

A Review on Anti Diabetic Plants and their Chemical Constituents

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ABSTRACT

Diabetes is one of the common metabolic disorders due to insulin deficiency. It is estimated that 1 in 5 may be diabetic by the year 2025. The most active plants are *Allium sativum*, *Azadirachtha indica*, *Momordica charantia* and *Ficus bengalensis*. The antidiabetic plants contains the compounds showing antidiabetic activity. The compounds are inorganic ions, coumarins, lipids, flavonoids, steroids, peptides, amines, terpenoids, glycopeptides, alkaloids, complex carbohydrates and others which decreases glucose level in blood. This review paper also discusses the chemical constituents of few antidiabetic plants.

1. Introduction

Human being has been interested to control diseases. As the world's population is nearing 5 billion, with this rate of growth, 75% of the world's population cannot afford the products of Western pharmaceutical industries. Plants are an important source of herbal medicines which find applications in pharmaceutical industry (Seetharami Reddi *et.al.*, 2005). In *Materia medica*, 42 medicinal plants have been recorded in the treatment of diabetes in India (Nadkarni, 1954). It is evident that herbal cure is gaining world wide acceptance and has emphasised on modern scientific exploration, extraction and evaluation of folk medicines from plants (Seetharami Reddi *et.al.*, 2005).

As per WHO, plant derived medicines constitute the mainstay of nearly 80% of the population for their primary

health care. Plant based medicines are either used directly extracted from plants or modified through further synthesis (Cox & Ballick, 1994). Human habits, adulteration, climatic factors either man made or natural have certainly led to decrease in the resistance capacity of mankind against chronic diseases like diabetes.

Diabetes was known to Indian Ayurveda since about 3000 years as a disease with some persons whose urine was sweet enough to attract insects and flies. It was "sushruta" the great Indian physician, who diagnosed diabetes during 1000 BC. Diabetes is a chronic disease and it is estimated that by 2025, there will be nearly 80 million diabetics in South East Asian region, the highest among all the WHO regions.

Table 1: Characteristics of Insulin dependent and Non-insulin dependent diabetes (Source: Rizwana Mubeen *et.al.*, 1995)

	Insulin dependant	Non-insulin dependent
Age of onset	Usually during youth, but can occur at any age	Usually during adulthood, more common in older people
How noticed	Usually appears abruptly and progress rapidly	Gradual in onset, the disease may go unnoticed for years
Family background	Diabetes not always present in other family members	Diabetes present in other members of the family
Treatment	Insulin injection, diet, exercise and emotional control are necessary	Insulin injections are not always necessary, oral medications recommended, diet, exercise are necessary
Complications	Affecting blood vessels, eyes, kidneys and nerves at any age	Problems affecting blood vessels, eyes, kidneys and nerves at any age
Linked to obesity	Not necessarily	80% of all patients are overweight at time of diagnosis

Symptoms of Diabetes

- Frequent urination
- Increased thirst and hunger
- Very tired without any particular reason
- Blurred vision
- No healing of wounds, cuts, boils and sores
- Continuous ache, pain in legs and feet
- Skin infections, Weight loss

Table 2: Symptoms of Insulin dependent and non-insulin dependent diabetes as per American Diabetic Association

Insulin dependent Type -I	Non-insulin dependent Type -II
Nausea and vomiting	Itching
Frequent urination	Excess weight

Increased thirst	Drowsiness
Weight loss	Tingling and numbness in hands and feet
Irritability	Skin infections
Unusual hunger	Blurred vision
Weakness and fatigue	Slow healing of cuts

(Source: Rizwana Mubeen *et.al.*, 2005; Irfan Ali Khan and Atiya Khanum, 2005)

Types of Diabetes mellitus

- 1) **Type I Diabetes**
 - a) Immune mediated
 - b) Idiopathic
- 2) **Type II Diabetes**
- 3) **Other specific type of diabetes**
 - a) Maturity onset diabetes of the young (MODY) due to genetic defects in the cell function, due to mutations.
 - b) Genetic defects in insulin action
 - c) Disease of exocrine pancreas
 - d) Endocrinopathies
 - e) Drug induced
 - f) Infections
 - g) Uncommon forms of immune mediated diabetes
- 4) **Gestational diabetes mellitus**

Types of Diabetes

According to WHO (1985) diabetes can be categorised into 2 types. *Diabetes insipidus* and *Diabetes mellitus*.

