



## A REVIEW ON INDIAN HERBS USED FOR THE MANAGEMENT OF DIABETES MELLITUS

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### ABSTRACT

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. Many synthetic drugs have been developed, but still, a complete cure is not provided by any of the molecules. Continuous use of some synthetic agents causes severe side effects, and thus the demand for non-toxic, affordable drugs still persists. Traditional treatments have been an extremely valued source of medicine all over human history. 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. 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. A list of medicinal plants with proven antidiabetic and related beneficial effects and of herbal drugs used in treatment of diabetes is compiled. One of the etiologic factors implicated in the development of diabetes and its complications is the damage induced by free radicals and hence an antidiabetic compound with antioxidant properties would be more beneficial. Therefore, information on antioxidant effects of these medicinal plants is also included in this review.

**KEYWORDS:** medicinal plant, antidiabetic, antioxidant, diabetes mellitus.

### INTRODUCTION

Lifestyle Diseases also called disease of civilization or longevity. These diseases, also known as non-communicable diseases (NCDs), India has recently started observing a rise in several types of health-related issues due to lifestyle changes are not limited to adults only as kids are also getting affected nowadays. They are caused by lack of physical activity, unhealthy eating, alcohol, substance use disorders and smoking tobacco, which can lead to heart disease, stroke, obesity, type II diabetes and lung cancer. The diseases that appear to increase in frequency as countries become more industrialized and people live longer include Alzheimer's disease, arthritis, atherosclerosis, asthma, cancer, chronic liver disease or cirrhosis, chronic obstructive pulmonary disease, colitis, irritable bowel syndrome, type 2 diabetes, heart disease, hypertension, metabolic syndrome, chronic kidney failure, osteoporosis, PCOD, stroke, depression, obesity and vascular dementia.<sup>[1]</sup>

### Diabetes Mellitus

The term diabetes derived from Greek word which means rapid urination, and in 1675 scientists add the word mellitus which means the honey, So the name diabetes mellitus is mentioned in 1675. It is the

shortened version of the full name diabetes mellitus. Diabetes mellitus is derived from the Greek word diabetes meaning siphon – to pass through and the Latin word mellitus meaning honeyed or sweet. This is because in diabetes excess sugar is found in blood as well as the urine. It was known in the 17<sup>th</sup> century as the "pissing evil".<sup>[2]</sup>

The term diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both. The effects of diabetes mellitus include long - term damage, dysfunction and failure of various organs. Diabetes mellitus has several categories, including type 1, type 2, maturity-onset diabetes of the young (MODY), gestational diabetes, neonatal diabetes, and secondary causes due to endocrinopathies, steroid use, etc. The main subtypes of DM are Type 1 diabetes mellitus (T1DM) and Type 2 diabetes mellitus (T2DM), which classically result from defective insulin secretion (T1DM) and/or action (T2DM).<sup>[3-5]</sup>

**Type 1 Diabetes**

Type 1 diabetes is usually diagnosed in children and young adults. It develops when the body’s immune system destroys pancreatic beta cells, the only cells in the body that make the hormone insulin, which regulates blood glucose.

Only 5% of people with diabetes have this form of the disease. To survive, people with type 1 diabetes must have insulin delivered by injection or a pump.

**Type 2 diabetes**

Type 2 Diabetes Mellitus (T2DM) is characterized by chronically elevated blood glucose (hyperglycemia) and elevated blood insulin (hyperinsulinemia) when the

blood glucose concentration is 100 milligrams/deciliter the bloodstream of an average adult contains about 5–10 grams of glucose. It is a lifelong disease that keeps your body from using insulin the way it should. People with type 2 diabetes are said to have insulin resist. It is the most common type of diabetes. In this there are primarily two interrelated problems at work. Your pancreas does not produce enough insulin — a hormone that regulates the movement of sugar into your cells — and cells respond poorly to insulin and take in less sugar. There's no cure for type 2 diabetes, but eating well, exercising and maintain lifestyle can help you manage the disease. Type 2 diabetes can cause such health problems as heart disease, kidney disease and stroke. You can manage this disease by making lifestyle changes.<sup>[6]</sup>



Figure 01: Type 1 vs Type 2 Diabetes.

**Causes of Diabetes Mellitus<sup>[7]</sup>**

**Lifestyle**

Lifestyle is the most common causes of type 2 diabetes. You are more likely to develop type 2 diabetes if you are not physically active and are overweight or have obesity. These things are responsible for about 90% to 95% of diabetes cases in the United States.

**Genes**

Scientists have found different bits of DNA that affect how your body makes insulin.

**Extra Weight**

Being overweight or obese can cause insulin resistance, especially if you carry your extra pounds around your middle.

**Metabolic Syndrome**

People with insulin resistance often have a group of conditions including high blood sugar, extra fat around the waist, high blood pressure, and high cholesterol and triglycerides.

**Too much glucose from your liver**

When your blood sugar is low, your liver makes and sends out glucose. After you eat, your blood sugar goes up, and your liver will usually slow down and store its glucose for later. But some people's livers don't. They keep cranking out sugar.

**Bad communication between cells**

Sometimes, cells send the wrong signals or don't pick up messages correctly. When these problems affect how your cells make and use insulin or glucose, a chain reaction can lead to diabetes.

**Broken beta cells**

If the cells that make insulin send out the wrong amount of insulin at the wrong time, your blood sugar gets thrown off. High blood sugar can damage these cells, too.

**Pathophysiology of Diabetes<sup>[8]</sup>**

As we learn more about the pathophysiology of diabetes mellitus, we find that there is more yet to be discovered. Diabetes mellitus is a syndrome with disordered metabolism and inappropriate hyperglycemia due to either a deficiency of insulin secretion or to a combination of insulin resistance and inadequate insulin secretion to compensate. Type 1 diabetes is due to pancreatic islet B cell destruction predominantly by an autoimmune process, and these persons are prone to ketoacidosis. While type 2 diabetes is the more prevalent form and results from insulin resistance with a defect in compensatory insulin secretion. Diabetes can lead to serious complications, resulting in multiple diseases or disorders that affect multiple systems that may result in premature death.

