. However, except for about 120 species, all others are collected from the wild. Developed countries in recent times are turning to traditional medicinal systems that involve the use of herbal drugs and remedies.

Diabetes mellitus, commonly known as **diabetes**, is a group of metabolic disorders characterized by a high blood sugar level over a prolonged period of time. Symptoms often include frequent urination, increased thirst and increased appetite. If left untreated, diabetes can cause many health complications. Acute complications can include diabetic ketoacidosis, hyperosmolar hyperglycaemic state, or death. Serious long-term complications include cardiovascular disease, stroke, chronic kidney disease, foot ulcers, damage to the nerves, damage to the eyes and cognitive impairment.

Diabetes is due to either the pancreas not producing enough insulin, or the cells of the body not responding properly to the insulin produced. Insulin is a hormone which is responsible for helping glucose from food get into cells to be used for energy.Type 1 diabetes results from failure of the pancreas to produce enough insulin due to loss of beta cells. This form was previously referred to as "insulin-dependent diabetes mellitus" or "juvenile diabetes". Type 1 diabetes usually appears during childhood or adolescence, it can also develop in adults. Type 2 diabetes begins with insulin resistance, a condition in which cells fail to respond to insulin properly. As the disease progresses, a lack of insulin may also develop. This form was previously referred to as " noninsulin-dependent diabetes mellitus" or "adult-onset diabetes".

Diabetes is a chronic disorder of carbohydrate, fat and protein metabolism characterized by increased fasting and post prandial blood sugar levels. The global prevalence of diabetes is estimated to increase, from 4% in 1995 to 5.4% by the year 2025. WHO has predicted that the major burden will occur in developing countries. Studies conducted in India in the last

decade have highlighted that not only is the prevalence of diabetes high but also that it is increasing rapidly in the urban population. It is estimated that there are approximately 33 million adults with diabetes in India. This number is likely to increase to 57.2 million by the year 2025.

Diabetes mellitus is a complex metabolic disorder resulting from either insulin insufficiency or insulin dysfunction. Type I diabetes (insulin dependent) is caused due to insulin insufficiency because of lack of functional beta cells. Patients suffering from this are therefore totally dependent on exogenous source of insulin while patients suffering from Type II diabetes (insulin independent) are unable to respond to insulin and can be treated with dietary changes, exercise and medication. Type II diabetes is the more common form of diabetes. constituting 90% of the diabetic population. Symptoms for both diabetic conditions may include: (i) high levels of sugar in the blood; (ii) unusual thirst; (iii) frequent urination; (iv) extreme hunger and loss of weight; (v) blurred vision; (vi) nausea and vomiting; (vii) extreme weakness and tiredness; (viii) irritability, mood changes etc.

Though pathophysiology of diabetes remains to be fully understood, experimental evidences suggest the involvement of free radicals in the pathogenesis of diabetes and more importantly in the development of diabetic complications. Free radicals are capable of damaging cellular molecules, DNA,

proteins and lipids leading to altered cellular functions. Many recent studies reveal that antioxidants capable of neutralizing free radicals are effective in preventing experimentally induced diabetes in animal models as well as reducing the severity of diabetic complications. For the development of diabetic complications, the abnormalities produced in lipids and proteins are the major etiologic factors. In diabetic patients, extra-cellular and long-lived

proteins, such as elastin, laminin, collagen are the major targets of free radicals. These proteins are modified to form glycoproteins due to hyperglycemia. The modification of these proteins present in tissues such as lens, vascular wall and basement membranes are associated with the development of complications of diabetes such as cataracts, microangiopathy, atherosclerosis and nephropathy. During diabetes, lipoproteins are oxidized by free radicals. There are also multiple abnormalities of lipoprotein metabolism in very low-density lipoprotein (VLDL), low density lipoprotein (LDL), and high-density lipoprotein (HDL) in diabetes. Lipid peroxidation is enhanced due to increased oxidative stress in diabetic condition. Apart from this, advanced glycation end products (AGEs) are formed by non-enzymatic glycosylation of proteins. AGEs tend to accumulate on long-lived molecules in tissues and generate abnormalities in cell and tissue functions. In addition, AGEs also contribute to increased vascular permeability in both micro and macrovascular structures by binding to specific macrophage receptors. This results in formation of free radicals and endothelial dysfunction. AGEs are also formed on nucleic acids and histones and may cause mutations and altered gene expression.