Diabetes insipidus

Urine is normal of low specific gravity and excessive by the deficiency of ADH. It is caused due to trauma or tumor involving posterior pituitary but may be idiopathic. Nephrogenic diabetes insipidus polyuria, results from abnormality or disease rendering renal tubules insensitive to ADH.

Diabetes mellitus

It is known to mankind from time immemorial. *Diabetes mellitus* is essentially a metabolic disorder, characterised by high concentration of glucose in the blood. It is arising from insufficient insulin or lack of insulin in the blood and or impairment in the action of insulin.

It is estimated that 1 in 5 may be diabetic by the year 2025. *Diabetes mellitus* is classified into 2 main types: namely insulin dependent diabetes mellitus and non-insulin dependent diabetes mellitus.

In *Diabetes mellitus*, hyperglycaemia results from impaired glucose uptake, utilisation and storage in concerned cells and tissues. Hyperglycaemia leads to increased aldolase reductase activity and accumulation of sorbitol, accelerated non-enzymatic glycosylation of proteins. The toxic effects of glucose, cause complications such as retinopathy, kidney and renal dysfunction, ulcers, autonomic neuropathy, hypertension and impotence (Irfan Ali Khan and Atiya Khanum, 2005).

2. Chemistry of Insulin

Insulin is a small peptide (protein) consisting of 51 amino acids synthesized and stored within the pancreas, an organ situated behind the stomach. The protein itself consists of 2 chains, denoted A and B, linked by disulfide (sulfur-sulfur) bridges between cysteine residues (Figure 1). Insulin is a hormone, a chemical transported in the blood that controls and regulates the activity of certain cells or organs in the body. When blood sugar levels rise following a meal, the pancreas is stimulated to release insulin into the bloodstream. In order for tissues to absorb glucose from the blood, they must first bind insulin.

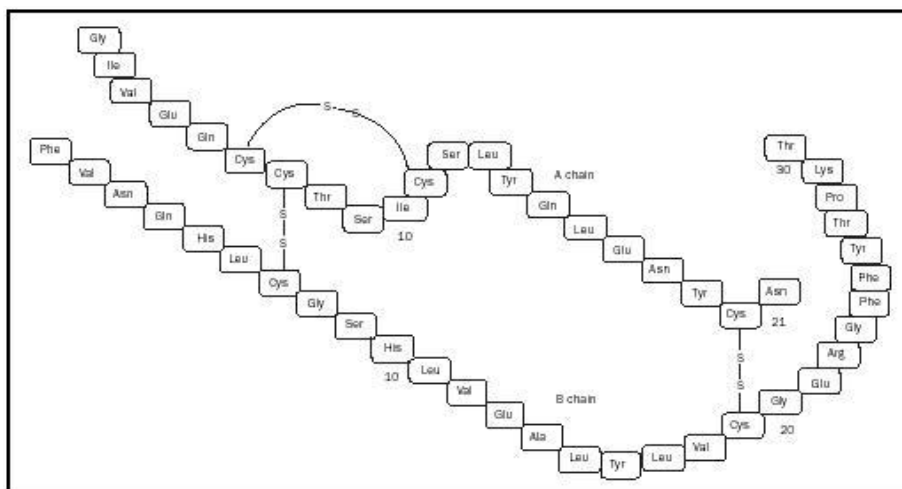


Figure 1. Structure of human insulin (<http://www.chemistryexplained.com/Hy-Kr/Insulin.html>).