**Risk factors of Diabetes Mellitus<sup>[9]</sup>**

- **Family:** If you have a parent or sibling with type 2 diabetes, your chance of developing the condition is greater. Having overweight or obesity. Weight can be a risk factor. People who have overweight or obesity are at elevated risk for developing type 2 diabetes.
- **Age:** You can develop type 2 diabetes at any age, but people over age 45 are at greater risk for type 2 diabetes.
- **Race / Ethnicity:** Type 2 diabetes is more prevalent Trusted Source in people who are African American, Hispanic/Latino, Native American, or Alaska Native, as well as for some Pacific Islanders and Asian Americans, according to the Centers for Disease Control and Prevention (CDC). Per research Trusted Source, this increased prevalence is due to a combination of factors, including access to and inequities in healthcare.

- **History of gestational diabetes:** People who develop gestational diabetes during pregnancy are more likely to go on and develop type 2 diabetes later in life. Research estimates that between 15 and 70 percent of people with gestational diabetes are more likely to eventually develop diabetes.

- **Sedentary lifestyle:** If you spend long periods of time sitting, (this does not include sleeping) this is known as a 'sedentary' lifestyle. Being sedentary is associated with an increased risk of type 2 diabetes.

**Diagnosis Methods<sup>[10]</sup>**

**A1C Test:** Type 2 diabetes is usually diagnosed using the glycated hemoglobin (A1C) test. This blood test indicates your average blood sugar level for the past two to three months. Results are interpreted as follows.

- Below 5.7% is normal.
- 5.7% to 6.4% is diagnosed as prediabetes.
- 6.5% or higher on two separate tests indicates diabetes.

**Fasting blood sugar test:** A blood sample is taken after an overnight fast. Results are interpreted as follows:

- Less than 100 mg/d is diagnosed as prediabetes.
- 126 mg/dL (7 mmol/L) or higher on two separate tests is diagnosed as diabetes.

**Oral glucose tolerance test:** This test is less commonly used than the others, except during pregnancy. You'll need to fast overnight and then drink a sugary liquid at the doctor's office. Blood sugar levels are tested periodically for the next two hours. Results are interpreted as follows:

- Less than 140 mg/dL (7.8 mmol/L) is normal.
- 140 to 199 mg/dL (7.8 mmol/L and 11.0 mmol/L) is diagnosed as prediabetes.
- 200 mg/dL (11.1 mmol/L) or higher after two hours suggests diabetes.

**Random blood sugar test:** Blood sugar values are expressed in milligrams of sugar per deciliter (mg/dL) or millimoles of sugar per liter (mmol/L) of blood. Regardless of when you last ate, a level of 200 mg/dL (11.1 mmol/L) or higher suggests diabetes, especially if you also have signs and symptoms of diabetes, such as frequent urination and extreme thirst.

**Screening:** The American Diabetes Association recommends routine screening with diagnostic tests for type 2 diabetes in all adults age 45 or older and in the following groups.

- People younger than 45 who are overweight or obese and have one or more risk factors associated with diabetes
- Women who have had gestational diabetes
- People who have been diagnosed with prediabetes
- Children who are overweight or obese and who have a family history of type 2 diabetes or other risk factors.

### Role of Traditional Medicines in Management of Diabetes Mellitus

According to the World Health Organization (WHO), up to 90% of the population in developing countries uses plants and its products as traditional medicine for primary health care. The WHO has listed 21,000 plants, which are used for medicinal purposes around the world. Among these, 2500 species are in India. There are about 800 plants which have been reported to show antidiabetic potential. A wide collection of plant-derived active principles representing numerous bioactive compounds have established their role for possible use in the treatment of diabetes. Traditional medicine has remained as the most affordable and easily accessible source of treatment in the primary healthcare system of resource poor communities in Zimbabwe. The local people have a long history of traditional plant usage for medicinal purposes. Despite the increasing acceptance of traditional medicine in Zimbabwe, this rich indigenous knowledge is not adequately documented. Documentation of plants used as traditional medicines is needed so that the knowledge can be preserved and the utilized plants conserved and used sustainably. Women number of drugs are available for the cure of diabetes, but clinical evaluation of these drugs indicates high relapse rate, side effects and drug interactions. These complications enforce for the development of new antidiabetic drugs and the search for novel molecules from the drug basket of nature, which is the herbal resources. Plants have been a valuable source of new molecules and considered as an alternative strategy in search for new drugs for numerous ailments. There are a number of plants used in traditional medicine known to possess antiulcer properties that may, after a few possible chemical modifications, provide new and improved antidiabetic agents.<sup>[11-13]</sup>

### Herbs

The word "herb" has been derived from the Latin word "herba" and an old French word "herbe" which means any part of the plant like fruit, seed, stem, bark, flower, leaf, stigma or a root, as well as a non woody plant. These plants can either be sold raw or as extracts, where the plant is macerated with water, alcohol, or other solvents to extract some of the chemicals. The resulting products contain dozens of chemicals, including fatty acids, sterols, alkaloids, flavonoids, glycosides, saponins, and others. Because any given herb contains multiple ingredients, some manufacturers attempt to create standardized herbal products by identifying a suspected active ingredient and altering the manufacturing process to obtain a consistent amount of this chemical.

