Herbal Drugs Used in Diabetes Mellitus

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Abstract

Diabetes mellitus (DM) is the most common of the endocrine disorders. It is an important human ailment, afflicting many, from various walks of life in different countries. The prevalence of diabetes mellitus is expected to reach up to 4.4% in the world by 2030. Among all type of diabetes, type 2 diabetes is main complication. Currently available treatment option in modern medicine have several adverse effects. Therefore, there is a need to develop safe and effective treatment modalities for diabetes. Medicinal plants play an important role in the management of diabetes mellitus especially in developing countries where resources are meager. This article presents a review on some reported anti-diabetic medicinal plants

Keywords: Diabetes, plants, endocrine, review.

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Introduction

Diabetes mellitus is a most common disease affecting the citizens of developed as well developing countries. Diabetes mellitus is mainly caused by abnormality of carbohydrate metabolism which linked with low insulin [1]. The imbalance between insulin and glucagon is one of the great reason which cause diabetes. Diabetes mellitus may also defined as a metabolic disorder characterized by hyperglycemia, hyper aminoacidemia and hyper insulinaemia which may also leads to decrease in the insulin secretions [2]. In healthy condition the pancreas important role in regulation of glucose in body. It mainly consist alpha cells which secretes glucagon, beta cells while the glucagon in the condition of low level of blood glucose, in order to maintain the normal blood glucose level [3,4]. DM is described not only as condition of madhumeha {sugar loss in urine} but also as condition Ojameha [immunity and hormone loss] in Ayurveda for treatment purpose.

Types of diabetes mellitus

There are three main types of diabetes mellitus

Type 1 Diabetes Mellitus –IDDM [beta cell destruction]

Type 2 Diabetes Mellitus-NIDDM [insulin resistance]

Gestational Diabetes Mellitus [5].

TYPE 1 Diabetes Mellitus–Type 1 diabetes mellitus is also known as insulin dependent diabetes. It is most commonly occurring metabolic disorder and autoimmune disorder which is charactrized by the destruction of the beta cells [5]

TYPE 2 Diabetes Mellitus–Type 2 diabetes mellitus or non insulin dependent DM is a complex heterogeneous group of metabolic disorder which include hyperglycemias and impaired insulin action or insulin secretion.T2DM causedysfunctioning in multiple organs or tissues[5].

Gestational Diabetes–Gestational diabetes is blood glucose elevation during pregnancy. It is a significant disorder of carbohydrate metabolism due to hormonal changes during pregnancy. This can lead to elevated blood glucose in genetically predisposed individuals. It is more common among obese women and women with a family history of diabetes mellitus. It usually resolves once the baby is born. However, after pregnancy 5-10% of women with gestational diabetes are found to have type II diabetes. About 20-50% of women have a chance of developing diabetes in the next 5-10 years[5].

Pathophysiology of diabetes mellitus

The pancreas plays a primary role of metabolism of glucose by producing and secreting the hormones like
insulin and glucagon. The islets of langerhans produce and secrete insulin and glucagon directly into the blood. Insulin is a protein that is essential for proper regulation of glucose and for maintenance of proper glucose levels.[9] Glucagon is a hormone that opposes the action of insulin. It is secreted when blood glucose level falls. It increases blood glucose concentration, partly by stimulating the breaking down of stored glycogen in the liver by a pathway known as gluconeogenesis (Fig 1). Gluconeogenesis is the production of glucose in the liver from non-carbohydrate precursors such as amino acids[6].

Fig 1: Outline of diabetes

Signs and symptoms of diabetes mellitus
Common symptoms of diabetes include
- Feeling very thirsty
- Obesity
- Extreme fatigue
- Blurry vision
- Cuts/bruises that are slow to heal
- Weight loss – even though you are eating more [type 1]
- Tingling, pain, or numbness in the hands/feet[6].

Causes of diabetes mellitus are discussed in Table 1.

Table 1: Causes of Diabetes Mellitus

| S/NO. | CAUSES                                                      |
|-------|-------------------------------------------------------------|
| 1     | Obesity/overweight (especially excess visceral adiposity)   |
| 2     | Excess glucocorticoids (cushing’s syndrome or steroid therapy) |
| 3     | Excess growth hormone (acromegaly)                         |
Complication of diabetes

Acute complications
- Hyperglycaemia
- Hypoglycaemia
- Diabetes Ketoacidosis

Chronic Complications
- Diabetic Retinopathy
- Diabetic Neuropathy
- Diabetic Nephropathy

**Diabetes diagnosis:** The blood glucose levels of a healthy man are 80 mg/dl on fasting and up to 160 mg/dl in the postprandial state. A number of laboratory tests are available to confirm the diagnosis of diabetes[4].