As diabetes is a multifactorial disease leading to several complications, and therefore demands a multiple therapeutic approach. Patients of diabetes either do not make enough insulin or their cells do not respond to insulin. In case of total lack of insulin patients are given insulin injections. Whereas in case of those where cells do not respond to insulin many different drugs are developed taking into consideration possible disturbances in carbohydrate-metabolism.

For example, to manage post-prandial hyper-glycaemia at digestive level, glucosidase inhibitors such as acarbose, miglitol and voglibose are used. These inhibit degradation of carbohydrates thereby reducing the glucose absorption by the cells. To enhance glucose uptake by peripheral cells biguanide such as metphormine is used. Sulphonylureas like glibenclamide is insulinotropic and works as secretagogues for pancreatic cells. Although several therapies

are in use for treatment, there are certain limitations due to high cost and side effects such as development of hypoglycemia, weight gain, gastrointestinal disturbances, liver toxicity etc. Based on recent advances and involvement of oxidative stress in complicating diabetes mellitus, efforts are on to find suitable antidiabetic and antioxidant therapy. These inhibit degradation of carbohydrates thereby reducing the glucose absorption by the cells. To enhance glucose uptake by peripheral cells biguanide such as metphormine is used. Sulphonylureas like glibenclamide is insulinotropic and works as secretagogues for pancreatic cells. Although several therapies are in use for treatment, there are certain limitations due to high cost and side effects such as development of hypoglycemia, weight gain, gastrointestinal disturbances, liver toxicity etc. Based on recent advances and involvement of oxidative stress in complicating diabetes mellitus, efforts are on to find suitable antidiabetic and antioxidant therapy. Medicinal plants are being looked up once again for the treatment of diabetes. Many conventional drugs have been derived from prototypic molecules in medicinal plants. Metformin exemplifies an efficacious oral glucose-lowering agent. Its development was based on the use of *Galega officinalis* to treat diabetes. *Galega officinalis* is rich in guanidine, the hypoglycemic component. Because guanidine is too toxic for clinical use, the alkyl biguanides synthalin A and synthalin B were introduced as oral anti-diabetic agents in Europe in the 1920s but were discontinued after insulin became more widely available. However, experience with guanidine and biguanides prompted the development of metformin. To date, over 400 traditional plant treatments for diabetes have been reported, although only a small number of these have received scientific and medical evaluation to assess their efficacy. The hypoglycemic effect of some herbal extracts has been confirmed in human and animal models of type 2 diabetes. The World Health Organization Expert Committee on diabetes has recommended that traditional medicinal herbs be further investigated.

OBJECTIVES

- TO CREATE OPTIMUM INTEREST AND AWARNESS AMONGST CULTIVARS / FARMERS FOR THE CULTIVATION OF ANTIDIABETIC MEDICINAL PLANTS.
- THIS SHORT REVIEW HELPS TO SUMMARIZE THE AVAILABLE TREATMENTS FOR DIABETES FOCUSSING ESPECIALLY ON HERBAL MEDICINE.
- TO PROMOTE DEVELOPMENT OF CULTIVATION TECHNIQUES (AGRO – TECHNIQUES) FOR OBTAINING GREATER YIEILD OF PLANTS.
- PROMOTION OF CULTIVATION AND CONSERVATION OF ANTIDIABETIC MEDICINAL PLANTS.
- TO DEVELOP EFFECTIVE MICRO PROPAGATION SYSTEM FOR COST EFFECTIVE QUALITY PLANT MATERIALS AMPHASIZING THE PROPER TIE UP WITH GROWERS INDUSTRIES FOR MASS PRODUCTION.
- TO STRENGTHEN THE RESEARCH WORK ON ANTIDIABETIC MEDICINAL PLANTS SO THAT THEY ARE MORE AFFORDABLE AND EFFECTIVE IN TREATMENT OF DIABETES AND HAVE LESS SIDE EFFECTS AS COMPARED TO SYNTHETIC DRUGS.