**Medicinal Plant** – Archaeological evidence indicates that the use of medicinal plants dates back to the Paleolithic age approximately 60,000 years ago. Some ancient cultures wrote about plants and their medical uses in books called herbals. The earliest known Greek herbals came from Theophrastus who wrote: "Historia Plantarum" having the classification of 500 medicinal plants. The term medicinal plant include various type of

plant used in herbalism ("herbology" or "herbal medicine"). These are considered as a resources of ingredient which can be used in drug development either pharmacopoeial, non – pharmacopoeial, or synthetic drugs. These plant play a critical role in the development of human cultures around the whole world. Treatment with medicinal plants is considered very safe as there is no or minimum side effect, these remedies are in sync with nature which is the biggest advantages. The golden fact is that use of herbal treatment is independent of any age groups and the sexes. According to WHO around 21000 plants species have the potential for being used as medicinal plant.<sup>[14-17]</sup>

### Medicinal Plant in Management of Diabetes

In this modern era also 75–80% of the world populations still use herbal medicine mainly in developing countries, for primary health care because of better cultural acceptability, better compatibility with the human body, and lesser side effects. Histological studies revealed that these medicinal plants did not show any acute toxicity. Preliminary photochemical screening of this medicinal plant identified the presence of important secondary metabolites like flavonoids and tannins which are the active principles of antidiabetic activity. Present study Plants are natural antioxidants and effective herbal medicines, in part due to their anti-diabetic compounds, such as flavonoids, tannins, phenolic, and alkaloids that improve the performance of pancreatic tissues by increasing the insulin secretion or decreasing the intestinal absorption of glucose. In order to achieve this aim, Indian ayurvedic book *Materia Medica* and electronic databases including science direct, pubmed, scopus, and google scholar were explored for each of the medicinal plants for diabetics and all retrieved articles were evaluated to achieve any in vitro, in vivo, or clinical evidence for their efficacy and possible mechanisms. The retrieved studies either demonstrate obviously effectiveness of these herbs or indirectly their efficacy on the involved mechanisms in the treatment of diabetes. *Materia Medica* provides lots of information about ethno medicinal herbs, which are valuable as antidiabetic agents and their use experimentally was evaluated and proved by many researchers for its antidiabetic activity. Following compiled data suggested that medicinal plant those are evidently reported for its antidiabetic activity.<sup>[18-19]</sup>

Such medicinal plant which have antidiabetic activity are as follows.

#### 1. Vinca

**Synonyms:** Periwinkle, sadabahar.

**Biological source:** obtain from dried whole plant of *Catharanthus roseus*.

**Family:** Apocynaceae.

**Chemical constituents:** Vincristine, vinblastine etc.

**Antidiabetic activity:** *roseus* are used traditionally by diabetic patients in India and are taken as water decoction. *Vinca rosea* whole plant alcoholic extracts has been shown to act by  $\beta$  cell regeneration. Alcoholic

extracts of *Vinca rosea* exhibited significant anti-hyperglycemic activities in alloxan-induced hyperglycemic without significant change in body weight; they can also improve the condition of Diabetic mellitus as indicated by parameters like body weight & lipid.

**How to use:** The fresh leaves of sadabahar can be dried, powdered and stored in an air-tight container. Consume one teaspoon of this dried leaf powder with a cupful of fresh fruit juice or water daily. The powder may taste bitter. Take not more than three to four leaves of the plant and chew them to manage blood sugar levels through the day. Take the pink coloured flowers of the sadabahar plant and boil them in a cupful of water. Strain the water and drink it every morning on an empty stomach.<sup>[20]</sup>

## 2. *Syzygiumcumini*

**Synonyms:** Malabar plum, java plum, black plum, jamun jambul, jambolan.

**Biological source:** obtain from ripe fruits of *syzygiumcumini*.

**Family:** Myrtaceae.

**Chemical constituents:** Anthocyanins.

**Antidiabetic activity:** Antidiabetic effect of Jamun has been indicated in Ayurvedic pharmacopeia, which states that the seed powder of Jamun is effective in controlling high blood sugar levels. Jamun has been used to control blood sugar levels for more than 130 years in West however, clinical studies are mixed results.

**How to use:** Dried jamun seeds can be powdered and consumed with warm milk and water. This drink can be consumed before meals for managing blood sugar levels.

## 3. *Neem*

**Synonyms:** Margosa

**Biological Name:** obtain from fresh or dried leaves and seeds oil of *Azadirachta indica*.

**Family:** meliaceae.

**Chemical Constituents:** Azadirachtin, Meliantriol, Salanin, Nimbin, Nimbidin, Nimbosterol, Myricitin, Kaempferol, Nimbinin, Margolonone, Margoloneetc.

**Antidiabetic activity:** *Azadirachta indica* (Neem) is a medicinal plant, used in Ayurveda for treating various diseases, one of which is diabetes mellitus. The bitter leaf of neem is an effective remedy for treating diabetes as they are loaded with flavonoids, triterpenoid, anti-viral compounds and glycosides.

**How to use:** Boil about 20 neem leaves in half a litre of water for about 5 minutes. You would see that the leaves have begun to appear soft. The water will gradually turn deep green in colour. Strain and store this water in a container. Drink this decoction at least twice.<sup>[21]</sup>

## 4. *Acacia*

**Synonyms:** Gum acacia, Gum arabica, indian gum.

**Biological source:** obtain from dried gummy exudation the stem and branches of wild acacia arabica.

**Family:** Leguminosae

**Chemical constituents:** Arabin,enzyme oxidase.

**Antidiabetic activity:** *Acacia arabica* is used traditionally to treat a variety of ailments, including diabetes. *Acacia Arabica* extract has hypoglycemic, hypolipidemic, and antioxidant properties, therefore, it can be investigated for its efficacy in the treatment of diabetes in humans. The gum is actively used as a dietary supplement for diabetes treatment in Ayurvedic medicine. Fruits reduce the blood glucose level. Several parts of *A. arabica* have been studied for hypoglycaemic effects.<sup>[22]</sup>

## 5. *Bael (Wood apple)*

**Synonyms:** Bael fruits, indianbael, bengal quince.

**Biological source:** Obtain from unripe or half ripe fruits of the plant *Aegle marmelos*.

**Family:** Rutaceae

**Chemical constituents:** Marmelosin, furocoumarin etc.

**Antidiabetic activity:** *Aegle marmelos* (the bael tree) is a popular medicinal plant in the Ayurveda and Siddha systems of medicine and folk medicines used to treat diabetes. It exhibits antidiabetic, antihyperlipidaemic and antioxidant properties. *A. marmelos* extracts from calluses are more effective than those from ordinary leaf material in the management of diabetes.

