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Review Article

ANTIDIABETIC HERBAL DRUGS A REVIEW

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ABSTRACT

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, C. indica, Helicteres isora, Stevia rebaudiana, Gymnema sylvestre, Enicostemma littorale* Blume.

Keywords: Medicinal plant, Antidiabetic drugs, Herbal drugs, Diabetes.

INTRODUCTION

Herbal medicine, also called botanical medicine or phytomedicine, refers to the use of any plant's seeds, berries, roots, leaves, bark, or flowers for medicinal purposes. Long practiced outside of conventional medicine, herbalism is becoming more mainstream as up-to-date analysis and research show their value in the treatment and prevention of disease.(Ang-Lee,Moss.2000) 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 rasayana are present in herbal preparations of Indian traditional health care systems. In Indian systems of medicine most practitioners formulate and dispense their own recipes. The World Health Organization (WHO) has listed 21,000 plants, which are used for medicinal purposes around the world. 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 huge economic losses (Barret, *et al.* 1999).

How do herbs work?

For most herbs, the specific ingredient that causes a therapeutic effect is not known. Whole

herbs contain many ingredients, and it is likely that they work together to produce the desired medicinal effect. The type of environment (climate, bugs, soil quality) in which a plant grew will affect its components, as will how and when it was harvested and processed.

How are herbs used?

For the reasons described in the previous section, herbalists prefer using whole plants rather than extracting single components from them. Whole plant extracts have many components. These components work together to produce therapeutic effects and also to lessen the chances of side effects from any one component. Several herbs are often used together to enhance effectiveness and synergistic actions and to reduce toxicity (D'Epiro.,1999). Herbalists must take many things into account when prescribing herbs. For example, the species and variety of the plant, the plant's habitat, how it was stored and processed, and whether or not there are contaminants (Fugh-Berman., 2000).

What is herbal medicine good for?

Herbalists treat many conditions such as asthma, eczema, premenstrual syndrome, rheumatoid arthritis, migraine, menopausal symptoms, chronic fatigue, and irritable bowel syndrome, among others. Herbal preparations are best taken under the guidance of a trained professional. Be sure to consult with your doctor or an herbalist before self-treating. Some common herbs and their uses are discussed below. Please see our monographs on individual herbs for detailed descriptions of uses as well as risks, side effects, and potential interactions.

- **Ginkgo (*Ginkgo biloba*)** particularly a standardized extract known as EGb 761, appears to produce improvements in awareness, judgment, and social function in people with Alzheimer's disease and dementia. In a year-long study of 309 people with Alzheimer's disease, those taking EGb 761 consistently improved while those on placebo worsened.
- **Kava kava (*Piper methysticum*)** has become popular as a treatment for anxiety, but recent reports have traced liver damage to enough people who have used kava that the U.S. FDA has issued a warning regarding its use and other countries, such as Germany and Canada, have taken kava off of the market.
- **St. John's wort (*Hypericum perforatum*)** is well known for its antidepressant effects, and an analysis of 27 studies involving more than 2,000 people confirmed that the herb is an effective treatment for mild to moderate depression.
- **Valerian (*Valeriana officinalis*)** has had a long tradition as a sleep-inducing agent, with the added benefit of producing no hangover feeling the next day.
- **Echinacea preparations (From *Echinacea purpurea* and other *Echinacea* species)** may bolster immunity. In a study of 160 volunteers with flu-like symptoms, echinacea extract reduced both the frequency and severity of cold symptoms.

What is the future of herbal medicine?

Although a renaissance is occurring in herbal medicine in the United States, the FDA still classifies herbs as dietary supplements and forbids manufacturers to claim that their products are able to treat or prevent specific diseases. In some countries in Europe, however, herbs are classified as drugs and are regulated. The German Commission E, an expert medical panel, actively researches their safety and effectiveness.(Fugh-Berman. 2000)

Diabetes mellitus

Diabetes mellitus is a syndrome of disordered metabolism, usually due to a combination of hereditary and environmental causes, resulting in abnormally high blood sugar levels (hyperglycemia). Blood glucose levels are controlled by a complex interaction of multiple chemicals and hormones in the body, including the hormone insulin made in the beta cells of the pancreas. Diabetes mellitus refers to the group of diseases that lead to high blood glucose levels

due to defects in either insulin secretion or insulin action (L M Tierney, *et al.* 2002). Diabetes develops due to a diminished production of insulin (in type 1) or resistance to its effects. Both lead to hyperglycaemia, which largely causes the acute signs of diabetes: excessive urine production, resulting compensatory thirst and increased fluid intake, blurred vision, unexplained weight loss, lethargy, and changes in energy metabolism. Monogenic forms, e.g. MODY, constitute 1-5 % of all cases.

