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Herbs and Botanical Ingredients with Beneficial Effects on Blood Sugar Levels in Pre-diabetes

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Abstract

Pre-diabetes is a condition with 'impaired glucose tolerance'. Majority of the cases suffering from pre-diabetes, if not attended, develop type-2 diabetes and type-1 diabetes over time. However, it is possible to halt or reverse the progression of pre-diabetes, or at least delay the development of diabetes by the use of herbs and botanical ingredients which regulate blood sugar levels. Active lifestyle and intake of diabetes preventing herbs can offer pre-diabetics a healthy life. This review summarizes diabetes preventing herbs and botanical ingredients which helps to prevent progression to diabetes without having the side effects to the body unlike the chemicals.

Keywords: Medicinal plants; Pre-diabetes; Herbs; Blood sugar; Insulin

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Introduction

The health condition in which the level of blood sugar is higher than normal but is not high enough to be categorized as diabetes is medically termed as pre-diabetes. 'Impaired glucose tolerance' is another term to describe the same condition. Prediabetes is considered to be an at risk state, with high chances of developing diabetes. While, prediabetes is commonly an asymptomatic condition, there is always presence of prediabetes before the onset of diabetes. The elevation of blood sugar is a continuum and hence prediabetes cannot be considered an entirely benign condition. Although most people with prediabetes have no symptoms, one might notice extra thirst, peeing a lot more, having blurred vision or extreme fatigue in the prediabetes conditions. Prediabetic condition can be diagnosed by performing one of three different blood tests, the fasting plasma glucose test, the oral glucose tolerance test, or the hemoglobin A1c test.

Pre-diabetes is a condition that affects a significant number of people across the whole globe. Latest research shows that, more than 470 million people will be affected by the condition by 2030 [1]. Majority of the cases suffering from pre-diabetes, if left unattended, develop type-2 diabetes and type-1 diabetes over time. However, it is possible to halt or reverse the progression of pre-diabetes, or at least delay the development of diabetes. People with pre-diabetes are often deficient in vitamins and nutrients that are needed to help the body function properly. Studies have shown that most pre-diabetics are vitamin D deficient. Supplementing with vitamin D can help ensure calcium absorption in the body and can also help control high blood pressure, obesity and diabetes.

There has been a great deal of research surrounding diabetes over the years, due to the fact that there are a large number of sufferers worldwide [2]. Patients often struggle to make the necessary lifestyle changes to control blood sugar levels, and current medications have limitations and can have adverse gastrointestinal side effects. Clinical studies and research have often recommended the use of natural or herbal cure for diabetes, rather than relying solely on drugs. Traditional herbs may offer a new option for managing blood sugar levels, either alone or in combination with other treatments. Some of the important herbs in this row include the following.

Banaba (*Lagerstroemia speciosa*)

It is commonly called as Queen's flower **(Figure 1),** pride of India, giant crape-myrtle or queen's crape-myrtle. It belongs to the family Loosestrife. Queen's flower is a deciduous tropical flowering tree growing up to 50 ft. tall, it has smooth rounded, red-orange leaves having higher levels of corosolic acid [3]. It lowers blood sugar levels (hypoglycemic effect), facilitates glucose transport into cells and reduces amount of triglycerides. Tea of the leaves is used against diabetes mellitus and for weight loss. Banaba leaves are able to lower blood sugar due to acid (triterpenoid glycoside)

and other phytochemicals. The phytochemicals in the leaves of banaba works at the molecular level by fine-tuning the damaged insulin receptor, which is the cause of insulin resistance.

Glucose uptake-inducing activity of banaba extract was investigated in differentiated adipocytes using a radioactive assay, and the ability of banaba extract to induce differentiation in preadipocytes was examined by Northern and Western blot analyses [4]. Studies on the efficacy and safety of banaba (*Lagerstroemia speciosa* L.) and corosolic acid have been performed and no adverse effects of it have been observed or reported in animal studies or controlled human clinical trials [5]. The hypoglycemic effects of banaba have been attributed to both corosolic acid as well as ellagitannins. Studies have been conducted in various animal models, human subjects, and *in vitro* systems using water soluble banaba leaf extracts, corosolic acid, and ellagitannins. Corosolic acid has been reported to decrease blood sugar levels within 60 min in human subjects. Corosolic acid also exhibits antihyperlipidemic and antioxidant activities [4].

Banaba also contains concentrations of dietary fiber and minerals such as magnesium and zinc. It helps the body handling glucose and is as such also effective in weight loss and against obesity. The hypoglycemic (blood sugar lowering) effect is similar to that of insulin (which induces glucose transport from the blood into body cells). The tea is therapeutic against ailments such as diabetes, kidney and urinary problems.