Indian Medicinal Plants with Antidiabetic and Related Beneficial Effects

There are many herbal remedies suggested for diabetes and diabetic complications. Medicinal plants form the main ingredients of these formulations. A list of medicinal plants with antidiabetic and related beneficial effects is given in Table 1 . A list of such formulations is given in Table 2.

Table 1. Indian medicinal plants with antidiabetic and related beneficial properties

SL. NO.	PLANT NAME	Ayurvedic/common name/herbal formulation	Antidiabetic and other beneficial effects in traditional medicine
1.	*Annona squamosa*	Sugar apple	Hypoglycemic and antihyperglycemic activities of ethanolic leaf-extract, Increased plasma insulin level
2.	*Artemisia pallens*	Davana	Hypoglycemic, increases peripheral glucose utilization or inhibits glucose reabsorption
3.	*Areca catechu*	Supari	Hypoglycemic
4.	*Beta vulgaris*	Chukandar (Beetroot)	Increases glucose tolerance in OGTT
5.	*Boerhaavia diffusa*	Punarava	Increase in hexokinase activity, decrease in glucose-6-phosphatase and fructose bis-phosphatase activity, increase plasma insulin level, antioxidant
6.	*Bombax ceiba*	*Semul*	*Hypoglycemic*
7.	*Butea monosperma*	Palasa	Antihyperglycemic
8.	*Camellia sinensis*	Tea	Anti-hyperglycemic activity, antioxidant
9.	*Capparis decidua*	Karir or Pinju	Hypoglycemic, antioxidant, hypolipidaemic
10	*Caesalpinia bonducella*	Sagarghota, Fevernut	Hypoglycemic, insulin secretagogue, hypolipidemic
11.	*Coccinia indica*	Bimb or Kanturi	Hypoglycemic

12.	*Emblica officinalis*	Amla, Dhatriphala, a constituent of herbal formulation, "Triphala"	Decreases lipid peroxidation, antioxidant, hypoglycemic
13.	*Eugenia uniflora*	Pitanga	Hypoglycemic, inhibits lipase activity
14.	*Enicostema littorale*	Krimihrita	Increase hexokinase activity, Decrease glucose 6-phosphatase and fructose 1,6 bisphosphatase activity. Dose dependent hypoglycemic activity
15.	*Ficus bengalenesis*	Bur	Hypoglycemic, antioxidant
16.	*Gymnema sylvestre*	Gurmar or Merasingi	Anti-hyperglycemic effect, hypolipidemic
17.	*Hemidesmus indicus*	Anantamul	Anti-snake venom activity, anti-inflammatory
18.	*Hibiscus rosa-sinesis*	Gudhal or Jasson	Initiates insulin release from pancreatic beta cells
19.	*Ipomoea batatas*	Sakkargand	Reduces insulin resistance
20.	*Momordica cymbalaria*	Kadavanchi	Hypoglycemic, hypolipidemic
21.	*Murraya koenigii*	Curry patta	Hypoglycemic, increases glycogenesis and decreases gluconeogenesis and glycogenolysis
22.	*Musa sapientum*	Banana	Antihyperglycemic, antioxidant
23.	*Phaseolus vulgaris*	Hulga, white kidney bean	Hypoglycemic, hypolipidemic, inhibit alpha amylase activity, antioxidant. Altered level of insulin receptor and GLUT-4 mRNA in skeletal muscle
24.	*Punica granatum*	Anar	Antioxidant, anti-hyperglycemic effect
25.	*Salacia reticulata*	Vaira	inhibitory activity against sucrase, α-glucosidase inhibitor
26.	*Swertia chirayita*	Chirata	Stimulates insulin release from islets
27.	*Syzygium alternifolium*	Shahajire	Hypoglycemic and antihyperglycemic