**How to use:** Bael leaves juice can be extracted by mixing them with little water in the blender. This juice is more effective if taken with a pinch of pepper. You can also chew both bael and tulsi leaves together to help keep diabetes and cholesterol in control. Bael fruits or leaves should be avoided during pregnancy.<sup>[23]</sup>

## 6. *Fenugreek*

**Synonyms:** Methi

**Biological source:** Obtain from dried leaflets and ripe dried seeds of cultivated plants *Trigonella foenum – graecum* Linn.

**Family:** Fabaceae

**Chemical constituents:** Mucilage, trigonelline, choline.

**Antidiabetic activity:** Research in the past two decades has shown that Fenugreek seeds help to lower blood glucose in patients with diabetes. Its role as an antidiabetic, by reducing fasting blood glucose levels and improved glucose tolerance in human subjects was reported. The seeds contain fiber and other chemicals that may slow digestion and the body's absorption of carbohydrates and sugar. The seeds may also help improve how the body uses sugar and increases the amount of insulin released.

**How to use:** Two tablespoons of fenugreek seeds boiled in a cup of water for about ten minutes can be taken as a tea twice a day. For people who do not like the taste of fenugreek seeds, capsules can be a better alternative. The recommended dosage for fenugreek seeds to lower blood glucose level is between 2.5-15 grams daily.<sup>[24]</sup>

## 7. *Garlic*

**Synonyms:** Allium

**Biological source:** It is obtained from bulb of the plant *Allium sativum* Linn.

**Family:** Liliaceae

**Chemical constituents:** Alliin, Allicin etc.

**Antidiabetic activity:** Garlic, *Allium sativum* L., Liliaceae, a popular cooking spice with a long history as traditional medicine, has been demonstrated to exhibit antidiabetic properties. Garlic is a rich natural source of bioactive sulfur-containing compounds with potential antidiabetic properties. Oral administrations of the garlic extract significantly decreased serum glucose, total cholesterol, triglycerides, urea, uric acid, creatinine, AST and ALT levels.

**How to use:** You can chop them and mix them in salads, dips, and savory spreads. It's recommended that you let chopped garlic sit for at least 5 minutes to allow allicin, one of the herb's main components, to be at its highest concentration. This may enhance the herb's potential health benefits.<sup>[25]</sup>

## 8. Aloes

**Synonyms:** Aloe, Musabber, Kumari

**Biological source:** obtain from the dried juice of leaves of the aloe species – *Aloe barbadensis* (Curacao aloe), *Aloe xerox*, *Aloe spicata* (cape aloe), *Aloe perryi* (socotrine aloe), *Aloe vera* (indian aloe).

**Family:** Liliaceae

**Chemical constituents:** Aloin – Barbaloin, B-barbaloin, isobarbaloin.

**Antidiabetic activity:** The effect of *Aloe vera* juice in combination with glibenclamide was investigated in diabetic patients. There was no response to glibenclamide alone but *Aloe vera* juice significantly reduced levels of fasting blood glucose within two weeks and of triglycerides within four weeks.

**How to use:** Ingesting two tablespoons of aloe vera juice per day can cause blood sugar levels to fall in people with type 2 diabetes.<sup>[26]</sup>

## 9. Mango

**Synonyms:** *Mangifera indica*

**Biological source:** obtain from dried ripe fruits of *mangifera indica*.

**Family:** Anacardiaceae.

**Chemical constituents:** Lysine, leusin, cystein, valine, argenine, phenylalanine, methionine etc.

**Antidiabetic activity:** Various phytochemicals present in mango leaves are thought to be responsible for its anti-hyperglycemia activity. Previously, it was shown that foliamangiferosides such as mangiferin had exerted their antidiabetic effect through increasing insulin sensitivity and inhibiting alpha-glucosidase activity. Iriflophenone 3-C-β-D-glucoside has also been reported to exhibit antidiabetic potential.

**How to use:** You need to follow a very simple method to use mango leaves for diabetes. All you need to do is take 10-15 mango leaves and boil them in water properly. After boiling the leaves properly, leave them overnight. Strain the water and drink it as the first thing in the morning on an empty stomach.<sup>[27]</sup>

## 10. Tulsi

**Synonyms:** Sacred basil, Holy basil.

**Biological source:** Obtain from fresh and dried leaves of *Ocimum Sanctum* Linn.

**Family:** Lamiaceae

**Chemical constituents:** Eugenol, Carvacrol, eugenol - methyl-ether.

**Antidiabetic activity:** *Ocimum sanctum* leaves have been traditionally used in treatment of diabetes mellitus. Tulsi is packed with many anti-inflammatory properties which makes it beneficial to manage diabetes-related ailments such as obesity. Dietary supplementation of fresh tulsi leaves in a dose of 2 gm/kg BW for 30 days led to significant lowering of blood glucose levels.

**How to use:** You can chew some tulsi leaves every day in order to soak all the goodness from them. You could also make some tulsi tea by adding a few leaves in boiling water. After about two- three minutes, strain the water and drink a cupful every day. One of the best and easiest ways to consume tulsi is by adding it to your tea. Add tulsi leaves in water and bring it to boil. Have the tea by adding more herbs and flavour as per your choice. The best part about this tea is that it is caffeine-free and also benefits people who have high blood sugar levels.<sup>[28]</sup>

## 11. Guar gum

**Synonyms:** Guar flour, jaguar gum

**Biological source:** Obtain from the powder of the endosperm of the seeds of *Cyamopsis tetragonolobus* linn.

**Family:** Leguminosae

**Chemical constituents:** guaran, mannose, galactose, protein etc.

**Antidiabetic activity:** The administration of 20% guar gum in the daily diet reduced the fasting blood glucose by 44.2% by the fourth week. Guar gum effectively lowers fasting plasma glucose and HbA1c levels in subjects with NIDDM. It is high in soluble fiber which prevents the absorption of excess sugar and results in reduced blood sugar levels. In a study, diabetic patients were given Guar Gum for 6 days 4 times a day.