Bitter melon (*Momordica charantia*)

It is commonly known as Aampalaya, balsam pear, balsamina, bitter melon, bittergourd or karela **(Figure 2).** It is a tender perennial, herbaceous tropical vine belonging to the family cucurbitaceae. The fruit is edible when harvested and cooked. Its taste is bitter. Bitter melon has twice the potassium of bananas and is also rich in Vitamin A and C. It has hypoglycemic (lowering blood sugar) properties and enhances cell uptake of glucose. It promotes insulin release and potentiates its effect. It also reduces total cholesterol and triglycerides. It was previously demonstrated that oral administration of *M. charantia* could lead to the secretion of insulin from endocrine pancreatic β

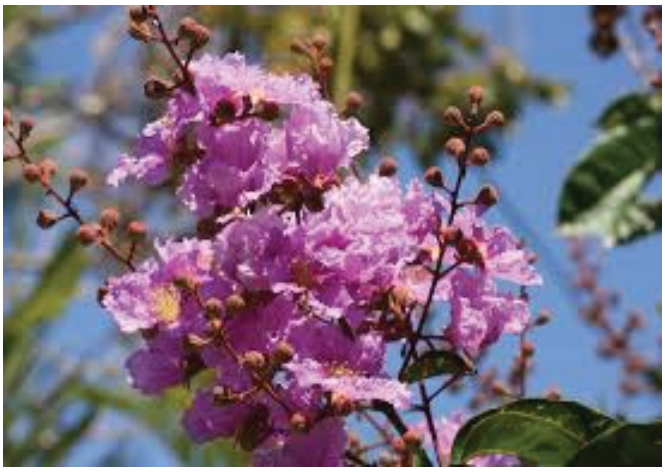

Figure 1 Banaba (*Langerstroemia speciosa*).

Figure 2 Bittermelon (*Momordica charantia*).

cells. This observation was further confirmed by observing the effect of daily oral administration of *M. charantia* fruit juice and the distribution of α, β and δ cells in the pancreas of STZ-induced diabetic rats using immunohistochemical methods [6]. Momordicine II and 3-hydroxycucurbita-5, 24-dien-19-al-7, 23- di-O-β-glucopyranoside, were isolated as saponins from *M. charantia*. Both compounds showed significant insulin releasing activity in MIN6 β -cells at concentration of 10 and 25 µg/mL. The major compounds that have been isolated from bitter melon and identified as hypoglycemic agents include charantin, polypeptide-p and vicine [6]. Processed bitter gourd in the form of capsules or tablets is commonly advertised and sold. The products are marketed under the brand names Gourdin, Karela, and Glucobetic in Canada, India, the United Kingdom, the United States, and many Asian countries. Products can also be ordered online. However, it is not yet known what dose is safe when taken with other antidiabetic agents, and there is a lack of information on other potential bioactive components of the capsules [7]. There is insufficient evidence on the effects of *M. charantia* for type 2 diabetes mellitus. Further studies are therefore required to address the issues of standardization and the quality control of preparations. For medical nutritional therapy, further observational trials evaluating the effects of *M. charantia* are needed before randomized clinical trials are established to guide any recommendations in clinical practice [8].

Bitterwood *(Quassia amara)*

Commonly called as Surinam wood, amargo, bitterwood or quassia wood **(Figure 3).** Amargo is a small tree, 6 to 18 ft. tall. Amargo is known to control the blood sugar and contains the phytochemical quassin. The findings indicate that *Quassia amara* extract may be potentially valuable in the treatment of diabetes and associated dyslipidemia [9]. This plant also possesses antileukemic, anti-tumorous, antibacterial and antifungal properties. It is used in cases of anorexia nervosa, is effective in chronic diseases of the liver and has anti-malaria activity. However, reproductive toxicity of *Quassia amara* extract has also been reported and its action on sperm capaciation and acrosome reaction is documented [10].

Silk cotton tree (*Ceiba pentandra*)

It is commonly called Kapok tree, silk cotton tree, sumauma or kankantri **(Figure 4).** It is very large majestic tree, with a conspicuously buttressed trunk. The kapok tree grows more than 200 ft. tall; with widely spreading branches. The silk cotton tree is cultivated for kapok. Oil from the seeds is used in edible products and the ground seeds in animal feed. *Ceiba pentandra* has hypoglycemic effect and its bark has been used as a diuretic, aphrodisiac, and to treat headache, as well as type II diabetes. The results of experimental animal study indicated that *Ceiba pentandra* possesses antidiabetic activity; and thus is capable of ameliorating hyperglycemia in streptozotocin-induced type-2 diabetic rats and is a potential source for isolation of new orally active agent(s) for anti-diabetic therapy [11,12].

Holy basil (*Ocimum sanctum*)

It is commonly called as Holy Basil, Tulsi, or Tulasi **(Figure 5).** Holy Basil is a tropical, much branched, annual herb, upto 18 inches tall, it grows into a low bush. Along with its religious significance, it also has substantial medicinal meaning and is used in Ayurvedic treatment. It may have a positive effect on fasting blood sugar and on blood sugar following meals [13]. The plant plays a role in the management of immunological disorders such as allergies and asthma. The juice of the leaves is used against diabetes and fever. It's anti-spasmodic properties, relieves abdominal pains and helps in lowering the blood sugar level [13,14].