28.	*Terminalia belerica*	Behada, a constituent of "Triphala"	Antibacterial, hypoglycemic
29.	*Terminalia chebula*	Hirda	Antibacterial, hypoglycemic
30.	*Tinospora crispa*		Anti-hyperglycemic, stimulates insulin release from islets
31.	*Vinca rosea*	Sadabahar	Anti-hyperglycemic
32.	*Withania somnifera*	Ashvagandha, winter cherry	Hypoglycemic, diuretic and hypocholesterolemic

TABLE 2. LIST OF SOME COMMON ANTIDIABETIC PLANTS WITH THEIR MODE OF ACTION.

COMMON NAME	*PART USED*	*MODE OF ACTION*
BANANA	FLOWER	INCREASE OF BLOOD GLUCOSYLATED HEAMOGLOBIN LEVELS AND INCREASE IN TOTAL HEMOGLOBIN.
TULSI	ENTIRE HERBS	INCREASE INSULIN RELEASED
AMLA	METHANOLIC EXTRACT OF LEAF	REDUCTION OF GLYCEMIA

POMEGRANA	METHANOLIC SEED EXTRACT	DECREASE OF GLYCEMIA
CHIRATA	ENTIRE HERBS	LOWER BLOOD GLUCOSE LEVEL
ARJUNA	DRIED STEM	DECREASE THE BLOOD GLUCOSE LEVEL AND DECREASE THE ACTIVITIES OF G6P
ALMOND	PETROLIUM ETHER FRUIT EXTRACT	
GULVEL	AQUEOUS EXTRATACT OF ROOT	DECREASE OF GLYCEMIA AND BRAIN LIPID
METHI	ETHANOLIC EXTRACT OF LEAVES	STIMULATE THE SECRETION OF INSULIN, REDUCE INSULIN RESISTANCE AND DECREASE BLOOD SUGAR LEVELS
SUNTH	RHIZOME	INCREASE OF INSULIN LEVEL

Table 3. Formulated Herbal Drugs with antidiabetic properties

DRUG	COMPANY	INGREDIENTS
Diabecon	Himalaya	Gymnema sylvestre, Pterocarpus marsupium, Glycyrrhiza glabra, Casearia esculenta, Syzygium cumin, Asparagus racemose, Boerhavia diffusa, Sphaeranthus indicus, Tinospora cordifolia, Swertia chirata, Tribulus terrestris, Phyllanthus amarus, Gmelina

		arborea, Gossypium herbaceum, Berberis aristata, Aloe vera, Triphala, Commiphora wightii, shilajeet, Momordica charantia, Piper nigrum, Ocimum sanctum, Abutilon indicum, Curcuma longa, Rumex maritimus
Diasulin		Cassia auriculata, Coccinia indica, Curcuma longa, Emblica officinalis, Gymnema sylvestre, Momordica charantia, Scoparia dulcis, Syzygium cumini, Tinospora cordifolia, Trigonella foenum graecum
Pancreatic tonic 180 cp	ayurvedic herbal supplement	Pterocarpus marsupium, Gymnema sylvestre, Momordica charantia, Syzygium cumini, Trigonella foenum graceum, Azadirachta indica, Ficus racemosa, Aegle marmelos, Cinnamomum tamala
Ayurveda alternative herbal formula to Diabetes:	Chakrapani Ayurveda	Gurmar (Gymnema sylvestre) Karela (Momordica charantia) Pushkarmool (Inula racemosa) Jamun Gutli (Syzygium cumini) Neem (Azadirachta indica) Methika (Trigonella foenum gracecum) Guduchi (Tinospora cordifolia)
Bitter gourd Powder	Garry and Sun natural Remedies	Bitter gourd (Momordica charantia)
Dia-care	Admark Herbals Limited	Sanjeevan Mool; Himej, Jambu beej, Kadu, Namejav, Neem chal.
Diabetes-Daily Care	Nature’s Health Supply	Alpha Lipoic Acid, Cinnamon 4% Extract, Chromax, Vanadium, Fenugreek 50% extract, Gymnema sylvestre 25% extract Momordica 7% extract, Licorice Root 20% extract