## 12. Hibiscus rosa

**Synonyms:** chinase hibiscus, China rose, hawaiian hibiscus, rose mallow,

**Biological source:** obtain from flower of *hibiscus rosa sinensis*.

**Family:** malvaceae

**Chemical constituents:** Quercetin, beta-sitosterol, orientin etc

**Antidiabetic activity:** The ethanol extract of flowers of *Hibiscus rosasinensis* at doses of 250 mg/kg and 500 mg/kg significantly reduced the blood glucose level in both acute (1, 3, 5 h) and sub acute (1, 3, 5, 7 days) treatments.

**How to use:** Hibiscus is very useful in treatment of diabetes. You can make Hibiscus tea and consume it every day to control your diabetes.<sup>[29]</sup>

### 13. Honey

**Synonyms:** Madhu, Honey purified, Mel.

**Biological source:** Honey is a sugar secretion deposited in honey comb by the bees, *Apis mellifera*, *Apis dorsata*, and other species of *Apis*.

**Family:** Apidae

**Chemical constituents:** Glucose, fructose, sucrose, etc.

**Antidiabetic activity:** A number of oligosaccharides present in honey might play a role in the antidiabetic effect of honey. Honey significantly increased insulin ( $0.41 \pm 0.06$  ng/ml), decreased hyperglycemia ( $12.3 \pm 3.1$  mmol/L), and fructosamine ( $304.5 \pm 10.1$   $\mu$ mol/L).

### 14. Guava

**Synonyms:** *Psidium guajava*

**Biological source:** Obtain from small tropical tree of shrub of the *psidium guajava*.

**Family:** Myrtaceae

**Chemical constituents:** oleanolic acid, ursolic acid, beta-sitosterol, guajanoic acid etc.

**Antidiabetic activity:** It have reported the effects of the aqueous extract from guava leaves on type 2 diabetic. the extract significantly reduced blood glucose level, increased plasma insulin level in an oral glucose tolerance test, and stimulated activities of some glucose metabolic enzymes.

**How to use:** the best way to consume a guava for diabetics is to peel off its skin." The study says: "Though the guava is known to contain free sugars, the fruit extract showed hypoglycaemic effect in mice. One can eat 1-2 guavas anytime in the day except for early morning, night, and just before an empty stomach."<sup>[30]</sup>

### 15. Allium cepa

**Synonyms:** onion, bulb onion

**Biological source:** obtain from bulb of the *allium cepa*.

**Family:** Alliaceae

**Chemical constituents:** Allicin, quercetin, fisetin, diallyl disulphide, diallyl trisulphide etc.

**Antidiabetic activity:** it reduced fasting blood glucose levels by 40 mg/dl, compared to glibenclamide (81 mg/dl) in type 2 diabetic patients, 4 hours later. Reduced GTT by 159 mg/dl in relation to water (55 mg/dl) and glibenclamide (114 mg/dl) in type 2 diabetic patients.

**How to use:** consumption of fresh onions reduced blood glucose levels among type-1 and type-2 diabetics. You can add onions to soups, stews, salads and sandwiches.<sup>[31]</sup>

### 16. Moringa oleifera

**Synonyms:** Moranga, drumstick tree, horseradish tree, Ben oil tree, benzlive tree.

**Biological source:** obtained from seed pods of *moringa oleifera*.

**Family:** Moringaceae.

**Chemical constituents:** Chlorogenic acid, kaempferol, Niazirin, beta-kerotin, beta sitosterol, quercetin.

**Antidiabetic activity:** The antidiabetic activity of Moringa seed powder has been observed in with the decreased glucose and the amelioration of levels of lipid

peroxide, the diminish levels of IL6, and immunoglobulins A in comparison with diabetic positive control in both insulin resistant and insulin deficient bioassays. Moringa leaves have Quercetin which is an antioxidant that helps to lower blood pressure and another antioxidant is Chlorogenic acid which stabilizes blood sugar levels. The Chlorogenic acid found in moringa may help the body process sugar better and affect insulin too.<sup>[32]</sup>

### 17. Papain

**Synonyms:** Papaya.

**Biological source:** Obtain from the latex of unripe fruit of tropical melon tree, *Carica papaya*.

**Family:** Caricaceae.

**Chemical constituents:** the most effective dose for *Carica papaya* for antidiabetic was 1000 mg/kg body weight. The antidiabetic activity of papaya leaf ethanol extract and glibenclamide reduce occurred because of chemical substances contained within the leaf that worked synergically in reducing blood glucose levels.

**How to use:** papaya can be taken as such as the ripe fruit, or added to fruit salads, squeezed into a juice and made into smoothies, to obtain the wealth of essential nutrients from the fruit, as well as effectively manage diabetes.<sup>[33]</sup>

### 18. Momordica

**Synonyms:** Bitter gourd, Karela, Bitter melon.

**Biological source:** obtain from fresh green fruits of the plant *momordica charantia*.

**Family:** Cucurbitaceae

**Chemical constituents:** Charantin, momordicin, etc

**Antidiabetic activity:** *M. charantia* has significant antidiabetic as well as hypolipidemic activity so that it can be used as an adjuvant along with allopathic treatment of medicine to treat diabetes as well as to delay the late complications of diabetes.

**How to use:** Anyone considering taking bitter melon alongside their diabetes treatment should consume no more than.

- 50–100 milliliters daily of juice.
- About 2–3 ounces throughout the day.
- One small bitter melon per day.
- The amount of supplement a doctor advises.<sup>[34]</sup>

### 19. Ginseng

**Synonyms:** Ninjin, Pannag, Panax.

**Biological source:** obtain from dried root of various species of panax, *p.ginseng* (korean ginseng), *p.japonica* (japanese ginseng), *p. notoginseng* (chinese ginseng), *p. quinquefolium* (American ginseng).