The term *diabetes*, without qualification, usually refers to diabetes mellitus, which is associated with excessive sweet urine (known as "glycosuria") but there are several rarer conditions also named diabetes. The most common of these is diabetes insipidus in which the urine is not sweet (insipidus meaning "without taste" in Latin); it can be caused by either kidney (nephrogenic DI) or pituitary gland (central DI) damage. Most cases of diabetes mellitus fall into one of two broad categories. The term "type 1 diabetes" has universally replaced several former terms, including childhood-onset diabetes, juvenile diabetes, and insulin-dependent diabetes (IDDM). Likewise, the term "type 2 diabetes" has replaced several former terms, including adult-onset diabetes, obesity-related diabetes, and non-insulin-dependent diabetes (NIDDM). Beyond these two types, there is no agreed-upon standard nomenclature. Various sources have defined "type 3 diabetes" as, among others, gestational diabetes, insulin-resistant type 1 diabetes (or "double diabetes"), type 2 diabetes which has progressed to require injected insulin, and latent autoimmune diabetes of adults (or LADA or "type 1.5" diabetes.) There is also maturity onset diabetes of the young (MODY) which is a group of several single gene (monogenic) disorders with strong family histories that present as type 2 diabetes before 30 years of age.(Ailloux, 2007)

AYURVEDIC HERBS IN THE TREATMENT OF DIABETES MELLITUS

Diabetes mellitus in Ayurveda is known as Madhu-meha. Several Ayurvedic formulations have been used in the treatment of Diabetes mellitus for centuries. In addition to herbs, minerals find wide application in Ayurvedic prescription for diabetes. Medicinal herbs like Momordica charantia, Gymnema sylvestre, Enicostermma littorale, Pterocarpus marsupium, Salacia reticulate, Coccinia gluaca and Trigonella foneum graceum are prescribed as single powder drugs or in combition (poly-herbal). Scientists have studies the chemical composition of the Antidiabetic medicinal herbs used in Ayurveda. The article deals with work done on Indian medicinal plants with anti diabetic potential.(Sadhu, 2005)

Aegle marmelos Corr. ex Roxb. (Bilava)

Family: Rutaceae.
Common name: Wood apple.
Parts used: Fruit & leaves.
Geographical source: India.
Chemistry: Tannins, active principle (marmelosin), alkaloids (aegelin & aegelinin) and coumarin (marmesin).
Pharmacological study: Das, Padayatil and Paulose (1996) studied the hypoglycemic activity of leaf extract of Aegle marmelos in streptozocin induced diabetes. The extract significantly reversed altered parameters in tissue of the experiment rats. According to authors, the drug seems to repair the injured pancreas (Das, et al. 1996)

Allium Sativum (Lahsun)

Synonyms: Garlic (eng), Lasan (Guj), Lasun (Hindi), Lashuna (Sanskrit).
Family: Liliaceae.
Parts used: Ripe Bulbs.
Geographical source: Central Asia, Southern Europe, USA, India.
Chemistry: It contains a wealth of sulphur compounds; most important for the taste is Allicin , which is produced enzymatically from allin. It also contain 65% water, 28% carbohydrate, 2.3% organosulphur compound, 2% proteins, !.2% free amino acid(mainly

arginine) , 1.5% fiber, 0.15% lipids, 0.08% phytic acid, 0.07% saponins.(Rangari, 2007)

Pharmacogical study: S-allyl cystein sulfoxide (SACS), the precursor of Allicin and garlic oil, is a sulfur 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.

Andrographis paniculata Nees.l (Kalmegh)

Family: Rutaceae

Common name: Kalmegh

Parts used: Whole plant

Geographical source: India

Chemistry: Diterpene lactones (andrographolide, Kalmegh and neoandrographolide).

Pharmacological study: Ahmad and Asmawi (1992) reported hypoglycemic activity of Andrographis paniculata. A significant decrease in blood glucose levels was observed on glucose tolerance test as compared to the untreated group. The authors concluded that the drug inhibits glucose absorption in the intestine.(Ghos, et al. 1990)

Asphaltum punjabianum (Shilajeet)

Common name: Black bitumen or Mineral pitch.