Gurmar powder	Garry and Sun natural Remedies	Gurmar (Gymnema sylvestre)
Epinsulin	Swastik Formulations	vijaysar (Pterocarpus marsupium)
Diabecure	Nature beaute sante	Juglans regia, Berberis vulgaris, Erytherea centaurium, Millefolium, Taraxacum
Diabeta	Ayurvedic cure Ayurvedic Herbal Health Products	Gymnema sylvestre, Vinca rosea (Periwinkle), Curcuma longa (Turmeric), Azadirachta indica (Neem), Pterocarpus marsupium (Kino Tree), Momordica charantia (Bitter Gourd), Syzygium cumini (Black Plum), Acacia arabica (Black Babul), Tinospora cordifolia, Zingiber officinale (Ginger)
Syndrex	Plethico Laboratories	Germinated Fenugreek seed extract

Description of some Indian Medicinal Plants with Antidiabetic Effects

***Acacia arabica*: (Babul)**

It is found all over India mainly in the wild habitat. The plant extract acts as an antidiabetic agent by acting as secretagogue to release insulin. It induces hypoglycemia in control rats but not in alloxanized animals. Powdered seeds of *Acacia arabica* when administered (2,3 and 4 g/kg body weight) to normal rabbits induced hypoglycemic effect by initiating release of insulin from pancreatic beta cells.

***Aegle marmelos*: (Bengal Quince, Bel or Bilva)**

Administration of aqueous extract of leaves improves digestion and reduces blood sugar and urea, serum cholesterol in alloxanized rats as compared to control. Along with exhibiting hypoglycemic activity, this extract also prevented peak rise in blood sugar at 1h in oral glucose tolerance test.

***Allium cepa*: (onion)**

Various ether soluble fractions as well as insoluble fractions of dried onion powder show anti-hyperglycemic activity in diabetic rabbits. *Allium cepa* is also known to have antioxidant and hypolipidaemic activity. Administration of a sulphur containing amino acid from *Allium cepa*, S-methyl cysteine sulphide (SMCS) (200 mg/kg for 45 days) to alloxan induced diabetic rats significantly controlled blood glucose as well as lipids in serum and tissues and normalized the activities of liver hexokinase, glucose 6-phosphatase and HMG Co A reductase. When diabetic patients were given single oral dose of 50 g of onion juice, it significantly controlled post-prandial glucose levels.

***Allium sativum*: (garlic)**

This is a perennial herb cultivated throughout India. Allicin, a sulphur-containing compound is responsible for its pungent odour and it has been shown to have significant hypoglycemic activity. This effect is thought to be due to increased hepatic metabolism, increased insulin release from pancreatic beta cells and/or insulin sparing effect. Aqueous homogenate of garlic (10 ml/kg/day) administered orally to sucrose fed rabbits (10 g/kg/day in water for two months) significantly increased hepatic glycogen and free amino acid content, decreased fasting blood glucose, and triglyceride levels in serum in comparison to sucrose control

S-allyl cystein sulfoxide (SACS), the precursor of allicin and garlic oil, is a sulphur containing amino acid, which controlled lipid peroxidation better than glibenclamide and insulin. It also improved diabetic conditions. SACS also stimulated *in vitro* insulin secretion from beta cells isolated from normal rats. Apart from this, *Allium sativum* exhibits antimicrobial, anticancer and cardioprotective activities.

