

## FARMING ANTI-DIABETIC MEDICINAL PLANTS - AN UPDATE

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### ABSTRACT

Diabetes mellitus was one of the major killers of mankind before the discovery of a pancreatic extract insulin in 1921 and oral hypoglycemic. Diabetes mellitus is associated with three times higher mortality rate, three times higher frequency of heart disease and ten times higher frequency of blindness and gangrene. Today's need of hour to reach effective treatment for everyone, which needs sustained supply of drugs. Here cultivation of medicinal plants plays a very important role, as the number of diabetic patients is increasing similarly increase of diabetic prone population is also needs qualitative control prophylaxis measures. In recent years the emphases have been to identify as many medicinal plants as possible which could have effective control of diabetes mellitus. Health restoration with fresh medication helps to recover from the condition early, reduce the side effects of preservatives and quick action towards the condition due to the potent phyto-constituents. Here comes importance of home gardening which will provide complete involvement of one's own mind and reduces stress level. This review article aims to provide ready reckoner for formers, pharmaceutical companies about cultivation, propagation of 13 important medicinal plants which prone to be all time anti-diabetic and easy to cultivate, propagate and use.

**Keywords:** Diabetes mellitus, Anti- diabetes, Home gardening, Cultivation and Propagation.

### INTRODUCTION

**World Health Organization** stated that, globally an estimated 422 million adults are living with diabetes mellitus and estimates that diabetes resulted in 1.5 million deaths in 2012, making it the 8th leading cause of death<sup>1</sup>. Until recently, India had more diabetics than any other country in the world, according to the **International Diabetes Foundation**. Diabetes currently affects more than 62 million Indians, which is more than 7.1% of the adult population. Nearly 1 million Indians die due to

diabetes every year<sup>2</sup>. India had an estimated 31,705,000 diabetics in the millennium year which is estimated to grow by over 100% to 79,441,000 by 2030<sup>3</sup>. Diabetes is a chronic disease, which occurs when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces. This leads to an increased concentration of glucose in the blood<sup>4</sup>.

There is increasing percentage of diabetes mellitus day by day. Many drugs are proved to be anti-diabetic.

Today's need of hour to reach effective treatment for everyone, which needs sustained supply of drugs. Here cultivation of medicinal plants plays a very important role, as the number of diabetic patients is increasing similarly increase of diabetic prone population is also needs qualitative control prophylaxis measures.

### Role Of Medicinal Plants In Diabetes Mellitus

Many medicinal plants have been reported to be useful in diabetes worldwide and have been used empirically as anti-diabetic remedies. Numerous mechanisms of actions have been proposed for anti-diabetic plant extracts. Some hypothesis relates to their effects on **1.** Facilitate the activity of pancreatic beta cells **2.** Increase in the inhibitory effect against insulinase enzyme **3.** Increase of the insulin sensitivity or the insulin-like activity of the plant extracts **4.** Increase of peripheral utilization of glucose, increase of synthesis of hepatic glycogen or decrease of glycogenolysis **5.** Inhibition of intestinal glucose absorption and reduction of glycemic index of carbohydrates

### ANTI-DIABETIC HOME GARDEN INCLUDES:

Home garden can produce many different things- fuel for cooking, wood for building, food, income, medicinal plants, herbs, spices and flowers. Home garden can be defined as a forming system which combines different physical, social and economic functions on the area of land around the family. Here are some plants which are prone to be all time anti-diabetic and easy to propagate.

## I. TREES

### 1. *Pterocarpus marsupium*

**Part used** – Stem and heart wood

**Cultivation and propagation**<sup>5</sup>

**Mode of propagation:** It is propagated using seeds.

**Nature of soil:** It prefers fertile, deep clay loam soil with good drainage. It can tolerate excessive temperatures in summer. **Season of sowing:** In the month of April. Transplanting may either be done in July–August (monsoon season) when the plants are two-month-old or delayed till next June–July. **Time of harvesting:** The tree is harvested after 10–15 years for production of heartwood. Kino gum is collected

through incision in the bark before logging of tree, and dried well in shade.