Charaka-samhita has described medicinal uses of Asphaltum punjabianum. Sushrita-samhita indicates the use if purified Asphaltum punjabianum is basically a natural exudates conatains shilajit up to forty percent rest being matter.

Chemistry: Fulvic acid and hippuric acid.

Pharmacological study: Trivedi, Saxena, Mazumdar, Bhatt and Hemavathi (2001) studied the effects of Asphaltum punjabianum on blood glucose, lipid profile and vascular preparation in alloxan induced diabetic rats. Diabetes was induced in albino rats by administration of alloxan 5% (125mg/kg, i.p.). Effect of three different doses of Asphaltum punjabianum (50,100 and 200mg/kg, p.o., daily) were studied on fasting blood glucose and lipid profile at the end of the 4th week. All three doses of Asphaltum punjabianum not only reduced blood glucose level in dose dependent manner, but significant reduction in blood cholesterol and triglycerides was observed. Asphaltum punjabianum also prevented induced vascular dysfunction.(Trivedi, et al. 2001)

Azadirachta Indica

Common Name: Limdo(Guj), Neem(Hindi).

Family: Meliaceae

Parts used: Whole plants.

Chemistry: Nimbidin is major source from seed oil, It is crude bitter principle.

It also contain nimbin, nimbinin, nimbidinin, nimbolide, nimbilic acid.

Gedunin obtained from neem's seed. It also contain mahmoodin, Azadirachtin.

It also contain some tannins like, Gallic acid. There are also present of Margolonon, Polysaccharide.

Pharmacology: Anti diabetic, Anti Inflammatory, Anti pyretic, Anti fungal, Anti bacterial, Anti malarial, Anti arthritis, Spermicidal, Anti tumour, Diuretic, Immunomodulatory.

Pharmacological study:

Researchers at India's University of Madras in the early 1990s found that high doses (40 gm of dried herb daily) of *Azadirachta Indica* extracts may actually help to repair or regenerate the pancreas's beta cells, which play a crucial role in the production and secretion of insulin. Few other substances, synthetic or natural, offer such promise for reversing beta cell damage and at least partially reducing diabetics' need for insulin and other drugs. On the other hand, studies indicate that animals that do not have diabetes do not produce more insulin after consuming *Azadirachta Indica* (Neem).

Caesalpinia bonducella F., (Karanja)

Family: Leguminosae .

Parts used: Seed, leaves & oil expressed from kernel of seeds.

Geographical Source: It is found in tropical parts of Asia & Africa.

Common name: Nicker tree.

Chemistry: Bitter principle (bonducin)

Pharmacological study: Biswas and workers (1997) studied the hypoglycemic activity of aqueous extract of Caesaplinia bonducella. The drug was tested in fasted, fed ,glucose loaded, streptozocin induced diabetes extract administered was 250 mg/kg of rat body weight. The extract was found to be effective in glucose loaded, streptozocin induced diabetes and alloxan induced diabetic rats. According to authors, the drug should be regarded as good oral hypoglycemic agents.(Biswas, 1997)

Coccinia indica

Family: Cucurbitaceae.

Parts used: Leaves.

Pharmacological study: Antia B.S, *et al.*1999 to study 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.(Antia, 1999)

Curcuma Longa

Family: Zingiberaceae (Ginger Family)

Chemistry: Curcumin, Turmeric Extract, Food Color E100 , diferuloylmethane,1,7-Bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione Chemical Formula: C21H20O6

Clinical study:

These statements have not been evaluated by the FDA. These products are not intended to diagnose, treat, cure, or prevent any disease. Pregnant or lactating women, diabetics, hypoglycemics, and people with known medical conditions and/or taking medicines should consult with a licensed physician and/or pharmacist prior to taking dietary supplements. (Subbaraj, 1995)

***Enicostemma littorale Blume* (Majmakbooti)**

Family: Gentiaceae

Parts used: Whole plant.

Geographical source: It is found throughout India up to height of 1500ft.

Chemistry: Bitter principle (swertimarine) two alkaloids (one gentianine and other's name not confirmed), ophelic acid and tannins.