Aloe vera* and *Aloe barbadensis

Aloe, a popular houseplant, has a long history as a multipurpose folk remedy. The plant can be separated into two basic products: gel and latex. Aloe vera gel is the leaf pulp or mucilage, aloe latex, commonly referred to as "aloe juice," is a bitter yellow exudate from the pericyclic tubules just beneath the outer skin of the leaves. Extracts of aloe gum effectively increases glucose tolerance in both normal and diabetic rats. Treatment of chronic but not single dose of exudates of *Aloe barbadensis* leaves showed hypoglycemic effect in alloxanized diabetic rats. Single as well as chronic doses of bitter principle of the same plant also showed hypoglycemic effect in diabetic rats. This action of *Aloe vera* and its bitter principle is through stimulation of synthesis and/or release of insulin from pancreatic beta cells. This plant also has an anti-inflammatory activity in a dose dependent manner and improves wound healing in diabetic mice.

***Azadirachta indica*: (Neem)**

Hydroalcoholic extracts of this plant showed anti-hyperglycemic activity in streptozotocin treated rats and this effect is because of increase in glucose uptake and glycogen deposition in isolated rat hemidiaphragm. Apart from having anti-diabetic activity, this plant also has anti-bacterial, antimalarial, antifertility, hepatoprotective and antioxidant effects.

Caesalpinia bonducellah

Caesalpinia bonducella is widely distributed throughout the coastal region of India and used ethnically by the tribal people of India for controlling blood sugar. Both the aqueous and ethanolic extracts

showed potent hypoglycemic activity in chronic type II diabetic models. These extracts also increased glycogenesis thereby increasing liver glycogen content. Two fractions BM 169 and BM 170 B could increase secretion of insulin from isolated islets. The aqueous and 50% ethanolic extracts of *Caesalpinia bonducella* seeds showed antihyperglycemic and hypolipidemic activities in streptozotocin (STZ)-diabetic rats. The antihyperglycemic action of the seed extracts may be due to the blocking of glucose absorption. The drug has the potential to act as antidiabetic as well as antihyperlipidemic.

Coccinia indica

Dried extracts of *Coccinia indica* (*C. indica*) (500 mg/kg body weight) were administered to diabetic patients for 6 weeks. These extracts restored the activities of enzyme lipoprotein lipase (LPL) that was reduced and glucose-6-phosphatase and lactate dehydrogenase, which were raised in untreated diabetics. Oral administration of 500 mg/kg of *C. indica* leaves showed significant hypoglycemia in alloxanized diabetic dogs and increased glucose tolerance in normal and diabetic dogs.

***Eugenia jambolana*: (Indian gooseberry, jamun)**

In India decoction of kernels of *Eugenia jambolana* is used as household remedy for diabetes. This also forms a major constituent of many herbal formulations for diabetes. Antihyperglycemic effect of aqueous and alcoholic extract as well as lyophilized powder shows reduction in blood glucose level. This varies with different level of diabetes. In mild diabetes (plasma sugar >180 mg/dl) it shows 73.51% reduction, whereas in moderate (plasma sugar >280 mg/dl) and severe diabetes (plasma sugar >400 mg/dl) it is reduced to 55.62% and 17.72% respectively. The extract of jamun pulp showed the hypoglycemic activity in streptozotocin induced diabetic mice within 30 min of administration while the seed of the same fruit required 24 h. The oral administration of the extract resulted in increase in serum insulin levels in diabetic rats. Insulin secretion was found to be stimulated on incubation of plant extract with isolated islets of Langerhans from normal as well as diabetic animals. These extracts also inhibited insulinase activity from liver and kidney.