Glucose metabolism is necessary for cell growth. When insulin binds to receptors on cell membranes, glucose transporter proteins are released from within the cell to the surface of the cell membrane. Once on the exterior surface of cells, glucose transporters can carry sugar from the blood into the tissue where it is metabolized. Without insulin, cells cannot absorb glucose and effectively starve. Large quantities of insulin were initially acquired from the pancreatic tissues of

slaughtered animals, typically cows and pigs. Since the 1980s, recombinant DNA techniques have made human insulin available for clinical use. Genetically modified strains of *Escherichia coli* bacteria or *Saccharomyces cerevisiae* (baker's yeast) containing human genes coding for insulin have been developed for the mass production of human insulin (<http://www.chemistryexplained.com/Hy-Kr/Insulin.html>).

3. List of Antidiabetic Plants & their Chemical Constituents:

- Acacia arabica willd.** : **Mimosaceae**
Parts used : Gum, bark
Chemical aspects : Polyphenolic compounds, catechin, quercetin, gallic acid, leucocyanidin gallate, sucrose, Tannin, Chlorogenic acid, Gum contains galactose L-rhamnose and its derivatives along with 4 aldobiouronic acids.
- Achyranthes aspera L.** : **Amaranthaceae**
Chemical aspects : The roots contain triterpenoids saponins, betaine, achyranthine, Lentriacotane, Ecdysterone and 2 glycosides of oleanolic acid have been reported. Dehusked seeds contain amino acids.
- Aegle marmelos Linn.** : **Rutaceae**
Chemical aspects : Fruit contains marmalosin, young bark contains coumarin, umbelliferone, old bark has coumarin, umbelliferone. Essential oil, β - phellandrene matured bark contains fragrine, umbelliferone marmesin, sterols & triterpenoids. The leaves contain 0.6% essential oil mostly compound of d-limonene.
- Allium cepa L.** : **Liliaceae**
Chemical aspects : The bulbs contain phenolic acids like protocatechuic acid, P-hydroxybenzoic acid, vanillic acid, caffeic acid, citric acid, oxalic acids, oligosaccharides. Amino acids like arginine, histidine, lysine, leucine, isoleucine etc. The bulbs on steam distillation yield onion oil.
- Allium sativum L.** : **Liliaceae**
Chemical aspects : Oil extracted from the bulbs contain sulfur compounds like Allicin, diallyl, disulfide, allyl propyl disulfide.
- Aloe vera L.** : **Liliaceae**
Chemical aspects : The plants contains aloesone and aloesin. Leaves contain glycoside and aglycone, barbaloin, glycoside galactose, protein with 18 amino acids.
- Anacardium occidentale L.** : **Zingiberaceae**
Parts used : Leaves
Chemical aspects : Amino acid, Arginine, histidine, phenyl alanine, lysine, valine, alanine, Aspartic acid, cystine, glutamic acid, tyrosine, glycine, serine. Polyphenols are present in testa. They are catechin, epicatechin, and leucocyanidin.
- Artocarpus heterophyllus Lam.** : **Moraceae**
Chemical aspects : Leaves consists of cycloartenone, cycloartenol, beta-sitosterol and tannins. Fruit consist of carbohydrates, amino acids. Beta carotene, latex from fruits contains cycloartenone, beta sitosterol, leucine, isoleucine valine, tyrosine.
- Asparagus racemosus Willd** : **Liliaceae**
Parts used : Root
Chemical aspects : Plant has 4 saponins, viz shatavarin I to IV. Shatavarin IV is a glycoside of sarsasapogenin having 2 molecules of rhamnose and 1 molecule of glucose. Mucilage and starch also present.
- Azadirachta indica Juss** : **Meliaceae**
Chemical aspects : Stem bark have tannin, non tannin and red dye. The bark exudes a clear, bright, amber-coloured gum. Leaves contain nimbin, 6-desacetylnimbinene, nimbandiol, nimbolide, quercetin. Mature leaves gave moisture, protein fat, fibre, carbohydrates and

minerals, calcium, phosphorus, iron, thiamine, niacin, carotene. The amino acids present are glutamic acid, tyrosine, aspartic acid, alanine, proline and glutamine. The fruits contain gedunin, &-de acetoxy- 7 alpha hydroxy gedunin, Azadiradione, 17 beta-hydroxy azadiradione 17- epiazadiradione and nimbiol.