Pharmacological study: In a study, Maroo and workers have shown hypoglycemic and antioxidants activity of methanol extract of Enicostema littorale. Administration of methanol extract (2.5 g/kg body weight/day) to diabetic rats for 20 days reduced blood glucose levels from 466.5+37.07 to 237.20+28.22.The extract not only raised the serum Insulin levels but improved the antioxidants status of the rats also.(Maroo, 2003)

***Gymne sylvestre* R.Br (Gurmar booti)**

Family: Asclepiadaceae

Chemistry:

Dried leaves: Resin, pararabin, triterpene glycoside (gymnemic acid 6%), peptide gurmarin), alkaloids (gymnamine), bitter principle (having sialagouge activity), lupenol, quercitol, coloring matter and anthraquinones.

Bark: Calcium and starch.

Alcoholic extract: Saponin.

Ash: Alkali, phosphoric acid and manganese.

Use as herbal medicine:The active ingredient is thought to be gurmenic acid which has structure similar to sac arose. Extracts of Gymnema is not only claimed to curb sweet tooth but also for treatment of as varied problems as hyperglycemia, obesity, high cholesterol levels, anemia and digestion. According to the Sushruta,the of the Ayurveda it helps to treat Madhumeha i.e.glycosuria.(Hishali, *et al.* 2002)

Pharmacological study: Shanmugassundaram and workers (1991) tested the hypoglycemic activity of water-soluble acidic fraction of the Gymnema sylvestre leaves in rats. The drug was tested in streptozotocine induced diabetic rats. It was concluded that G.sylvetre raises levels of insulin. Mechanism of action however remains unclear & gymnemic acid is a constituent of Gymnema sylvestre (Shanmugasundram,1990).

Helicterus Isora

Family: Sterculiaceae.

Parts used: Roots.

Chemistry: In traditional the root juice is claimed to be useful in diabetes, empyema, and a favorite cure for snakebite1, 3. From the roots betulic acid, daucosterol, sitosterol, isorin4 were isolated. Cucurbitacin B and isocucurbitacin B were isolated and reported to possess cytotoxic activity5. The present study was undertaken to verify the claim and evaluate the anti-diabetic property of the roots H. isora.

Pharmacological study: The different extracts of the roots of Helicteres isora (Family-Sterculiaceae) were tested for anti-diabetic activity, by glucose tolerance test in normal rats and alloxan induced diabetic rats. Aqueous ethanol and butanol extracts had shown significant protection and lowered the blood glucose levels to normal in glucose tolerance test. In alloxan induced diabetic rats the maximum reduction in blood glucose was observed after 3h at a dose level of 250 mg/kg of body weight. The percentage protections by aqueous ethanol and butanol extracts were 30 and 48% respectively. In long term treatment of alloxan induced diabetic rats, the degree of protection was determined by measuring blood glucose, triglycerides, cholesterol and urea levels on 0,3,5,7 and 10th day. Both the extracts showed a significant anti- diabetic activity comparable with that of glibenclamide. The histopathological studies during the long-term treatment have shown to ameliorate the biochemical damages caused by alloxan. These results indicate that the Helicteres isora root possess significant antidiabetic activity.(Ventkatesh, *et al.* 2007)

Jambul *(Syzygium Cumini)*

Family: Myrtaceae.

Pharmacological study: The present study evaluated the hypoglycemic activity of different parts of *Eugenia jambolana* seeds such as whole seed, kernel, and seed coat on streptozotocin-induced diabetic rats. Administration of the ethanolic extract of kernel at a concentration of 100 mg/kg of body weight significantly decreased the levels of blood glucose, blood urea, and cholesterol, increased glucose tolerance and levels of total proteins and liver glycogen, and decreased the activities of glutamate oxaloacetate transaminase and glutamate pyruvate transaminase in experimental diabetic rats. Whole seed showed a moderate hypoglycemic effect, and seed coat did not show any hypoglycemic effect. The hypoglycemic efficacy was compared with that of glibenclamide, a standard hypoglycemic drug.(Ravi, *et al.* 2004)

***Momordica charantia* (Karvellaka)**

Family: Cucurbitaceae.

Pharmacological study: Ahmed, et al.(1999) studied the mechanism of action of juice in rats. Rats were rendered diabetic by single injection (60 mg/kg body weight) of streptozocin. One week after injection, treated animals were fed with juice of M.charantia (10 ml/kg) daily for three in glucose uptake and it attenuated the insulin induced increase in glucose uptake (Ahmed, 1999).