Mangifera indica: (Mango)

The leaves of this plant are used as an antidiabetic agent in Nigerian folk medicine, although when aqueous extract given orally did not alter blood glucose level in either normoglycemic or streptozotocin induced diabetic rats. However, antidiabetic activity was seen when the extract and glucose were administered simultaneously and also when the extract was given to the rats 60 min before the glucose. The results indicate that aqueous extract of *Mangifera indica* possess hypoglycemic activity. This may be due to an intestinal reduction of the absorption of glucose.

***Momordica charantia*: (bitter gourd)**

Momordica charantia is commonly used as an antidiabetic and antihyperglycemic agent in India as well as other Asian countries. Extracts of fruit pulp, seed, leaves and whole plant was shown to have hypoglycemic effect in various animal models. Polypeptide p, isolated from fruit, seeds and tissues of *M. charantia* showed significant hypoglycemic effect when administered subcutaneously to langurs and humans. Ethanolic extracts of *M. charantia* (200 mg/kg) showed an antihyperglycemic and also hypoglycemic effect in normal and STZ diabetic rats. This may be because of inhibition of glucose-6-phosphatase besides fructose-1, 6-biphosphatase in the liver and stimulation of hepatic glucose-6-phosphate dehydrogenase activities.

***Ocimum sanctum*: (holy basil)**

It is commonly known as Tulsi. Since ancient times, this plant is known for its medicinal properties. The aqueous extract of leaves of *Osmium sanctum* showed the significant reduction in blood sugar level in both normal and alloxan induced diabetic rats. Significant reduction in fasting blood glucose, uranic acid, total amino acid, total cholesterol, triglyceride and total lipid indicated the hypoglycemic and hypolipidemic effects of tulsi in diabetic rats. Oral administration of plant extract (200 mg/kg) for 30 days led to decrease in the plasma glucose level by approximately 9.06 and 26.4% on 15 and 30 days of the experiment respectively. Renal glycogen content increased 10-fold while skeletal muscle

and hepatic glycogen levels decreased by 68 and 75% respectively in diabetic rats as compared to control. This plant also showed antiasthemitic, antistress, antibacterial, antifungal, antiviral, antitumor, gastric antiulcer activity, antioxidant, antimutagenic and immunostimulant activities

***Phyllanthus amarus*: (bhuiawala)**

It is a herb of height up to 60 cm, from family Euphorbiaceae. It is commonly known as Bhuiamala. It is scattered throughout the hotter parts of India, mainly Deccan, Konkan and south Indian states. Traditionally it is used in diabetes therapeutics. Methanolic extract of *Phyllanthus amarus* was found to have potent antioxidant activity. This extract also reduced the blood sugar in alloxanized diabetic rats. The plant also shows anti-inflammatory, antimutagenic, anticarcinogenic, antidiarrheal activity.

Pterocarpus marsupium:

It is a deciduous moderate to large tree found in India mainly in hilly region. Pterostilbene, a constituent derived from wood of this plant caused hypoglycemia in dogs showed that the hypoglycemic activity of this extract is because of presence of tannates in the extract. Flavonoid fraction from *Pterocarpus marsupium* has been shown to cause pancreatic beta cell regranulation. Marsupin, pterosupin and liquiritigenin obtained from this plant showed antihyperlipidemic activity. (−) Epicatechin, its active principle, has been found to be insulinogenic, enhancing insulin release and conversion of proinsulin to insulin *in vitro*. Like insulin, (−) epicatechin stimulates oxygen uptake in fat cells and tissue slices of various organs, increases glycogen content of rat diaphragm in a dose-dependent manner.

***Trigonella foenum graecum*: (fenugreek)**

It is found all over India and the fenugreek seeds are usually used as one of the major constituents of Indian spices. 4-hydroxyleucine, a novel amino acid from fenugreek seeds increased glucose stimulated insulin release by isolated islet cells in both rats and humans. Oral administration of 2 and 8 g/kg of plant extract produced dose dependent decrease in the blood glucose levels in both normal

as well as diabetic rats. Administration of fenugreek seeds also improved glucose metabolism and normalized creatinine kinase activity in heart, skeletal muscle and liver of diabetic rats. It also reduced hepatic and renal glucose-6-phosphatase and fructose −1,6-biphosphatase activity. This plant also shows antioxidant activity.