- Abutilon indicum L.Sweet** : **Malvaceae**
Chemical aspects : Leaves contain Glycosides, Amino acids, fatty acids, flavonoids, Alkaloids, Steroids, Mucilage, traces of ash, chlorides, calcium carbonate, magnesium phosphate etc.
- Aegle marmelos Correa.** : **Rutaceae**
Parts used : Leaf extract
Chemical aspects : Tannins, Anthocyanins, glycosides, b-sitosterol, rutin, marmecinin fruit contains marmalosin, flavan-3-ols, essential oil aegelenine and aegeline, umbelliferone present in bark roots and fruits with sitosterol and lupicol.
- Areca catechu L.** : **Arecaceae**
Parts used : Nuts
Chemical aspects : Alkaloids arecaine, arecaidine, arecoline, guvacine, flavonoids, polyphenols, tannins, alkaloids, oil.
- Bauhinia variegata L.** :
Caesalpineaceae
Parts used : Roots, Bark
Chemical aspects : Beta-sitosterol, lupeol, kaempferol-3-glucoside & 5.7 -dehydroxy, .and 5.7 dimethoxyflavanone -4-0-al-rhamnopy-ranosyl - beta - D-glucopyranosides.
- Butea monosperma (Lam.) Taub** :
Fabaceae
Parts used : Bark, Seeds, Gum
Chemical aspects : The composition of leaves varies with the place of origin leaves from jammu show crude protein fibre, ether extract, N-free extract, minerals, Calcium and phosphorus.
- Bacopa monnieri Penn.** :
Scrophularaceae
Parts used : Leaves
Chemical aspects : Alkaloid herpestine, Boxalate bases, chloroplatinate, sterol, nicotine, lutealin, betulinic acid, stigmasterol, b- sitosterol, Bacosaponins A,B,C. Alkaloid Brahmine in leaves.
- Bougainvillea spectabilis Wild** : **Nyctaginaceae**
Chemical aspects : Leaf contains Pinitol
- Bombax ceiba L.** :
Bombacaceae
Chemical aspects : Roots contains Lactones, b-sitosterol, lupeol, biosides, Napthaquinone.
- Cassia fistula L.** :
Caesalpineaceae
Chemical aspects : The plant contains sennosides A and B, rhein and its glucoside, barbaloin, aloin, formic acid, butyric acid their ethyl esters and oxalic acid. Sap, acetyl acidiod thiocyanogen and unsapon matter, tannins, phlobaphenes, reducing sugars and oxanthraquinones.
- Cassia occidentalis** :
Caesalpineaceae

Parts used : Roots
Chemical aspects : Chrysophanol, emodin, glycosides, physcion, metteucinol-7-rhamnoside, jaceidin-7-rhamnoside and 4.4.5.5- tetrahydroxy-2. 2-dimethyl-1, 1 bianthra-quinone, crude protein. Ether extract, crude fibre, ash, calcium, phosphorus, iron, niacin, ascorbic acid, beta-sitosterol.

Catharanthus roseus (L) G.Don.: **Apocynaceae**
Chemical aspects : The leaves contain alkaloids, serpentine, ajmaline, catharanthine, catharanthinole, vindoline, vindolinine, vincalucoblastine, leurosidine, vincristine.

Citrus Limon Burm.f. : **Rutaceae**
Chemical aspects : Lemon oil, pectin, Carotene, Citric acid

Cocos nucifera L. : **Palmae**
Parts used : Flower, Fruits
Chemical aspects : Sorbitol, diphenylurea, ketones, aliphatic alcohols, leucoanthocyanins, saccharose, myoinositol, glycerol, sucrose, stachyose, glucosan, polyphenols, sesquiterpenes, Campesterol, Beta- Sitasterol, Stigmasterol, Alpha tocopherol, Ligustrazine, Alkaloids.