**Anti-diabetic activity**<sup>6</sup>: *Pterocarpus marsupium* enhanced glucose uptake by skeletal muscle cells (C2C12) in a dose dependent manner it may due to primarily be concluded that phenolic-C-glycosides present in the *P. marsupium*. **1**  $\beta$ -cell Regeneration: There is evidence to suggest that (-)-epicatechin is effective in beta -cell regeneration. **2** Insulin Release: Ethyl acetate fraction and (-)-Epicatechin PM bark increased the cAMP content of the islets of pancreas in rats with an associated increase in insulin release and conversion of pro-insulin to insulin. **3.** Increase in glucose uptake: **11.1** Four phenolic compounds namely vijayoside, pteroside, marsuposide and pterosupol (10  $\mu$ M/ml) increased the a glucose uptake in basal and insulin-stimulated cells in a concentration-dependent manner. **4.** Increase in glycogen synthesis: Oral administration of the aqueous extract of P.M bark (300 and 500mg/kg/day for 12 weeks) to diabetic rats restored the level of glycogen synthase. (-)-Epicatechin increased the glycogen content in rat diaphragm in a dose-dependent manner. Ahmad et al. revealed insulin-like activities of (-)-Epicatechin and demonstrated that (-)-Epicatechin does not share the plasma membrane receptor with insulin.

### 2. *Salacia chinensis*

**Part used**-stems and roots

**Cultivation and Propagation**<sup>7</sup>

**Mode of propagation:** It is a shade loving plant. *Salacia* plant is generally propagated through seeds, stem cutting and root cuttings. **Nature of soil:** Well drained rich sandy loamy soil. **Season of sowing:** Mid-March to July. **Time of harvesting:** one year for the stem and two years for the root from the time of cultivation.

**Anti-diabetic activity**<sup>8</sup>: New type of anti-diabetic agents -Evaluation of the  $\alpha$ -glucosidase inhibitory activity of the active constituents, salacinol (1) etc by employing human  $\alpha$ -glucosidases revealed that these compounds inhibited them as potently as they inhibited rat small intestinal  $\alpha$ -glucosidase. The principal sulfonium constituents (1–4) were highly

stable in an artificial gastric juice. In addition, constituents were hardly absorbed from the intestine. The results indicate that this sulfonium is promising leads for a new type of anti-diabetic agents. Highest  $\alpha$ -Glucosidase enzyme inhibition activity was obtained from plant roots, followed by stems, seeds and leaves. Comparing enzyme activity across plant parts yielded promising findings. Successive aqueous extracts of stems and seeds exhibited inhibition values of 73.44% and 56.00%, respectively, values that are comparable to those obtained from root extracts (80.99%).

### 3. *Syzigium cumini*

**Part used:** Fruit and seed

#### **Cultivation and propagation<sup>9</sup>**

**Mode of propagation:** It can be propagated by seeds as well as by vegetative grafting and budding. **Nature of soil:** For development of seedlings, moisture is important than shade, as seedlings in the sun develop well, provided the soil is kept moist, but seedlings in the shade die if the soil is dry. **Season of sowing:** Monsoon season is the best for planting. In areas where rains are low, planting should be done with the onset of monsoon. However, in areas of heavy rainfall planting is done in post monsoon season. **Time of Harvesting:** A seedling plants start bearing after 8 to 10 years of planting whereas, grafted plants bear after 5 to 6 years. The fruit ripens in the month of June – July. It takes about 3-5 months to **ripen after full bloom.**

**Anti-diabetic activity<sup>10</sup>:** Flavonoids rich *S. cumini* seed extracts were able to maintain glucose homeostatic and enhanced glycogen biosynthesis significantly by stimulating insulin secretion. **Quercetin**, a flavonoid present in *S. cumini* helps in regeneration of the pancreatic  $\beta$ -cells and stimulates insulin release. **Anthocyanin** has effective insulin secretagogue properties. **Inhibition of glucose absorption:**  $\alpha$ -glucosidase and pancreatic  $\alpha$ -amylase inhibitors can be used to check the initiation and progression of type II diabetes mellitus and will be an important strategy to manage the disease.