**Random plasma test:** The simplest test and doesn’t require fasting before taking the test. If 200 or more than 200 mg/dl of blood glucose it probably indicates diabetes but has to be reconfirmed[4].

**Fasting plasma glucose test:** There should be eight hours fasting before taking this test. Blood glucose more than 126 mg/dl on two or more tests conducted on different days confirms a diabetes diagnosis[5]. Fasting glucose level is determined, and then gives 75 gm of glucose, 100 gm for pregnant women. The blood is tested every 30 minutes to one hr for two or three hrs. This test is normal if your glucose level at two hrs is less than 140 mg/dl. A fasting level of 126 mg/dl or greater and two hour glucose level of 200 mg/dl or higher confirms a diabetes diagnosis [5].

**Glycated proteins:** Proteins react spontaneously in blood with glucose to form glycated derivatives. The extent of glycation of proteins is controlled by the concentration of glucose in blood and by the number of reactive amino groups present in the protein that are accessible to glucose for reaction. All proteins with reactive sites can be glycated and the concentration of the glycated proteins that can be measured in blood is a marker for the fluctuation of blood glucose concentrations during a certain period. From a clinical diagnostic point glycated proteins with of these proteins to glucose for longer periods[2].

**Glycated haemoglobin:** The life span of hemoglobin in vivo is 90 to 120 days. During this time glycated hemoglobin A forms, being the ketoamine compound formed by combination of hemoglobin A and glucose. Several subfractions of glycated hemoglobin have been isolated, of these, glycated hemoglobin A fraction HbA1c is most interest serving as a retrospective indicator of the average glucose concentration. HbA1c is recommended as an essential indicator for the monitoring of blood glucose control. The blood HbA1c≥6.5% is considered as diabetes [6].