Cynodon dactylon Pers. : **Poaceae**
Parts used : Whole plant
Chemical aspects : 4 hydroxybenzoic, 2 propionic phytol, beta sitosterol -D- glucoside, stigma sterol acetate, phytone, glycosides, beta-ionone, saponins, tannins, carbohydrates, flavonoids.

Cyperus rotundus L. : **Cyperaceae**
Parts used : **Rhizomes**
Chemical aspects : An essential oil is extracted from rhizomes. Oil has cyperene, cyperol, a-cyperone, cineol and starch, L- apinene.

Curcuma longa Linn. : **Zingiberaceae**
Parts used : **Rhizomes**
Chemical aspects : The Rhizomes contain pigment curcumin, essential oil having sesquiterpenes, zingiberene, D-a-phellandrene, turmerone, dehydro turmerone and a- alanto lactone, curcurosmene, cineol.

Catharanthus roseus G.Don. : **Apocynaceae**
Chemical aspects : The leaves- alkaloids ,serpentine,ajmaline, catharanthine, catharanthinole, vindoline, Vindolinine, vincalucoblastine, leurosidine, vincristine.

Carica papaya L. : **Caricaceae**
Parts used : Fruits
Chemical aspects : Carpaine, carposide, papain, sucrose, malic acid, citric and tartaric acid salts. Pectins carotenoid pigments, vitamin C, nicotinic acid.

Calotropis procera R.Br. : **Asclepiadaceae**
Parts used : Roots
Chemical aspects : Hexose, syriogenin, benzylinedone, calactin, voruscharin, proceroside.

Calotropis gigantea R.Br. : **Asclepiadaceae**
Parts used : Flowers
Chemical aspects : Saponins, alkaloids, glycosides, steroids, terpenes alcohol, calotropin, giganteol, enzymes, esters of α and β calotropols.

Cassia tora L. : **Caesalpiaceae**
Parts used : Seeds
Chemical aspects : Emodine, glucoside, oil, quinones, fatty acids, glycosides, amino acids, steroids.

Euphorbia hirta Linn. : **Euphorbiaceae**
Chemical aspects : Plant contains flavonoids terpenoids, phenolicacid, choline, Alkane shikimic acid (Alkanes and shikimic acid for antispas-modic action.)

Ficus bengalensis L. : **Moraceae**
Parts used : Bark
Chemical aspects : Bengalenoside and the flavonoid-glycosides, leucocyanidin 3-0- β -D-galactosyl cellobioside, 5.3-dimethyl ether an leucopelar-gonidin-3-0- α -L-rhamnoside 5.7 dimethyl ether, leucopelargonidin glycoside, leucocyanidin glycoside.

Ficus religiosa L. : **Moraceae**
Parts used : Fruits, Bark
Chemical aspects : Glucose, mannose, arabinose, flacourtin, phenolic glucoside ester beta-sitosterol, steroids, beta- D glucopyronoside ramontoside.

Holarrhena antidysenterica : **Apocynaceae**
Parts used : Seeds, Bark.
Chemical aspects : Alkaloids- conessine, conessimine, curchine, conimine, conamine, holarrhine, holarrhimine, resins, tannins gums, triterpene alcohol, b-sitosterol lupeol.

Hibiscus rosa sinensis L. : **Malvaceae**
Parts used : Flowers
Chemical aspects : Taraxeryl acetate, stigmasterol, lipids, flavonoid, flavoniod glycosides, cyanin glucosides, steroids, organic acids, vitamins, hibiscetin, fructose, glucose, sucrose cyanidin diglucoside.

Lawsonia inermis L. : **Lythraceae**
Parts used : Leaves
Chemical aspects : Henna contains 25-33% water soluble compounds. Aqueous solution shows green fluorescence. Law sone is the colouring matter, 4-naphthaquinone, 2-hydroxy-1 in dry Leaves. Behenic, Arachidic, stearic, Oleic, palmitic acid.