### 4. *Aegle marmelos*

**Part used:** Leaves, fruit

#### **Cultivation and propagation**

**Mode of propagation:** Seed - the plant is commonly grown from seed in nurseries and transplanted into the field.<sup>11</sup> **Nature of Soil:** *Aegle marmelos* is said to do best on rich well drained soil. It also grows well in swampy, alkaline or stony soils having pH range from 5-8. **Season of sowing:** Seeds are sown in June and seedlings became ready for transplanting after 7 weeks. February – March or July – August is the right time for planting. **Time of Harvesting:** Mature green fruits are ideal for harvesting. Fruits became fully mature 8 months after fruit set.<sup>12</sup>

**Anti-diabetic activity:** Oral administration of *Aegle marmelos* fruit extract twice resulted in improved functional state of the pancreatic  $\beta$ -cells and partially reversed the damage caused by streptozotocin to the pancreatic islets<sup>13</sup>. The leaf extract of *Aegle marmelos* was found to be as effective as insulin in restoring of blood glucose and body weight to normal levels. In clinical study using *Aegle marmelos* leaves on diabetic subjects the results indicated significant reduction in FBS level. There was a significant reduction in total cholesterol and triglycerides and increase in HDL<sup>14</sup>

### 5. *Azardicta indica*

**Part used:** stem bark and leaf

#### **Cultivation and propagation<sup>15</sup>**

**Mode of propagation:** Propagators usually select healthy, vigorous, well-matured and young shoots with viable buds as the source of cuttings. It can be propagated using seeds also. **Nature of soil:** it grows well in black cotton soil and needs moist, dry, stony, clayey or shallow soil. They need plenty of sunlight. It can tolerate a soil pH of 5-10. **Season of sowing:** Planting or transplanting before or during rainy season. **Time of Harvesting:** Scented white flowers appear during March-April. Fruits ripen from June to August.

**Anti-diabetic activity:** Leaf extract of *Azadirachta indica* contain principle bioactive compounds namely Nimbidin which bind to receptor sites especially the peroxisome proliferator – activated receptors which are the chief regulators of glucose metabolism and reported to possess hypoglycemic activity after glucose administration. *A. indica* chloroform extract

have regeneration property of functional beta cells in pancreas further helps in insulin secretion.<sup>16</sup>

**NOTE: For each tree 3x3 feet spacing is required and place of cultivation preferably in the corner of garden.**

## II. HERBS AND SHRUBS

### 1. Eclipta alba

**Part used:** whole plant

**Propagation and cultivation**<sup>17</sup>

**Mode of propagation:** Seed and Cuttings are the mode of propagation. **Nature of soil:** It can be grown in any type of soil but it prefers red loamy soil, with little moisture. **Season of sowing:** Rainy season. **Time of Harvesting:** The whole plant is plucked after 9 to 10 month. The seeds are collected when it turns black in color.

**Anti-diabetic activity:** The possible mechanism by which plant extract brings about a decrease in blood sugar level may be by potentiation of the insulin effect of plasma by increasing either the pancreatic secretion of insulin from  $\beta$  cells of the islets of *langerhans* or its release from the bound form. *E. alba* possesses a hypoglycemic effect may primarily by modulating and regulating the activities of glucose-6-phosphatase and fructose 1,6 biphosphatase enzymes either through regulation of cAMP or inhibition of gluconeogenesis. *E. alba* plants significantly decreased blood glucose level and showed anti-diabetic effect by suppressing carbohydrate absorption from the intestine<sup>18</sup>.

### 2. Boerhavia diffusa

**Part used:** Leaves

**Cultivation and propagation**<sup>19</sup>

**Mode of propagation:** *Boerhavia diffusa* can be propagated from seeds. **Nature of soil:** Drained and sandy soil and sunny condition is required. **Season of sowing:** May- June is the favorable time for sowing seeds. **Time of Harvesting:** leaves can be collected after flowering, usually October to December

**Anti-diabetic activity:** A study was carried out to investigate the effect of daily oral administration of aqueous solution of *Boerhavia diffusa L.* leaf extract for 4 weeks on blood glucose concentration and hepatic enzymes in normal and Alloxan induced

diabetic rats. A significant decrease in blood glucose and significant increase in plasma insulin level were observed in normal and diabetic rats treated with *Boerhavia diffusa L.* leaf extract<sup>20</sup>.