***Musa Paradisiacal* (Banana)**

Common name: Banana, Pisang.

Family: Musaceae.

Parts used: Seed, fruit.

Chemistry: It is the rich source of Carbohydrate, fair source of Vitamins, Minerals. Starch (Amylose-20.5%) present in unripe fruit. It also contain Protein like; Albumin, Globulin, Glutelin, Prolamine. It also contain some freeamino-acids. e.g. Glutamic acid, Gama amino butyric acid. It also contain calcium, Iron, Potassium, Magnesium, Sodium, Phosphorous. Different vitamins present in fruits like; Carotene, Niacin, Ascorbic acid, Riboflavin, Folic acid, Biotin, Pyridoxine, Inositol.

Pharmacological study: Diabetes mellitus is a debilitating hormonal disorder in which strict glycemic control and prevention of associated complications are of crucial importance. This study was designed to evaluate the hypoglycemic effect of methanolic extract of mature, green fruits of Musa paradisiaca (MEMP) in normal (normoglycemic) and streptozotocin (STZ)-treated, diabetic (hyperglycemic) mice, using chlorpropamide as the reference Antidiabetic agent. MEMP (100-800 mg/kg p.o.) induced significant, dose-related

($p < 0.05$-0.001) reductions in the blood glucose concentrations of both normal and diabetic mice. Chlorpropamide (250 mg/kg p.o.) also produced significant ($p < 0.01$-0.001) reductions in the blood glucose concentrations of normal and diabetic mice. The results of this experimental study indicate that, in the mammalian model used, MEMP possesses hypoglycemic activity. Although the precise mechanism of the hypoglycemic action of MEMP is still unclear and will have to await further studies, it could be due, at least in part, to stimulation of insulin production and subsequent glucose utilization. Nevertheless, the findings of this experimental animal study indicate that MEMP possesses hypoglycemic activity, and thus lends credence to the suggested folkloric use of the plant in the management and/or control of adult-onset, type-2 diabetic mellitus among the Yoruba-speaking people of South-Westerns Nigeria (Chhanda, 2006).

Ocimum sanctum Linn. **(Tulsi)**

Family: Labiatae

Chemistry: Volatile oil (containing eugenol and caryophyllene), triterpenoid (rosmarinic acid and ursolic acid) Flavonoids and Saponin.

Clinical study: Agraval, Rai and Singh (1996) in randomized, placebo-controlled, single-bind, crossover trial studied the effects of Ocimum sanctum (dried leaf 2.5g daily)on fasting and postprandial blood glucose and serum cholesterol levels in patients diagnosed with non-insulin dependent diabetes mellitus. 40 patients, 20 of whom were receiving oral hypoglycemic drugs and twenty of whom were newly diagnosed without a history of anti diabetic drug use, took 2.5 g of Ocimum sanctum leaf or placebo in water on an empty stomach upon Rising, Followed by the other treatment for four weeks. Investigators were blinded to the sequence of treatments.The results showed that Ocimum sanctum treatment caused a significant decrease in both fasting and postprandial blood glucose levels compared with placebo. A mild reduction in total cholesterol levels was also observed. The mechanism responsible for the hypoglycemic activity of sacred basil is not known but Gymnema sylvestre raises levels of insulin.(Agraval, et al. 1996)

Phyllanthus niruri

Family: Euphorbiaceae

Chemistry: It is a rich source of plant chemicals, including many which have been found only in the Phyllanthus genus. The main plant chemicals in chanca piedra include alkaloids, astragalin, brevifolin, carboxylic acids, corilagin, cymene, ellagic acid, ellagitannins, gallocatechins, geraniin, hypophyllanthin, lignans, lintetralins, lupeols, methyl salicylate, niranthin, nirtetralin, niruretin, nirurin, nirurine, niruriside, norsecurinines, phyllanthin, phyllanthine, phyllanthenol, phyllochrysine, phyltetralin, repandusinic acids, quercetin, quercetol, quercitrin, rutin, saponins, triacontanal, and tricontanol.