Different plants used in diabetes mellitus are discussed in table 2

**Table 2:** List of plants used in diabetes mellitus [5-15]

| Sr.No. | Plant                          | Family       | Part Used     |
|-------|--------------------------------|--------------|---------------|
| 1     | *Abelmoschus moschatus*         | Malvaceae    | Mucilage      |
| 2     | *Abroma augusta*                | Sterculiaceae| Leaves        |
| 3     | *Abrus precatorius*             | Leguminosea  | Seeds         |
| 4     | *Abutilon indicum*              | Malvaceae    | Whole Plant   |
| 5     | *Acacia arabica*                | Rubaceae     | Seeds         |
| 6     | *Acacia bilimekii*              | Fabaceae     | Leaves        |
| 7     | *Acacia catechu*                | Rubaceae     | Bark          |
| 8     | *Acacia farmesiana*             | Fabaceae     | Bark          |
| 9     | *Acacia nilotica*               | Fabaceae     | Leaves,Bark   |
| 10    | *Acacia pennata*                | Rubaceae     | Shoot Tips    |
| 11    | *Achranthes aspera*             | Amaranthaceae| Whole Plant   |
| 12    | *Aconitum carmichaeli*          | Ranunculaceae| Roots         |
| 13    | *Aconitum ferox*                | Ranunculaceae| Root          |
|   | Species                                   | Family          | Part                  |
|---|-------------------------------------------|-----------------|-----------------------|
|14 | Aconitum palmatum                         | Ranunculaceae   | Roots                 |
|15 | Adhatoda vasica                           | Acanthaceae     | Leaves                |
|16 | Adiantum capillus                         | Polypodiaceae   | Whole Plant           |
|17 | Aegle marmelos                            | Rutaceae        | Flower, Leaves        |
|18 | Aerva lanata                              | Amaranthaceae   | Leaves                |
|19 | Afzelia africana                          | Fabaceae        | Stem, Bark            |
|20 | Ajuga iva L                               | Lamiaceae       | Whole Plant           |
|21 | Ajuga remota                              | Lamiaceae       | Leaves                |
|22 | Albizia amara                             | Mimosoideae     | Leaves                |
|23 | Allium cepa                               | Liliaceae       | Stem, Tops.           |
|24 | Allium sativum                            | Liliaceae       | Bulbs                 |
|25 | Aloe vera                                 | Liliaceae       | Leaves                |
|26 | Annona muricata                           | Annonaceae      | Leaves                |
|27 | Annona squamosa                           | Annonaceae      | Leaves                |
|28 | Anethum graveolens                        | Apiaceae        | Seeds                 |
|29 | Anthocleista voglii                       | Logoniaceae     | Bark                  |
|30 | Anthocleista indicus                      | Rubiaceae       | Bark                  |
|31 | Areca catechu                             | Areaceae        | Seeds                 |
|32 | Argyreia nervosa                          | Convolvulaceae  | Roots                 |
|33 | Artocarpus altilis                        | Moraceae        | Leaves                |
|34 | Asparagus gonooclados                      | Apargaceae      | Bulb                  |
|35 | Astragalus species                        | Leguminosea     | Roots                 |
|36 | Asystasia gaunigica                       | Acanthaceae     | Leaves                |
|37 | Avena sativa                              | Poceae          | Whole Plant           |
|38 | Averrhoa bilimbi                          | Oxalidaceae     | Leaves                |
|39 | Azadirachta indica                        | Meliaceae       | Seed Oil, Leaves      |
|40 | Bacopa monnieri                           | Scrophulariaceae| Aerial Parts          |
|41 | Bambusa vulgaris                          | Gramineae       | Leaves                |
|42 | Barleria noctiflora                       | Acanthaceae     | Whole Plant           |
|43 | Barleria prionotis                        | Acanthaceae     | Leaf, Bark, Root      |
|44 | Basella rubra                             | Basellaceae     | Leaves                |
|45 | Bauhinia rectusa                          | Leguminoseae    | Seeds                 |
|46 | Bauhinia variegata                        | Caesalpiniaceae | Bark                  |
|47 | Bauhinia forficate                        | Caesalpiniaceae | Leaves                |
|48 | Bauhinia divaricata                       | Leguminoseae    | Leaves                |
|49 | Bauhinia candidans                        | Leguminoseae    | Leaves                |
|50 | Barleria lupulina                         | Acanthaceae     | Aerial Part           |
|51 | Balanites aegyptiaca                      | Simarubiaee     | Fruit                 |
|52 | Baccharis trimera                         | Myrtaceae       | Leaves                |
|53 | Averrhoa carambola                         | Oxalidaceae     | Leaves                |