### 3. Aloe vera

**Part used-**Pulp of the leaf

**Cultivation and propagation**<sup>21</sup>

**Mode of propagation:** *Aloe vera* can be propagated from root suckers/ rhizome cuttings. Indoor cultivation of *Aloe vera* also can be done. **Nature of soil:** Sandy to loamy soil with well-drained soil. Avoid stagnant of water. **Season of sowing:** Hot summer will result good yield. **Time of Harvesting:** New leaves grown from the center upward. Crop is ready to harvest after 18 months. The plant takes 4-5 years to reach maturity and has a life span of about 12 years.

**Anti-diabetic activity:** The increased levels of insulin observed in the study indicate that the *A. vera* gel ethanol extract stimulates insulin secretion from the remnant  $\beta$ -cells and from regenerated  $\beta$ -cells<sup>22</sup>. Effect of pseudo protinosaponin AIII and protinosaponin AIII on glucose uptake and insulin release suggested their hypoglycemic effects are due to their action on hepatic gluconeogenesis or glycogenolysis<sup>23</sup>.

### 4. Vinca rosea

**Part used:** leaves

**Cultivation and propagation.**<sup>24</sup>

**Mode of propagation:** It is propagated from seeds. **Nature of soil:** It grows on any type of soil except those which are highly alkaline/water. Light sandy soil which is rich in humans is required. **Season of sowing:** Annual rainfall of 100cm or more is ideal. **Time of harvesting:** The crop becomes ready for harvest after one year.

**Anti-diabetic property:** Administration of aqueous extracts of *V. rosea* flower and leaf has been found to regulate the blood sugar level in Alloxan diabetic male albino rats. *V. rosea* therapy not only produced blood glucose homeostasis but also reversed changes in carbohydrate, protein, lipid metabolisms and metabolic and pathologic changes that took place in pancreatic islet cells, liver and kidney following a single dose (150 mg/kg body weight) of Alloxan

monohydrate. Other study proving that *V. rosea* manifests its beneficial activity through B-cell rejuvenation, regeneration and stimulation<sup>25</sup>.

### 5. *Curcuma longa*

**Part used** - The rhizome

#### **Cultivation and propagation**<sup>26</sup>

**Mode of propagation:** Dividing the fleshy root and planting root segments. **Nature of soil:** A well-drained, slightly acidic soil with ample organic matter and will not perform well in poorly draining, alkaline sites. **Season of sowing:** It is a nine-month crop sown in July. **Time of Harvesting:** The crops are ready for harvest in seven to nine months depending upon the time of sowing. The harvest is carried out during January to March.

**Anti-diabetic activity:** Intake of *Curcuma longa* provides the hypoglycemic effect as a result of partially regeneration of  $\beta$  - islet cells, reducing the structural damage of cells and the intercellular substances, improving blood supply, resulting in stimulation of insulin and C - peptide secretion, the activation process of glycogenesis in the liver, and reducing the rate of glucose absorption in the small intestine. One of the reasons for decreasing blood glucose after ingestion of turmeric may be a reduction of the absorption rate of glucose in the gastrointestinal tract due to inhibition of the Na<sup>+</sup> -glucose co-transporter. One can suggest that turmeric can activate liver enzymes involved in glycogenesis. The curcuminoids 6-9, on erythrocytes, capillaries, and endocrinocytes, which do stabilization of structural and functional disorders of the pancreas, manifested itself in the absence of signs of stromal edema and hyper-cellularity at the periphery of the islets of Langerhans<sup>27</sup>.

**NOTE: For individual species 20x20 feet size plots can be made at the center and sideways of your garden.**

### III. CLIMBERS

#### 1. *Gymnema sylvestre*

**Part used:** Leaves

#### **Cultivation and propagation**<sup>28</sup>

**Mode of propagation:** *Gymnema sylvestre* can be propagated from seeds or cuttings. Pretreated seeds in

cold water for 24hours improve the germination. **Nature of soil:** Red sandy loam or medium deep black soil is ideal. **Season of sowing:** March and July. **Time of Harvesting:** After two- year leaves are ready for harvesting. The leaves are usually collected during October-February. Seed has to be collected between October-December.