Clinical study: In the above 1995 study, researchers also reported that blood sugar levels were reduced significantly in human subjects studied. Two other studies with rabbits and rats document the hypoglycemic effect of chanca piedra in diabetic animals. Yet another study documented chanca piedra with aldose reductase inhibition (ARI) properties. Aldose reductases are substances that act on nerve endings exposed to high blood sugar concentration and can lead to diabetic neuropathy and macular degeneration. Substances which inhibit these substances can prevent some of the chemical imbalances that occur and thus protect the nerve. This ARI effect of chanca piedra was attributed, in part, to a plant chemical called ellagic acid. This well-studied plant chemical has been documented with many other beneficial effects in numerous clinical studies (Chakrabarti, *et al.* 1995).

Polyalthia Longifolia Var. Angustifolia

Family: Annonaceae.

Parts used: Bark

Chemistry: Preliminary phytochemical screening revealed the presence of alkaloids, glycoside, Saponin, polyphenolic compounds, diterpenoids & tannins.

Pharmacological study: The chloroform extract of stem bark of Polyalthia var. Angustifolia was evaluated for it's Antidiabetic activity in alloxan induced diabetic rats and euglycaemic rats after a single dose of 200 mg/kg p.o and prolonged treatment of 100 mg/kg p.o for 10 days. The results revealed significant antihyperglycemic activity ($P<0.01$). Glibenclamide showed hypoglycemic activity in euglycaemic rats but the said extract did not show hypoglycemic activity.(Andier, 1990)

Pterocarpus Marsupium

Family Name: Fabaceae

Chemistry: Pterostilbene, a constituent derived from wood of this plant Flavonoids fraction from *Pterocarpus marsupium* has been shown to cause pancreatic beta cell regranulation Marsupin, pterosupin and liquiritigenin obtained from this plant. (−) Epicatechin, its active principle, (−) epicatechin.

Pharmacological study: 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. Flavonoids 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 (Chakrabarti, *et al.* 1996).

Pterocarpus Santalinus L.F.

Family: Fabaceae (Papillionaceae).

Chemistry: The red wood yields a natural santalin. It also contain ether, alkalis, Crystalline principle of santal, pterocarpin, Homopterin. Small quantity tannin, Kino tannic acid. It also present in isoflavone, calocedrin, triterpene, lignan, savinin, Calcocedrine, Glucosidessavinin (Sivaranjan, 2004).

Medicinal Importance:Ethanol extract of stem bark at 0.25 g/kg body weight was reported to possess anti-hyperglycaemic activity.

***Salacia reticulate and Salacia oblonga Wall* (Saptachakra)**

Family: Hippocrateaceae.

Chemistry: Flavonoids (Salacinol and kotalanol)

Pharmacological study: Augusti, Joseph and Bapu (1995) studied the Hypoglycemic activity of chloroform eluted fraction of the petroleum ether extract of the root bark of Salacia demonstrated potent hypoglycemic activity in rats when compared to tolbutamide.(Augusti, et al. 1995)

***Saraca Indica* (Ashoka bark)**

Synonym: Ashok Hindi), Asok (Bengali).

Family: Leguminosae.

Chemistry: 6% condensed tannins & anthocyanin derivatives, Catechol,Sterol, Haemotoxyline, Phlobaphenes, Organic calcium compound Ktosterol, Phenolic & Nonphenolic Glycosides. –(-)Epicatechin, ProcyanidinB2, -(-)Epicatechol, antocyanin pigments , Kaempterol.(85)

Use: In Diabetes Mellitus, Uterine stimulant, sedative , oxytocic activity, In menorrhagia Non Phenolic glycoside has Parasympathomimetic activity. In intrinsic hemorrhages Ashoka flower are used. Used in burning sensation . Dried flowers used in Diabetes (Rangari, 2007).

Satureja khuzestanica

Family: Lamiaceae.

Chemistry: 0.5% essential oil, carvacrol, Flavones, triterpenoid, steroids, tannins.

Pharmacological study: Sanaz Vosaugh-Ghanbari, Roja Rahimi, Shima Zeinali, Mohammad abddollahi study the Investigate the effect of S. khuzestanica supplement in metabolic parameter of Hyperlipidimic patients with type2 diabetes mellitus. A significant decrease in blood glucose levels was observed an glucose tolerance test as compared to the untreated group. The authors concluded that the drug inhibits glucose absorption in the intestine. (Sanaz, et al, 2000)

Scoparia dulcis

Family: Scrophulariaceae

Chemistry: Flavone, terpene.Main chemical constituents: scopadulcic acids A & B, scopadiol, scopadulciol, scopadulin, Betulinic acid. It include acacetin, Amyrin, apigenin, benzoxazolin, cirsimarin, cirsitakaoside, coixol, dulcinol, dulcionic acid, friedelin, gentisic acid, glutinol, stigmasterol, taraxerol, vicenine & vitexin.