|54 | Atractylode japonica                      | Composiayae     | Rhizomes              |
|55 | Asteracantha longifolia                   | Acanthaceae     | Leaves                |
| No. | Plant Name                  | Family         | Part     |
|-----|----------------------------|----------------|----------|
| 55  | Asparagus racemosus         | Meliaceae      | Roots    |
| 56  | Artocarpus heterophyllus   | Moraceae       | Leaves   |
| 57  | Artemocnemum glaucum       | Chenopodiaceae | Whole    |
| 58  | Artemisia pallens wall      | Compositae     | Aerial Part |
| 59  | Artemisia ludoviciana       | Compositae     | Leaves   |
| 60  | Artemisia herba-alba        | Compositae     | Leaves   |
| 61  | Artemisia dracunculus       | Compositae     | Whole Plant |
| 62  | Artemisia absinthium        | Compositae     | Leaves   |
| 63  | Aronia melanocarpa         | Rosaceae       | Fruit    |
| 64  | Arctostaphylos uva ursi     | Ericaceae      | Fruit    |
| 65  | Aralia elata seem           | Araliaceae     | Root     |
| 66  | Aquilaria sinesis           | Thymelaceae    | Leaves   |
| 67  | Aquilaria agallocha         | Thymelaceae    | Stem     |
| 68  | Aporosa lindleyana          | Euphorbiaceae  | Leaves   |
| 69  | Asporosa lanceolata         | Euphorbiaceae  | Leaves   |
| 70  | Anthocleista voglii         | Lohoniaceae    | Root     |
| 71  | Anthocleista rhizophoroides | Logoniaceae    | Bark     |
| 72  | Anthocleista nobilis        | Logoniaceae    | Bark     |
| 73  | Anthemis herba alba         | Compositae     | Aerial Part |
| 74  | Andropogon citratus         | Poaceae        | Aerial Part |
| 75  | Andrographis paniculata     | Acanthaceae    | Whole Plant |
| 76  | Andrographis paniculata     | Acanthaceae    | Root     |
| 77  | Andrographis lineata        | Acanthaceae    | Leaves   |
| 78  | Anacardium occidentale      | Anacardiaceae  | Leaves   |
| 79  | Anacardium occidentale      | Anacardiaceae  | Bark     |
| 80  | Amphipterygium adstringens  | Anacardiaceae  | Bark     |
| 81  | Amorphophallus konjac       | Araceae        | Rhizome  |
| 82  | Amomum subulatum            | Zingiberaceae  | Root     |
| 83  | Amomum aromaticum           | Zingiberaceae  | Root     |
| 84  | Amaranthus spinosus         | Amaranthaceae  | Stem     |
| 85  | Amaranthus esculants        | Amaranthaceae  | Whole Plant |
| 86  | Amaranthus caudatus         | Amaranthaceae  | Leaves   |
| 87  | Althaca officinalis         | Malvaceae      | Leaves, Whole Plant |
| 88  | Alternanthera sessillis     | Amaranthaceae  | Whole Plant |
| 89  | Alstonia scholaris          | Apocynaceae    | Bark     |
| 90  | Alstonia macrophylla        | Apocynaceae    | Whole Plant |
| 91  | Akpinia galanga             | Zingiberaceae  | Rhizome  |
| 92  | Aloe barbadensis            | Liliaceae      | Leaves   |
| 93  | Aloe arborescens            | Liliaceae      | Leaves   |
| 94  | Alchemilla vulgaris         | Rosaceae       | Aerial Parts |
| 95  | Alangium salvifolium        | Alangiacae     | Leaves   |
| 96  | Agrimonia pilosa            | Rosaceae       | Leaves   |
| 97  | Agrimonia eupatoria         | Rosaceae       | Leaves   |
| 98  | Agarista mexicana           | Ericaceae      | Aerial Parts |
| No. | Scientific Name       | Family      | Plant Part       |
|-----|-----------------------|-------------|------------------|
| 99  | Agapetes sikkimensis  | Ericaceae   | Aerial Parts     |
| 100 | Aframomum memegueta   | Zingiberaceae| Leaves          |
| 101 | Aesculus hippocastanum| Hippocastanaceae | Seeds    |
| 102 | Adiantum caudatum     | Petridae    | Leaves          |
| 103 | Adansonia digitata    | Bombacaceae | Stem Bark       |
| 104 | Acrocomia mexicana    | Leguminosae | Roots           |
| 105 | Acosmium panamense    | Leguminosae | Bark            |
| 106 | Achyrocline sareioides| Asteraceae  | Aerial Parts     |
| 107 | Achyranthes aspera    | Amaranthaceae| Whole Plant     |
| 108 | Acanthopanax senticosus| Araliaceae  | Leaves          |
| 109 | Bauhinia variegata    | Caesapinaceae| Flowers         |
| 110 | Benincasa hispida     | Cucurbitaceae| Fruit            |
| 111 | Berberis aristata     | Berberidaceae| Stem Bark       |
| 112 | Berberis vulgaris     | Berberidaceae| Root            |
| 113 | Berenia stachyi       | Saxifragaceae| Root            |
| 114 | Beta vulgaris         | Chenopodiaceae| Root Bark     |
| 115 | Bighia sapida         | Sapindaceae | Unripe Fruits   |
| 116 | Bidens pilosa         | Asteraceae  | Whole Plant     |
| 117 | Bixa orellana         | Bixaceae    | Leaves          |
| 118 | Bombax ceiba          | Bombacaceae | Seed            |
| 119 | Boswellia serata      | Frankincense| Whole Plant     |
| 120 | Bougainvillea glabra  | Rubiaceae   | Leaves          |
| 121 | Brassica juncea       | Brassicaceae| Seeds           |
| 122 | Brassica junceca coss | Brassicaceae| Leaves          |
| 123 | Brassica napiformis    | Brassicaceae| Leaves          |
| 124 | Brassica nigra        | Brassicaceae| Seeds           |
| 125 | Brassica oleracca     | Brassicaceae| Leaves          |