**Anti-diabetic activity:** It is proved to increase circulating insulin and c- peptide which produces reduction in fasting and post prandial glucose. In vitro study on human pancreatic cells (beta cells) proved that aqueous extract of *Gymnema sylvestra* stimulate the secretion of insulin<sup>29</sup>.

#### 2. *Coccinia indica*

**Part used-** Fruits, leaf

#### **Cultivation and propagation**<sup>30</sup>

**Mode of propagation:** Propagation of *Coccinia indica* by seed and also vegetative via stem fragments.

**Nature of soil:** Well drained rich sandy loamy soil.

**Season of sowing:** Before rainy season (June-July) or in spring season (Feb to March). **Time of Harvesting:** After 3 months of cultivation.

**Anti-diabetic property:** The acute anti-hyperglycemic activity of Leaf extract of *C. grandis* may is due to a reduction in the absorption of glucose in the small intestine, enhancement of uptake of glucose by peripheral tissues and exhibited a remarkable reduction in the percentage of HbA1C in streptozotocin induced diabetic rats. Pancreatic  $\beta$ -cell regeneration: The extract of *C. grandis* showed  $\beta$ -cell regeneration as evident through an increase in the number of insulin secreting  $\beta$ -cells in streptozotocin induced diabetic rats<sup>31</sup>. Clinical study- clinical trial of an ingestion of a meal containing 20 g of leaves of *C. grandis* mixed with a measured amount of scraped coconut and table salt were able show acute hypoglycemic effects in a selected group of healthy subjects<sup>32</sup>.

#### 3. *Tinospora cordifolia*

**Part used:** Stem and leaf

#### **Cultivation and propagation**<sup>33</sup>

**Mode of Propagation:** Stem cuttings are the best planting material for raising commercial crop. The plant can also be raised using seeds. Seeds take almost

more than double the time to mature and yield the same quantity of drug. **Nature of soil:** Light medium sandy loam soil rich in organic matter with adequate drainage. It does not tolerate high rainfall or waterlogged conditions. **Season for propagation:** Cuttings should be sown within 24 hours of their removal from the mother plant. Meanwhile, they should be half-dipped in water vertically. The cuttings can be obtained from mother plants in June–July. **Intercropping system-** Being a large climber, it needs a host to twine and covers the host in a very short period. If the stem cuttings with aerial roots are thrown over trees, they start growing and strike roots in the ground. **Time of Harvesting:** Stem is harvested during autumn when it develops to a diameter of more than 2.5 cm.

**Anti-diabetic activity:** The isoquinoline alkaloid rich fraction from stem includes palmatine, jatrorrhizine, and magnoflorine which have been reported for insulin mimicking and insulin releasing effect<sup>34</sup>. Isoquinoline alkaloid ‘berberine’ lowers elevated glucose level as effectively as metformin. It also inhibits FOXO1, which integrates insulin signaling with mitochondrial function, thus improving hepatic metabolism during insulin resistance and metabolic syndrome<sup>35</sup>.

**NOTE:** Climber needs little space and support for its growth. This needs encouragement like pole, growing up from below (hanging), balcony etc.

## DISCUSSION

Gardening is the art of growing one of the world’s most incredible organisms i.e. plants. Health restoration with fresh medication helps to recover from the condition early; reduce the side effects of preservatives and quick action towards the condition due to the potent phyto-constituents. Gardening provides job opportunities for many employers like garden designers, gardener, groundskeepers and horticulture therapist etc. Ready recover for the cultivators and provides buy back policy for the formers. Many pharmaceutical industries inaugurated the contract farming program by giving maximized assurance to the farmer with optimum price and latest

technical knowledge to improve their productivity. And here few health improving guidelines, gardening is a healthy hobby, “Mental health gardening therapy”- gardening has been shown to improve the mental health, speed healing from substance abuse and reduce depression. Going outside and putting hands in the soil can reduce anxiety and promote positive thinking and inner tranquility. Gardening also increases the ones physical activity, sense of responsibility for another living thing-plant, connection with the earth, reminder of life cycle and sense of accomplishment.

Trees can be planted as avenue tree or surrounding corner, creepers over the fencing, shrubs as a hedge and herbs as a surface coverage of the garden.

## CONCLUSION

A diabetic patient can walk around the greens, breath fresh air, sit and eat fresh leaves and maintain health.

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