**Family:** Araliaceae.

**Chemical constituents:** Ginsenosides, Panaxosides, Chikusetsusaponin..

**Antidiabetic activity:** Ginseng is a medicinal plant that may help a person manage type 2 diabetes. The plant contains active components known as ginsenosides that may stabilize insulin and glucagon to help maintain optimal blood glucose levels. Asian ginseng and

American ginseng do indeed decrease blood glucose in type 2 diabetics.

**How to use:** The root of the ginseng plant has been used for thousands of years in traditional Eastern medicine. It can be eaten raw or you can lightly steam it to soften it. It can also be stewed in water to make a tea. To do this, just add hot water to freshly sliced ginseng and let it steep for several minutes. Ginseng can be added to various recipes like soups and stir-frys, too.<sup>[35]</sup>

## 20. Bromelin

**Synonyms:** Pineapple, ananas comosus

**Biological source:** Bromelin is a mixture of proteolytic enzyme from the stem and ripe fruits of pineapple plant *Ananas comosus*.

**Family:** Bromeliaceae

**Chemical constituents:** Bromelin

**Antidiabetic activity:** Pineapple is a good source of vitamin C and manganese. It also contains fiber, vitamin A and B vitamins, as well as a compound called bromelain, which has many reported health benefits. These factors make pineapple a healthful addition to a diabetes-friendly diet. *Ananas comosus* leaves extract possesses significant antidiabetic activity which in turn is partially due to its antioxidant nature.

**How to use:** It is found in pineapple juice and in the pineapple stem. Take Bromelain when you first wake up in the morning, between meals, and/or just before bedtime. It must be taken on an empty stomach, which means two hours after your last food intake, which means two hours after your last food intake. You may have food 30 minutes after taking Bromelain.<sup>[36]</sup>

## 21. Cabbage

**Synonyms:** Broccoli, savoy, colewort.

**Biological source:** originated from the wild cabbage (*B. oleracea* var. *oleracea*)

**Family:** Brassicaceae

**Chemical constituents:** Lysophosphatidic acid.

**Antidiabetic activity:** Cabbage extract exhibited lowering effect on blood sugar level and also reduced resistance of the cells to insulin meaning that the uptake of glucose by the cells was improved by the cabbage extracts. Cabbage extract exhibited lowering effect on blood sugar level and also reduced resistance of the cells to insulin meaning that the uptake of glucose by the cells was improved by the cabbage extracts.

**How to use:** A cup of chopped, green, raw cabbage has 5 g of carbs, according to the USDA. Eating this vegetable is an inexpensive way to add vitamin C (32.6 mg, or 37 percent of the DV) and vitamin K (67.6 micrograms, or about 56 percent of the DV) to your diabetes-friendly diet. Sauté cabbage into your next healthy stir-fry.<sup>[37]</sup>

## 22. Solanum nigrum

**Synonyms:** makoi, black, nightshade, berries.

**Biological source:** obtain from the small rounded berry fruits of *solanum nigrum*.

**Family:** solanaceae.

**Chemical constituents:** Galic acid, chebulinic acid, lucilage, sorbitol etc.

**Antidiabetic activity:** Aqueous extract of *Solanum nigrum* Linn berries in the dose of 200 mg/kg/day produced significant blood glucose reduction ( $p < 0.01$ ) from day 7 and 400 mg/kg/day produced highly significant reduction in blood glucose from day 7 ( $p < 0.001$ ).

## 23. Brahmi

**Synonyms:** Bacopa.

**Biological source:** obtain from fresh leaves and the stems of plant as *Becopamoniera*.

**Family:** Scrophulariaceae.

**Chemical constituents:** Herpestine, Becoside A and B, betulic acid, stigmaterol, monnierin etc.

**Antidiabetic activity:** The efficacy of Brahmi in maintaining normal levels of glycosylated haemoglobin is indicative of good control over blood glucose levels.

**How to use:** It is safe to consume 2 – 3 grams of Brahmi powder daily along with meals. The decoction of brahmi powder in boiled water can be ingested at a dose of 25 – 50 ml per day for adults.<sup>[38]</sup>

## 24. Coconut oil

**Synonyms:** Copra oil

**Biological source:** Obtain from dried kernels of the *cocus nucifera*.

**Family:** Palmae.

**Chemical constituents:** Trimyristine, triaurin, tripalmetin, tristearin, glycerides etc.

**Antidiabetic activity:** Some evidence suggests coconut oil could be beneficial for type 2 diabetes. Virgin coconut oil possesses antidiabetic effect either alone or in combination with metformin in an animal model of type II diabetes mellitus. It improves the undesirable impact of diabetes on both liver and kidney.

### How to use

- Addition to smoothies.
- Stir-frying.
- Used to cooking, grilling and baking.
- Pre-workout drinks like Bullet coffee or tea.
- Salad Dressing – as an emulsion or just oil dressing.<sup>[39]</sup>

## 25. Yasti

**Synonyms:** Glycyrrhiza, Liquorice root, Glycyrrhizae radix, Mulethi

**Biological source:** Obtain from the dried unpeeled, roots and stolons of *glycyrrhiza glabra* linn.

**Family:** Leguminosae

**Chemical constituents:** Glycyrrhizin, Glycyrrhetic acid, Liquiritin, isoliquiritin etc.

**Antidiabetic activity:** It is cited as belonging to plants that reduce blood sugar levels. Liquorice can help to treat diabetes. It possesses hypoglycaemic properties and its consumption helps in lowering glucose or sugar in blood.

Alpha amylase method is used to demonstrate the Anti-diabetic activity.

**How to use:** Add one teaspoon of dried licorice root to the boiling water and let it steep for 3-4 minutes. Strain and pour in the cup. You can also add cinnamon to the tea, if you wish to. Cinnamon is also dense with potent anti-diabetic effects. But, make sure you do not have more than 2-3 cups of these a day.<sup>[40]</sup>

## 26. Cinnamon

**Synonyms:** Dalchini

**Biological source:** obtained from dried stem outer bark of plant *cinnamomum cassia* (Chinese cinnamon) and dried inner bark of the shoots of coppiced tree *cinnamomum zeylanicum* (Ceylon cinnamon).