| 126 | Brassica rapa         | Brassicaceae| Root            |
| 127 | Bryonia alba l.       | Cucurbitaceae| Roots          |
| 128 | Bryonia cretica       | Cucurbitaceae| Aerial Parts   |
| 129 | Bumelia sartorum      | Sapotaceae  | Root Bark       |
| 130 | Butea monosperma      | Fabaceae    | Fruits          |
| 131 | Caesalpinia cristata  | Fabaceae    | Seeds           |
| 132 | Caesalpinia decapetala| Leguminosae | Seeds           |
| 133 | Caesalpinia digyna    | Leguminosae | Roots           |
| 134 | Caesalpinia sappan    | Fabaceae    | Stem            |
| 135 | Caseria esculanta     | Caesalpinioideae | Roots     |
| 136 | Cajanus cajan         | Fabaceae    | Seeds           |
| 137 | Calamintha macrostema | Lamiaceae   | Root            |
| 138 | Calamintha officinalis| Lamiaceae   | Aerial Parts    |
| 139 | Calamintha umbrossa   | Lamiaceae   | Whole Plant     |
| 140 | Calotropis procera    | Asclepiadaceae| Latex          |
| 141 | Camellia sinesis      | Theaceae    | Leaves          |
| 142 | Canaryium schweinfurthi | Burseraceae | Stem Bark       |
| #   | Species                      | Family            | Part      |
|-----|------------------------------|-------------------|-----------|
| 143 | Canarium zeylanicum         | Burseraceae       | Bark      |
| 144 | Canavalia ensiformis        | Leguminosae       | Seeds     |
| 145 | Cannabis indica             | Cannabinaceae     | Whole Plant |
| 146 | Canecora decussata         | Gentianaceae      | Whole Plant |
| 147 | Capparis decidua           | Gentianaceae      | Fruits    |
| 148 | Capparis incana            | Capparaceae       | Leaves    |
| 149 | Capparis moon              | Capparaceae       | Fruit     |
| 150 | Capparis sepiaria           | Capparaceae       | Leaves    |
| 151 | Capravia biflora           | Scrophulariaceae  | Leaves    |
| 152 | Carica papaya              | Caricaceae        | Fruit     |
| 153 | Carissa carandas           | Apocynaceae       | Fruit     |
| 154 | Carissa edulis             | Apocynaceae       | Fruit     |
| 155 | Carmona retusa             | Boraginaceae      | Leaves    |
| 156 | Carum carvi                | Apiaceae          | Seeds     |
| 157 | Caseria glauca             | Salicaceae        | Bark      |
| 158 | Cassia esculenta           | Flacourtiaeae     | Root      |
| 159 | Cassia glauca              | Saliaceae         | Bark      |
| 160 | Casseria zeylanica         | Flacourtiaeae     | Stem Bark |
| 161 | Cassia alta                | Fabaceae          | Leaves    |
| 162 | Cassia auriculata          | Leguminoseae      | Roots     |
| 163 | Cassia fistula             | Leguminoseae      | Seeds     |
| 164 | Cassia occidentallis       | Caesalpiniaceae   | Leaves    |
| 165 | Cassia siamea              | Fabaceae          | Leaves    |
| 166 | Castela texana             | Simaroubaceae     | Leaves    |
| 167 | Cecropia obtusifolia       | Moraceae          | Leaves    |
| 168 | Cecropia peltata l         | Moraceae          | Leaves    |
| 169 | Ceiba pentandra            | Malvaceae         | Roots     |
| 170 | Ceiba pentandra            | Malvaceae         | Roots     |
| 171 | Centella asiatica          | Apiaceae          | Whole Plant |
| 172 | Cephalandra indica         | Cucurbitaceae     | Leaves    |
| 173 | Cephallanthus glabratus    | Rubiaceae         | Wood      |
| 174 | Chamaemelum nobile         | Compositae        | Leaves    |
| 175 | Cichorium intybus          | Asteraceae        | Seeds     |
| 176 | Cinnamomum cassia          | Lauraceae         | Leaves    |
| 177 | Cinnamomum tamala          | Lauraceae         | Bark      |
| 178 | Cistanche tubulosa         | Scrophulariaceae  | Whole Plant |
| 179 | Citrullus lantatus         | Cucurbitaceae     | Pulp      |
| 180 | Citrus aurantum            | Rutaceae          | Peels     |
| 181 | Citrus limetta             | Rutaceae          | Peels     |
| 182 | Citrus maxima              | Rutaceae          | Peels     |
| 183 | Citrus sinensis            | Rutaceae          | Peels     |
| 184 | Clausena anisata           | Rutaceae          | Leaves    |
| 185 | Cleome aspera              | Capparidaceae     | Whole Plant |
| 186 | Clitoria termatea          | Fabaceae          | Seeds     |
| No. | Species Name          | Family       | Part        |
|-----|----------------------|--------------|-------------|
| 187 | Coccina grandis      | Cucurbitaceae | Whole Plant |
| 188 | Coccina indica       | Cucurbitaceae | Leaves      |
| 189 | Coccins cardifolia   | Menispermaceae | Stem       |
| 190 | Cocculus villosus    | Menispermaceae | Roots      |
| 191 | Cocos nucifera l.    | Arecales     | Fiber       |
| 192 | Coffea Arabica l.    | Rubiaceae    | Seeds       |
| 193 | Coix lacrymal        | Poaceae      | Seed        |
| 194 | Convallaria majalis  | Asparagaceae  | Bulb        |
| 195 | Cordia dichotoma     | Boraginaceae  | Stem, Bark  |
| 196 | Cordia morelosiana   | Boraginaceae  | Leaves      |
| 197 | Cordia myxa          | Boraginaceae  | Stem, Bark  |
| 198 | Carinadrum sativum   | Apiaceae     | Whole Plant |