Mangifera indica L. : **Anacardiaceae**
Parts used : **Young leaves**
Chemical aspects : β -Carotene, Xanthophylls, in ripe mango, neo- β -carotene Uand neo- β -carotene Bare present only in few varieties. 42.1 xanthophylls β carotene, 96.3; neo- β -carotene U, 7.3. and neo-Carotene, 19.2. It has 2-octene, α and β -pinene α -phellandrene, limonene, dipentene, nerol, geraniol, nerylacetate, citronellal, mangiferol (sequiterpene alcohol).

Momordica charantia L.: **Cucurbitaceae**
Parts used : Fruits
Chemical aspects : Vicine, mycose, steroidal glucosides, momorcharaside A,B,Cucurbitane triterpenoids, momordicines I and II, cyc-loeucalenol, spinasterol, stigmasterol, taraxeral, lophenol, momordicosides, dios-genin, thiocyanogen, 24-methylencycloartenol, phenyl propanoids, carotenoids, squalene (oil) stigmastadien-3-beta-ol and glucoside.

Musa paradisiaca L. : **Musaceae**
Parts used : Flowers, Fruits
Chemical aspects : The principle proteins of the banana are albumin, and a globulin, glutelin,

prolamines and proteases. Cystine arginine, glycine, Alanine, Methionone and valine, phenyl alanine, leucine, isoleucine.

Michelia champaca L. : **Magnoliaceae**
Chemical aspects : Oleic acid,
 Palmiticacid, ester, Carbonyl.

Murraya koenigii Spreng : **Rutaceae**
Parts used : Leaves
Chemical aspects : The
 constituents in oil are b-Caryophyllene, b-elemene, b-phellandrene, b-gurjunene, murrayanine, koenigicine from leaves.

Moringa oleifera Lam. : **Moringaceae**
Parts used : Fruits, seeds, leaves
Chemical aspects : Carotene, nicotinic acid, ascorbic acid, arginine, histidine, lysine (essential amino acids) aspartic acid, glycine, glutamic acid, threonine, alanine, valine are present in leaves. Seeds contain glycoside Moringyne, pods have globulin.

Mimosa pudica L. : **Mimosaceae**
Parts used : Whole plant, leaf
Chemical aspects : Steroids, alkaloids, tannins, mimosine (amino acid), gentisic acid, D- panitol.

Nelumbo nucifera Gaertn. : **Nymphaeaceae**
Chemical aspects : Alkaloids in leaves are nuciferine, quercetin, proteins sugars, vitamins, neferine, arnepavine, 4 methyl- N-methyl coclaurine.

Oryza sativa Linn. : **Poaceae**
Parts used : Roots
Chemical aspects : Protein Fat, Carbohydrates, Fibre, Ash, Thiamine, Riboflavin, Nicotinicacid pantothenic acid, pyridoxine, chloride, choline chlorolide.

Ocimum sanctum L. : **Lamiaceae**
Parts used : Leaves
Chemical aspects : Eugenol, eugenol metholether and methyl chavicol, carvacrol, cineole, linalool.

Oxalis corniculata L. : **Oxalidaceae**
Chemical aspects : Oxalic acid, vitexin, glycolipids, vitamin C, phospho lipids, fatty acids, beta And alpha tocopherols, flavonoids, vitexin and isovitexin.

Phyllanthus emblica L. : **Euphorbiaceae**
Parts used : Fruits
Chemical aspects : Alamine, Aspartic acid, glutamic acid, lysine and proline, analysis of fresh fruit pulp gave moisture, protein fat, carbohydrate, niacin, fibres, minerals, chromium and copper are present in fruit ash.

Pongamia pinnata (L.) Pierre : **Fabaceae**
Parts used : Flower
Chemical aspects : Pongaglabrone, diketone pongamol, glabrin, karanjin, pongapin, kanjone, waxes, fatty acid etc.