**Family:** Lauraceae.

**Chemical constituents:** Cinnamaldehyde, Eugenol.

**Antidiabetic activity:** administration of 1 g of cinnamon powder for 12 weeks reduces fasting blood glucose and glycosylated Hb among poorly controlled type 2 diabetes patients.

### How to use

Drink Cinnamon Water. The best way to consume cinnamon for diabetes is to drink water infused with the spice.

- Replace Sugar With Cinnamon
- .Drink Cinnamon Tea Or Coffee.
- Add Cinnamon To Your Oatmeal.
- add It to Indian Curries.<sup>[41]</sup>

## 27. Ladies finger

**Synonyms:** Okra plant, gumbo, *abelmoschus esculentus*, *hibiscus esculentus*.

**Biological source:** obtained from unripe fruits of *Abelmoschus esculentus*.

**Family:** Malvaceae

**Chemical constituents:** carotene, folic acid, thamine, riboflavin, niacin, vitamin c, oxalic acid, aminoacid etc.

**Antidiabetic activity:** Ladies' fingers are a healthy green vegetable. It has several health benefits due to its superior fibre and mucilage content. These properties of ladyfinger regulate the blood sugar level in a diabetic patient by controlling the rate at which blood glucose is absorbed from his intestinal tract.

**How to use:** Drinking "okra water" is a popular new method of using okra. Some have even suggested that drinking it helps lessen diabetes symptoms. The drink is made by putting okra pods in water and soaking them overnight. Some of the valuable nutrients in the skin and seed pods will be absorbed into the water.<sup>[42]</sup>

## 28. Gudmar

**Synonyms:** *Gymnema*, madhunashini

**Biological source:** obtained from the leaves of a perennial woody climber plant known as *GymnemaSylvestre*.

**Family:** Asclepiadaceae

**Chemical constituents:** Pentriacontane, hentriacontane, phytin, alpha and beta chlorophylls, resin, tartaric acid, formic acid, butyric acid mucilage inositol, d- quercitol, gymnemic acid etc.

**Antidiabetic activity:** *Gymnemasylvestre* is traditionally consumed as a tea or by chewing its leaves. In Western medicine, it's typically taken in pill or tablet form, making it easier to control and monitor dosage. It can also be ingested in extract or leaf powder form. Saponins regulate plasma glucose levels and prevent diabetic complications due to its antioxidant activity. Use of such antioxidants can also be used for management of noninsulin dependent diabetes mellitus by inhibiting  $\alpha$ -glucosidase and  $\alpha$ -amylase activity.

**How to use:** You can also take Gudmar (Gurmar) churna or kwatha with water to help manage cholesterol by reducing the levels of bad cholesterol (LDL) and increasing good cholesterol (HDL).

1. GudmarChurna
  - a. Take ¼ - ½ teaspoon of Gudmar(Meshashringi) Churna.
  - b. Swallow it with water after lunch and dinner.
2. Gudmar Capsule
  - a. Take 1-2 capsules of Gudmar.
  - b. Swallow it with water after meals twice a day.
3. Gudmar Tablets
  - a. Take 1-2 tablets of Gudmar.
  - b. Swallow it with water after meals twice a day.
4. GudmarKwatha
  - a. Take 4-5 teaspoon of GudmarKwatha.
  - b. Add same quantity of water to it and drink before food once a day.<sup>[43]</sup>

## 29. Clove

**Synonyms:** *Caryophyllum*.

**Biological source:** obtained from dried closed flower buds of *Eugenia Caryophyllus*.

**Family:** Myrtaceae

**Chemical constituents:** Eugenol, gallotannic acid, caryophyllenes, Eugenol acetate.

**Antidiabetic activity:** Clove (*Syzygiumaromaticum* flower buds) EtOH extract significantly suppressed an increase in blood glucose level in type 2 diabetic KK-A(y). In-vitro evaluation showed the extract had human peroxisome proliferator-activated receptor (PPAR)- $\gamma$  ligand-binding activity in a GAL4-PPAR- $\gamma$  chimera.

**How to use:** clove bud essential oil could play a role in preventing or managing type 2 diabetes.

Intake of 1 to 3 grams of cloves per day lowered risk factors of diabetes without changing HDL concentration suggest strongly that cloves are beneficial for people with type 2 diabetes.<sup>[44]</sup>

## 30. Salvia officinalis

**Synonyms:** Culinary sage, garden sage.

**Biological source:** It is a aromatic plant rather woody perennial shrub obtained from *salvia officinalis*

**Family:** Lamiaceae

**Chemical constituents:** alpha – thujone, beta- thujone, 1,8 – cineole, champhor, beta – caryophyllene etc.

**Antidiabetic activity:** Oral administration of 0.2 and 0.4 g/kg body wt. of the sage extract for 14 days exhibited a significant reduction in serum glucose, triglycerides, total cholesterol, urea, uric acid, creatinine, AST, ALT and increased plasma insulin in streptozotocin-induced diabetic.

**How to use:** It's a hearty herb with thick, almost fuzzy leaves, so, unlike many other herbs, it's usually not sprinkled fresh onto finished foods. Rather, it's generally chopped into a fine mince or ribbons and incorporated into dishes during cooking, or occasionally fried as whole leaves until crisp and used as a garnish. Sage tea. Sage has shown to have the ability to boost insulin activity in diabetics. All you need to do is simply pour a cupful of boiling water over a tablespoon of sage leaves and steep to the desired strength before straining out the leaves. Drinking sage tea in the morning could be more effective.<sup>[45]</sup>

### 31. Stevia

**Synonyms:** candy leaf, sweet honey leaf, sugar leaf.

**Biological Source:** Obtained from dried root and leaves of plant *stevia rebaudiana*.

**Family:** Asteraceae.

**chemical constituents:** stevioside, rebaudioside -A, rebaudioside-B, dulcoside -A etc.

**Antidiabetic activity:** Stevia is full of many important phytochemicals (Steviol, Steviosides, rebaudiosides, etc.) that have properties to reduce blood sugar levels. It possesses high anti-hyperglycemic activity and serves as a substituent for saccharose in diabetes patients. Stevia stimulates a protein that is essential for our perception of taste and is involved in the release of insulin after a meal. These results create new possibilities for the treatment of diabetes. One of the most important biological effects of stevia is opening calcium channels in pancreatic beta cells mediated by the active constituent of *S. rebaudiana*, steviol. This stimulates insulin secretion in response to glucose.