| 199 | Corni fructus        | Comaceae     | Whole Plant |
| 200 | Cormus officinalis   | Comaceae     | Fruit       |
| 201 | Costus specious      | Costaceae    | Rhizome     |
| 202 | Coutarea latiflora   | Rubiaceae    | Bark        |
| 203 | Crataegus Mexicana   | Rosaceae     | Root        |
| 204 | Crataegus pubescens  | Rosaceae     | Whole Plant |
| 205 | Crotonaria medicaginea | Fabaceae  | Seeds        |
| 206 | Cucumis callosus     | Cucurbitaceae | Seeds      |
| 207 | Cucumis metuliferus  | Cucurbitaceae | Fruit      |
| 208 | Cucumis sativus      | Cucurbitaceae | Fruit      |
| 209 | Cucumis trigonos     | Cucurbitaceae | Fruit      |
| 210 | Cuminum cyminum      | Umbelliferae | Seeds       |
| 211 | Cuminum nigrum       | Apiaceae     | Seeds       |
| 212 | Curcuma longa        | Zingiberaceae | Rhizome   |
| 213 | Cyathea divergens    | Cyatheaceae  | Bark        |
| 214 | Cyclanthera pedata   | Cucurbitaceae | Shoot     |
| 215 | Cymbalaria muralis   | Crophulariaceae | Whole Plant  |
| 216 | Cynodon dactylon     | Roaceae      | Whole Plant |
| 217 | Cyperus iria         | Cyperaceae   | Root        |
| 218 | Dalbergia sissoo     | Fabaceae     | Bark        |
| 219 | Daucus carota        | Apiaceae     | Root        |
| 220 | Decalepis root       | Apocynaceae  | Root        |
| 221 | Delonix regia        | Fabaceae     | Leaves      |
| 222 | Dendrobium nobile    | Orchidaceae  | Stem        |
| 223 | Desurainia Sophia    | Brassicaceae | Whole Plant |
| 224 | Desmodium motorium   | Fabaceae     | Leaves      |
| 225 | Dillenia indica      | Dilleniaceae | Leaves      |
| 226 | Diospyros lotus      | Ebenaceae    | Fruit       |
| 228 | Diospyros peregrine  | Ebenaceae    | Bark        |
| 229 | Discorea japonica    | Diseoraceae  | Tubers      |
| 230 | Discorea batalas      | Diseoraceae  | Tubers      |
| 231 | Discorea bulbifera   | Diseoraceae  | Bulb        |
| No. | Plant Name          | Family                | Part        |
|-----|---------------------|-----------------------|-------------|
| 232 | Discorea rhizoma    | Diseoraceae           | Tubers      |
| 233 | Dodonaea viscosa    | Sapindaceae           | Leaves      |
| 234 | Eclipta alba        | Asteraceae            | Leaves      |
| 235 | Eleusine coracana   | Poaceae               | Seeds       |
| 236 | Ephedra elata       | Ephedraceae           | Aerial Parts|
| 237 | Eriobatrya japonica | Rosaceae              | Seeds       |
| 238 | Eruca sativa        | Brassicaceae          | Seeds       |
| 239 | Erythrina indica    | Fabaceae              | Leaves      |
| 240 | Erythrina variegata | Fabaceae              | Leaves      |
| 241 | Eucalyptus citriodora | Myrtaceae          | Leaves      |
| 242 | Eucalyptus globules | Myrtaceae             | Leaves      |
| 243 | Eugenia jambolana   | Myrtaceae             | Fruit       |
| 244 | Ficus bengelensis   | Moraceae              | Root, Bark  |
| 245 | Ficus carica        | Moraceae              | Leaves      |
| 246 | Ficus glomerata     | Moraceae              | Bark        |
| 247 | Ficus hispida       | Moraceae              | Leaves      |
| 248 | Ficus racemosa      | Moraceae              | Bark        |
| 249 | Ficus religiosa     | Moraceae              | Root, Bark  |
| 250 | Ficus retusa        | Moraceae              | Leaves      |
| 251 | Ficus sycomorus     | Moraceae              | Leaves      |
| 252 | Fraxinus excelsior  | Oleaceae              | Seeds       |
| 253 | Gallegan officinalis| Leguminoseae          | Leaves      |
| 254 | Ganoderma lucidum   | Ganodermataceae       | Fruit       |
| 255 | Ginkgo biloba       | Ginkgoaceae           | Whole Plant |
| 256 | Ginseng radix       | Araliaceae            | Root        |
| 257 | Glycine max         | Leguminoseae          | Seeds       |
| 258 | Gmelina arborea     | Verbenaceae           | Root        |
| 259 | Grewia asiatica     | Tiliaceae             | Bark        |
| 260 | Grewia flavensis    | Tiliaceae             | Leaves      |
| 261 | Grifola frondosa    | Meripilaceae          | Fruit       |
| 262 | Guaiacum coulteri   | Zygophyllaceae        | Bark        |
| 263 | Guaxuma ulmifolia   | Sterculiaceae         | Bark        |
| 264 | Gymnema sylvestre   | Asclepiadaceae        | Leaves      |
| 265 | Gymnura procumbens  | Asteraceae            | Leaves      |
| 266 | Hamada salicornica  | Hammamelidaceae       | Whole Plant |
| 267 | Hedychium spicatum  | Zingiberaceae         | Rhizome     |
| 268 | Helicteres isora    | Sterculiaceae         | Root        |
| 269 | Heritiera minor     | Sterculiaceae         | Aerial Parts|
| 270 | Hintonia latiflora  | Rubiaceae             | Leaves      |
| 271 | Hintonia standleyan | Rubiaceae             | Stam, Bark  |
| 272 | Hoodia curror       | Apocynaceae           | Stem        |
| 273 | Hordeum vulgare     | Gramineae             | Seeds       |
| 274 | Humulus lupulus     | Cannabinaceae         | Strobiles   |
| 275 | Hydrolea zeylanica  | Hydrangeaceae         | Whole Plant |
Indian medicinal plants with antidiabetic and related beneficial effects