Tinospora cordifolia: **(Guduchi)**

It is a large, glabrous, deciduous climbing shrub belonging to the family Menispermaceae. It is widely distributed throughout India and commonly known as Guduchi. Oral administration of the extract of *Tinospora cordifolia* (*T. cordifolia*) roots for 6 weeks resulted in a significant reduction in blood and urine glucose and in lipids in serum and tissues in alloxan diabetic rats. The extract also prevented a decrease in body weight. *T. cordifolia* is widely used in Indian ayurvedic medicine for treating diabetes mellitus. Oral administration of an aqueous *T. cordifolia* root extract to alloxan diabetic rats caused a significant reduction in blood glucose and brain lipids. Though the aqueous extract at a dose of 400 mg/kg could elicit significant anti-hyperglycemic effect in different animal models, its effect was equivalent to only one unit/kg of insulin. It is reported that the daily administration of either alcoholic or aqueous extract of *T. cordifolia* decreases the blood glucose level and increases glucose tolerance in rodents

PHOTOGRAPHS OF FEW ANTIDIABETICS MEDICINAL PLANTS COMMONLY FOUND IN INDIA.

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DISCUSSION

A good number of plants belonging to different families are used by a good number of tribal communities distributed in the different parts of the country starting from the altitude of 700

feet to plain region. Indigenous traditional knowledge as far as health &hygiene is concerned is very productive as well as urge of this millennium in the context of globalization, climate change and sustainable development.

But unfortunately, the precious and perennial non- documented traditional knowledge and its full potentiality have not yet been utilized in the light of modern art and science of medical sciences. Observation states that most of the aforesaid plants do not have any recorded toxic effect upon the users. This review paper accumulates about 35 plant species with their scientific names, and local names. Traditional knowledge of many unexplored medicinal plants used by the tribals as remedies for diabetic disease are discussed here mentioning their medicinally useful parts and their therapeutic uses. It has been mentioned in "Materia medica" that the active principles of the plant drugs are commonly more concerned in the storage organs like roots, seeds, barks, and leaves of plants than in their flowers. The observations here also hold good in this context.

CONCLUSION

Traditional medicines derived from medicinal plants are used by about 60% of the world's population. This review focuses on Indian Herbal drugs and plants used in the treatment of diabetes, especially in India. Diabetes is an important human ailment afflicting many from various walks of life in different countries. In India it is proving to be a major health problem, especially in the urban areas. Though there are various approaches to reduce the ill effects of diabetes and its secondary complications, herbal formulations are preferred due to lesser side effects and low cost. A list of medicinal plants with proven antidiabetic and related beneficial effects and of herbal drugs used in treatment of diabetes is compiled. These include, *Allium sativum*, *Eugenia*

jambolana, *Momordica charantia Ocimum sanctum*, *Phyllanthus amarus*, *Pterocarpus marsupium*, *Tinospora cordifolia*, *Trigonella foenum graecum* and *Withania somnifera*. One of the etiologic factors implicated in the development of diabetes and its complications is the damage induced by free radicals and hence an antidiabetic compound with antioxidant properties would be more beneficial. Therefore, information on antioxidant effects of these medicinal plants is also included.

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. 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. Major hindrance in amalgamation of herbal medicine in modern medical practices is lack of scientific and clinical data proving their efficacy and safety. There is a need for conducting clinical research in herbal drugs, developing simple bioassays for biological standardization, pharmacological and toxicological evaluation, and developing various animal models for toxicity and safety evaluation. It is also important to establish the active compones from these plant extracts.

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