**How to use:** Using stevia in place of sugar in sweetened foods and drinks may help people with diabetes stabilize their blood glucose levels. This replacement for sugar may also reduce the number of calories that a person consumes, which is likely to aid weight loss. Baking with stevia can be tricky. Because it doesn't have the same chemical properties as sugar, it won't give cakes, cookies, and breads the right texture. Try experimenting with proportions or extra ingredients. For example, adding whipped egg whites to a cake batter or extra baking powder and baking soda to a quick bread dough will help them rise.

### 32. Cucumber

**Synonyms:** *cucumis sativus*

**Biological source:** Obtained from creeping vine plant that bears usually cylindrical fruits of *cucumis sativus*.

**Family:** Cucurbitaceae.

**Chemical constituents:** water, protein, lipid, carbohydrates etc.

**Antidiabetic activity:** It has been exhibited that cucumber contains Hypoglycemic and Hypolipidemic activity; the extract decreased blood glucose level by 67%, reduced low-density lipoproteins level by 87%, and reduced the overall cholesterol level to 29%; besides, *Cucumis sativus* reduced triglycerides levels to 72% with significant...

**How to use:** if you have diabetes you can eat cucumber.

### 33. Haldi

**Synonyms:** indian saffron, curuma, turmeric.

**Biological source:** Obtained from dried as well as fresh rhizome of the plant as *curcuma longa* Linn.

**Family:** Zingiberaceae

**Chemical constituents:** Curcuminoids, de-methoxy curcumin, Bis-de-methoxy curcumin etc

**Antidiabetic activity:** Turmeric extracts showed improved beta-cell function, insulin sensitivity and decreased insulin resistance. BTE-30 had more pancreatic bioavailability of curcumin than RTE-30. Effective doses appear to range from 1,000 to 2,000 mg per day.

**How to use:** One of the simple ways that can help you fight against diabetes is Turmeric Milk. For the same, boil milk and then add turmeric in it. Let it simmer and once done, have it warm in the morning. Add it to scrambles and frittatas. Use a pinch of turmeric in scrambled eggs, a frittata, or tofu scramble. ...

- Toss it with roasted vegetables. ...
- Add it to rice. ...
- Try it with greens. ...
- Use it in soups. ...
- Blend it into a smoothie. ...
- Make tea.<sup>[46]</sup>

### 34. Dill

**Synonyms:** sowa

**Biological source:** Obtained from dried fruits of *Anethum graveolens*.

**Family:** Umabelliferae

**Chemical constituents:** Carvone, Limonene etc.

**Antidiabetic activity:** administration of DT significantly reduced blood glucose and AGEs formation in diabetic rats. Mobasser et al. reported that dill has useful effects on insulin sensitivity and also normalized lipid profiles in diabetic patients.

**How to use:** if you have diabetes and use dill extract in amounts larger than the amounts normally found in food. Use it as a garnish for soups or roasted vegetables.

- Sprinkle it on top of cold cucumber salads.
- Use it in potato salads or on baked or roasted potatoes.
- Place it over gravlax.
- Stir it into yogurt-based dips like tzatziki.
- Chop and add it to salads.

- Use it to add flavor to fish, lamb, or egg dishes.<sup>[47]</sup>

### 35. Fennel

**Synonyms:** saunf

**Biological source:** Obtained from dried fruits of plant *Foeniculum vulgare*.

**Family:** Umabelliferae

**Chemical constituents:** Anethole, Fenchone, phellandrene, Limonene etc.

**Antidiabetic activity:** *F. vulgare*, it is also traditionally recommended for diabetes, *F. vulgare* essential oil corrected hyperglycemia, Fennel seeds have alleviated diabetic properties which helps in fighting against diabetes. Due to its high source of nutrients like vitamin C and Potassium, it helps in lowering the blood sugar levels and also helps to increase insulin reactivity resulting in balancing the sugar.

**How to use:** Crush or grind whole fennels seeds just before you add them to your cooking or tea..Add toasted fennel seeds to dishes to give them a sweet, licorice flavor.Make a simple tea by crushing a spoonful of fennel seeds and pouring hot water over them.Add a tablespoon of the seeds to batter for baked goods.<sup>[48]</sup>

### CONCLUSION

Herbs are a growing part of modern and high-tech medicines. The World Health Organization (WHO) has listed a total of 21,000 plants, which are used for medicinal purposes around the world. Among them, more than 400 plants are available for the treatment of diabetes. Despite the fact that there are many herbal drugs available for treating diabetes, only a small number of these plants have undergone scientific and medical evaluation to assess their efficacy. The presence of phenolic compounds, flavonoids, terpenoids, and coumarins is responsible for the antidiabetic nature of the medicinal plants. These constituents have shown a reduction in blood glucose levels. The active principles derived from the plants work through many antidiabetic mechanisms, which include inhibition of  $\alpha$ -glucosidase,  $\alpha$ -amylase, and protein tyrosine phosphatase 1B activities. One of the major advantages of herbal drugs is the low level of side effects attributed to these medicines, and this attracted various researchers to develop new molecules for the treatment of diabetes. In this review, recent advances in the field of herbal drugs to treat diabetes, prevent secondary complications from arising due to diabetes, and various herbal molecules in different stages of clinical trials will be emphasized upon.

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