There are many herbal remedies suggested for diabetes and diabetic complication. Medicinal plants form the main ingredients of these formulations. A list of medicinal plants with antidiabetic and related beneficial effects[7].

**Acacia arabica**

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 produces hypoglycemia in control rats but not in alloxanized animals. Powdered seeds of acacia arabica when administered (2.3 and 4g/kg body weight ) to normal rabbits induced hypoglycemic effect by initiating release of insulin from pancreatic beta cells[8].

**Aegle marmelos**

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, the extract also prevented peak rise in blood sugar at 1h in oral glucose[9].

**Allium cepa**

Various ether soluble fraction as well as insoluble fraction 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 sulfur containing amino acid from allium cepa, S-methyl cysteine sulphoxide (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[10,11]. When diabetic patients were given single oral dose of 50 g of onion juice, it significantly controlled post-prandial glucose levels[12].

**Allium sativum**

*Allium sativum* is a perennial herb cultivated throughout India. Allin, a sulfur-containing compound is responsible for its pungent odour and it has been shown significant hypoglycemic activity[13]. This effect is thought to be due to increased hepatic metabolism, increased insulin release from pancreatic beta cells and/or insulin sparing effect[14]. Aqueous hómogenate of garlic (10 ml/kg/day) administered orally to sucrose fed rabbits (10 g/kg/day in water for two month ) significantly increased hepatic glycogen and free amino acid content, decreased fasting blood glucose, and triglyceride levels in serum in comparison to sucrose controls[15].

**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 exudates of aloe barbadensis leaves showed hypoglycemic effect in alloxanized diabetic rats[16].

**Azadirachta indica**

Hydroalcoholic extracts of this plant showed antihyperglycemic activity in streptozotocin treated rats and this effect is because of increase in glucose uptake and glycogen deposition in isolated rat hemidiaphragm[17,18]. Apart from having anti-diabetic activity, this plant also has anti-bacterial, antimalarial, antifertility, hepatoprotective and antioxidant effects[19].

**Caesalpinia bonducella**

It is widely distributed throughout the coastal region of India and used ethanolic extracts also increased glycogenesis thereby increasing liver glycogen content[20]. Two fraction BM 169 and BM 170 B could increase secretion of insulin from isolated islets. The aqueous and 50% ethanolic extract of caesalpinia bonducella seeds showed antihyperglycemic and hypolipidemic activites in streptozotocin (stz)- diabetic rats[21]. 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[22].

**Capparis decidua**

This is found throughout India, especially in dry areas. Hypoglycemic effect was seen in alloxanized rats when the rats were fed with 30% extracts of capparis is decidua (c. decidua ) fruit powder for 3 weeks. This extract also reduced alloxan induced lipid peroxidation. 