Pharmacological use: Analgesic, Anti-inflammatory, Antitumorous, Antibacterial, anticancerous, carditonic, diuretic ,Hypoglycemic Hypotensive, sedative.

Pharmacogical study: In 2002, researchers in India verified Vassourinha's Antidiabetic blood sugar-lowering effects in rats.

Stevia Rabudiana

Family: Asteraceae.

Chemistry: Steviol is the basic building block of stevia's Sweet Glucoside: Stevioside and rebaudioside A are constructed by replacing the bottom hydrogen atom with glucose and the top hydrogen atom with two or three linked glucose groups, respectively.

Clinical study: Jeppesen, et al. 2004 Stevioside is present in the plant *Stevia rebaudiana Bertoni* (SrB). Extracts of SrB have been used for the treatment of Diabetes in, for example, Brazil, although a positive effect on glucose metabolism has not been unequivocally demonstrated.

They studied the acute effects of stevioside in type 2 diabetic patients. We hypothesize that supplementation with stevioside To a test meal causes a reduction in postprandial blood glucose. Twelve type 2 diabetic patients were included in an acute, Paired cross-over study. A standard test meal was supplemented with either 1 g of stevioside or 1 g of maize starch (control). Blood samples were drawn at 30 minutes before and for 240 minutes after ingestion of the test meal. Compared to control, stevioside reduced the incremental area under the glucose response curve by 18% (P _ .013). The insulinogenic index (AUCi, insulin/AUCi, glucose) was increased by approximately 40% by stevioside compared to control (P < .001). Stevioside tended To decrease glucagon levels, while it did not significantly alter the area under the insulin, glucagon-like peptide 1, and glucose-dependent insulinotropic polypeptide curves. In conclusion, stevioside reduces postprandial blood glucose levels in Type 2 diabetic patients, indicating beneficial effects on the glucose metabolism. Stevioside may be advantageous in the Treatment of type 2 diabetes (Jeppesen, *et al.* 2004).

***Tinospora Cordifolia* (Gaduchi)**

Family: Menispermaceae.

Chemistry: A variety of constituents have been isolated from *Tinospora cordifolia* plant and their structures were elucidated. They belong to different classes such as Alkaloids, diterpenoid lactones, glycosides, steroids, Sesquiterpenoid, phenolics, aliphatic compounds and Polysaccharides. Leaves of this plant are rich in protein (11.2%) and are fairly rich in calcium and phosphorus**.**

Chemistry and medicinal properties: Weight produces a temporary but marked fall in blood pressure and bradycardia in anaesthetized dogs. *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

Pharmacological study: 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. Aqueous extract also caused a reduction in blood sugar in alloxaninduced hyperglycemia in rats and rabbits in the dose of 400 mg/kg. However, histological examination of pancreas has not revealed any evidence.(Gangan, et al. 1996)

Of regeneration of b-cells of islets of Langerhans and the possible mode of action of the plant is through glucose metabolism. The aqueous

extract has also exhibited some inhibitory effect on adrenaline-induced hyperglycemia. Ethyl acetate extract of its roots has afforded a pyrrolidine derivative with hypoglycemic activity in rabbits. Another study has also revealed significant hypoglycemic effect of extract of leaves in normal and alloxan diabetic rabbits. However, the extract had no significant effect on total lipid levels in normal or treated rabbits.(Ipahimalni, *et al.* 2004)

RASAYANA THERAPY IN DIABETES MELLITUS

Rasayana is an important branch of Ayurveda. The main goal of Rasayana therapy is better quality of life with increased lifespan. Rasayana includes drug formulation, dietary regimen and code of conduct. Many of the drugs used in Rasayana therapy in diabetes mellitus have excellent antioxidant properties, like Phyllanthus emblica, Azadirachta indica, Ocium sanctum and Tinospora cordifolia.(Patel, *et al.* 2006)

The Rasayana approach to treat diabetes consists of Aeara Rasayana (antistress), Ajasrika Rasayana (dietary control), Osad Rasayana (Preventive), Naimittika Rasayana (hypoglycemic)

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