Phaseolus vulgaris L. : **Fabaceae**
Parts used : Seeds, pods
Chemical aspects : Pods contain sugars, Leucine, Allantoin, arginine, inositol, tyrosine.

Phyllanthus niruri L. : **Eupharbiaceae**
Parts used : Whole plant

Chemical aspects : Lignana like phyllanthine and hypoph-yllanthine have been found. Flavonoids like quercitrin, isoquercitrin and rutin. Four leucodelphinidine alkaloids, Astralgin.

Psidium guajava L. : **Myrtaceae**
Parts used : Fruits
Chemical aspects : Lipids (seed), gallic acid, quercetin, Eugenol, Tannins, vitamin B and C, sequenterpenes, Brahmic acid, lupeol, oleanolic acid, Allagic acid, Catechin, Amyrins, Trans-Cinnamic acid, Arjunolic acid, Benzaldehyde, Acetyl Furan, leucocyamidin, procyadins, ursolic acid, zeatin, nucleatide.

Punica granatum L. : **Punicaceae**
Parts used : Flower rind, seeds, fruit Rind
Chemical aspects : Betulinic acid, Tannins, Callistephin, Apigenin glucoside, Chrysanthemin, conine, coumestrol, cyanin, liadzin delphin, m.delphinidin, ellagic acid, estrone, fallic acid, freidelin, genistein, lipids, hygrine, luteolin glycosides, pelargonin, mannitol, poly phenols, piperidine derivatives estradiol, xanthoxylin, sedndine.

Phoenix sylvestris (L) Roxb.: **Areaceae**
Parts used : Stem Extract
Chemical aspects : Sugars, Vitamins, Aminoacids.

Piper nigrum L. : **Piperaceae**
Parts used : Fruits
Chemical aspects : Alkaloid-piperine, volatile oil, terpenes, caryophyllene, oil consists of myrcene, limonene, α and β - pinenes, oleoresin, amide- pipericide.

Ricinus communis L. : **Euphorbiaceae**
Parts used : Seeds, Leaves
Chemical aspects : Betacarotene, Tannins, betasisterol, Stigmasterol, lupeol, chlorogenic acid, coumarin, ellagic acid, quinic acid, indole acetic acid, N-dimethyl ricinine, Oricinus agglutinins, glycoproteins, vitamins, B1 and B6. Seeds saponins, kaempferol, flycoside, Epicatechin hyperuside. Hemagglutinin. Beta-amyrin, Ricins, 5-dehydro-avenasterol.

Rauvolfia serpentina Benthex Kurtz. : **Apocynaceae**
Parts used : Roots
Chemical aspects : Canembine, seredine, raunescine, reserpine, ajmalicine, rauniticine, reserpinine, serpentine, sarpagine, ajmaline, rauwolfinine, obscurine, samatine, steroids, amino acids, fatty acids, alkaloids, semperflorine.

Saraca asoca (Roxb). de Wilde : **Caesalpinaceae**
Parts used : Dried Flowers
Chemical aspects : The bark contians Tannin, catechol, sterol and organic calcium compounds. Its methanol fraction contain haematoxylene, tannin and water soluble glycoside. The latter has glucose, galactose and mannose as sugars.

Syzygium cumini (L) Skeels : **Myrtaceae**
Parts used : Fruits and Seeds
Chemical aspects : Seeds contain glycoside jambolin, Ellagicacid, Tannin, gallic acid, chlorophyll, Fatty oil, starch, resin, sugar and traces of oil. Flowers give acetyl oleanolic acid two other triterpenoids, ellagic acid, isoquercitrin, quercetin, kaempferol and myricetin. Oils have α -pinene, α -pinene.

Santalum album L. : **Santalaceae**
Parts used : Heart wood
Chemical aspects : Santalbic acid, palmitic oleic, linoleic acid, sugar. Fatty oils, betulinic acid, β -sitosterol, glucose, fructose, sucrose in leaves. Heartwood yeilds oil having santalenes, santenol, teresantanol.