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**Table:**

| Plant Name          | Family       | Plant Part                  |
|---------------------|--------------|-----------------------------|
| Hyptis suaveolens   | Lamiaceae    | Aerial Plant                |
| Hyssop’s officinalis| Lamiaceae    | Leaves                      |
| Ivervillea sonorae  | Curcurbitaceae| Root                        |
| Inula racemoma      | Tubuliflorae | Root                        |
| Ipomea aquatic      | Convolvulaceae| Whole Plant                 |

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**References:**

[10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22].

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significantly in erythrocytes, kidney and heart. C. decidua was also found to alter superoxide dismutase and catalase enzyme levels to reduce oxidative stress[23]. C.decidua additionally showed hypolipidaemic[24].

**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 diabetic[25]. 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**

In India decocation 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 reduced to 55.62% and 17.72% respectively[13]. 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[26].

**Mangifera indica**

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 hormoglycemic 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[27].

**Momordica charantia**

*M. charantia* is commonly used as an antidiabetic and antihyperglycemic agent in india as well as other asain countries. Extracts of fruit pulp,seed,leaves and whole plant was shown to have hypoglycemic effect in various animal models[28]. Polupeptide p, isolated from fruit, seeds and tissues of M.charantia showed significant hypoglycemic effect in normal and STZ diabetic rats. This may be because of inhibition of glucose-6-phosphate dehydrogenase activities[29].

**Ocimum sanctum**

It is commonly known as tulsi. Since ancient times, this plant is known for its medicinal properties. The aqueous extract of leaves of ocimum sanctum showed the significantreduction in blood sugar levels in both normal and alloxan induced diabetic total cholesterol, triglyceride and total lipid indicated the hypoglycemic and hypolipidimic effects of tulsi in diabetic rats[30]. Oral administration pf 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[31]. 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[32].

**Phyllanthus amarus**

It is a herb of height up to 60 cm, from family euphorbiaceae known as bhuiamala. It is scattered throughout the hotter parts of india, mainly deccan, konkan and south indian states. Traditionally it is used in diabetic therapies,methanolic extract of phyllanthus amarus was found to have potent antioxidant activity. This extract also reduced the blood sugar in alloxanized diabetic rats[33]. The plant also shows antinflammatory, antimutagenic, anticarcinogenic, anti diarrhoeal activity.

**Pterocarpus marsupium**

It is a deciduous moderated to large tree found in india mainly in hilly region,pterostilbene, a constituent derived from wood of this plant caused hypoglycemia in dogs[34,35]. Showed that the hypoglycemic activity of this extract is because of presence of tannates in the extract. Flavonoid fraction from pterocarpus marsupium has been shiwn to cause pancreatic beta cell regranulation[36]. Marsupin, pteropisin and liquiritigenin obtained from this plant showed antihyperlipidemic ctitivity,[35](+) epicatechin , its active principle, has been found to be insulinogenic, enhancing insulin relase and conversion of proinsulin to insulin in vitro. Like isulin(+) epicatechin stimulates oxygen uptake in fat cells and tissue slices of various organs, increase glycogen content of rat diaphragm in a dose-dependent manner[36].

**Trigonella foenum graecum**

It is found all over india and the fenugreek seeds are usually used as one of the major constituents of indian species. 4-hydroxyxleucine, a novel amino acid from fenugreek seed increased glucose stimulated insulin release by isolated islet cells in both rats and humans[50]. Oral administration of 2 and 8 g/kg 0f plant extract produced dose dependent decrease in the blood glucose levels in both normal as well as diabetic
Tinospora cordifolia: (guduchi) It is the 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 also prevented a decrease in body weight[44]. T.cordifolia is widely used in Indian ayurvedic medicine for treating diabetes mellitus[45-47]. 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[48]. It is reported that the daily administration of either alcoholic or aqueous extract of T.cordifolia decrease the blood glucose level and increases glucose tolerance in rodents[49].

Conclusion
Diabetes is a metabolic disorder which can be considered as a major cause of high economic loss which can in turn impede the development of nations. Moreover, uncontrolled diabetes leads to many chronic complications such as blindness, heart failure, and renal failure. In order to prevent this alarming health problem, the development of research into new hypoglycaemic and potentially anti diabetic agents is of great intrest. In conclusion, this paper has presented a list of anti-diabetic plants used in the treatment of diabetes mellitus. It showed that these plants have hypoglycaemic effects.

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