Tamarindus indica L. : **Casealpiniaceae**
Parts used : Seeds
Chemical aspects : Fruit contains tartaric acid, citric acid, maleic acid and Pot.Bitartarate, traces of oxalic acid. Kernel, Polysaccharide, leaves contain flavonoid glycosides, saponaretin, vitexin, orientin and homoorientin. 1-lordenine isolated from leaves, Bark, flowers.

Tectona grandis L.f. : **Verbenaceae**
Parts used : Bark, Flowers
Chemical aspects : Wood contains in its cavities white crystalline deposits of calcium phosphate, silica and ammonium and magnesium phosphate, also a resin.

Terminalla arjuna : **Combretaceae**
Parts used : Bark
Chemical aspects : Arjunolic acid, tomentosic acid, β -sitosterol, ellagic acid, saponin and leucodelphinidin, Bark contains a crystalline compound arjunine, lactone, arjunetin, essential oil, tannin pyrocatachol, large quantities of calcium salts and traces of aluminium and magnesium salts, reducing sugars.

Tinospora Cordifolia Hook f. & Thorns: **Menispermaceae**
Parts used : Stem
Chemical aspects : Tinosponin, Columbin, chasmanthin, palmarin, berberine, tinoporin acid, tinosporon, tinosporol, giloin, giloinisin, diterpenoid, furanolactone, octacosanol, sitosterol, aryl tetrahydro furano lignan.

Trigonella foenum-gracum L. - F. : **Fabaceae**
Chemical aspects : Young seeds contain sugar and carbohydrates, mature seeds contain fatty acids, Aminoacids, vitamins, saponins, Diosgenin, gitogenin, neogitogenin, saponaretin, tigogenin. Endosperm of seed consists of galactomannan. Bignoniaceae Pachagotla Leaf decoction Tecostanine, Tecomine, Alkaloids.

Trapa natans L. : **Trapaceae**

Chemical aspects : Fruits pulp has Gallic acid

Zingiber officinale Rosc. : **Zingiberaceae**
Parts used : Rhizome powder
Chemical aspects : Essential oil with camphene, β -phellandrene and zingiberene, volatile oil has camphene, phellandrene, ginger diol, sesquithujene, monoterpene-hydrocarbon in oils, 7 β -pinene, cumene, myrcene, limonene, oleoresin, gingerin, contains gingerol, paradol, zingerone, cineol, citral, borneol, gingerol and shogaol are the pungent constituents.

4. Conclusion

To contest the complications of diabetes a number of plant products not only in the form of drugs but as food can be included in diet. Higher fiber foods like fruits, vegetables, whole grains and whole pulses regular usage prevents unnecessary fluctuations in blood sugar level, as it has a low glycemic index. Pulses like soybeans are highly useful to diabetes, as they help the cell to accept insulin more easily. This leads to quicker blood sugar control. A number of commonly available plants can also be taken in the form of medicines to normalise the blood sugar content (Rizwana Mubeen et al.,2005).

Many traditional plant treatments for diabetes are used throughout the world. Plant drugs and herbal formulations are frequently considered to be less toxic and free from side effects than synthetic ones. Based on the WHO recommendations, hypoglycemic agents of plant origin used in traditional medicine are important. The recognized antihyperglycemic effects of these plants are due to their ability to restore the function of pancreatic tissues by causing an increase in insulin output or a decrease in the intestinal absorption of glucose. Hence, treatment with herbal drugs has an effect on protecting β -cells and smoothing out fluctuation in glucose levels. In general, there is very little biological knowledge on the specific modes of action in the treatment of diabetes, but most of the plants have been found to contain substances like glycosides, alkaloids, flavonoids etc. that are frequently implicated as having antidiabetic effects (Neelesh Malviya et al.,2010). Hence, this review article deals with a few number of antidiabetic plants with their chemical constituents, which further help the researcher to carry out innovative research in the development of anti diabetic drugs

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