Indian gooseberry (*Eugenia jambolana*)

It has common names such as Java plum, jamun, jaman, black plum **(Figure 6).** The Jamun is an evergreen tropical tree 50 to 100 ft. tall, with fragrant white flowers and purplish-black oval edible berries. The juicy fruit-pulp contains resin, gallic acid and tannin. It has hypoglycemic (lowering blood sugar) and antioxidant properties [15]. All parts of the java plum can be used medicinally and it has a long tradition in alternative medicine. The bark has anti-inflammatory activity and is used In India for anemia, the bark and seed for diabetes which reduce the blood sugar level quickly. In laboratory experiments, the oral administration of the extract of jamun pulp increases serum insulin levels. These extracts also inhibited insulinase activity from liver and kidney [16-18]. Studies on gastric mucosal offensive acid-pepsin secretion exhibited antidiabetic and antiulcer effects of extract of *Eugenia jambolana* seed in mild diabetic rats [19].

Shatterstone (*Phyllanthus niruri/amarus*)

It is commonly called as Child pick-a-back, gulf leafflower, shatterstone, bahupatra or gale of wind **(Figure 7).** Shatterstone is a common annual weed from the genus *Phyllanthus* that contains more than 700 species. The plant grows up to 1½ ft. tall and has small yellow flowers.

Figure 3 Bitter wood (*Quassia amara*).

Figure 4 Silk Cotton Tree (*Ceiba pentandra).*

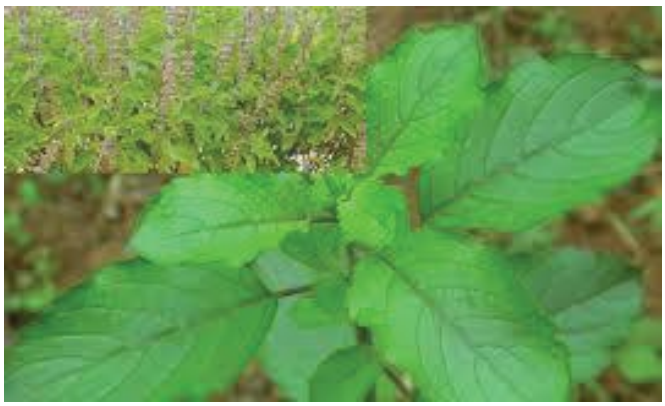

Figure 5 Holy Basil *(Ocimum sanctum).*

Figure 6 Indian gooseberries *(Eugenia jambolana).*

The leaf and seed aqueous extract of *Phyllanthus amarus* have been shown to improves insulin resistance diabetes in experimental animal studies [20] while a single study on aqueous extract of *Phyllanthus amarus* has demonstrated no effect on blood glucose in non-insulin dependent diabetic patients [21]. The extract of *Phyllanthus niruri* lowered blood glucose, suppressed postprandial rise in blood glucose following a glucose meal, reduced hemoglobin glycation and increased absolute and relative weights as well as glycogen content of liver in diabetic rats [22]. They are anti-hepatotoxic (liver protecting), antibacterial and hypoglycemic. Other applications are against inflammation of the appendix and for prostate problems. An interesting aspect is the use of this plant for weight loss (slimming down).

Ponkoranti (*Salacia oblonga/Salacia reticulata*)

It is commonly known as Saptrangi or Ponkoranti **(Figure 8).** It is a woody plant found in the forests of Srilanka and India. The roots and stems of *Salacia oblonga* for diabetes treatment have been used extensively in Ayurveda and traditional Indian Medicine for the treatment for diabetes.

It as an effective anti-diabetic and weight control agent. Our body naturally has alpha-glucosidase enzyme which break downs oligosaccharides into monosaccharides like glucose. The extract from *S. oblonga* binds to this enzyme and inhibits it. Because of this inhibition, glucose is not released into the blood stream. In a doubleblind Placebo-controlled, randomized trial, it was demonstrated that *Salacia reticulata* improves serum lipid profiles and glycemic control in patients with prediabetes and mild to moderate hyperlipidemia [23]. This herbal medicine for diabetes treatment is well proved and is very successful in giving a solution for the same.

Figure 7 Shatter stone *(Phyllanthus niruri).*

Figure 8 Ponkoranti *(Salacia oblonga).*

Ivy gourd (*Coccinia indica*, *Coccinia cordifolia* or *Coccinia grandis*)

It is known by several names; Calabacita, Calabaza Hiedra, Courge Écarlate, Kovai, Little Gourd, Tela Kucha, baby watermelon, little gourd, gentleman's toes or Tindola **(Figure 9).** Ivy gourd is a tropical plant used as vegetable and grown wildly throughout the Indian sub-continent. Ivy plant has been used in traditional medicine as a household remedy for various diseases. Ivy gourd can help regulate blood sugar levels and, in turn, prevent or treat diabetes. Anti-inflammatory, antioxidant, antimutagenic, antidiabetic, antibacterial, antiprotozoal, antiulcer, hepatoprotective, expectorants, analgesic are the reported pharmacological activities of ivy gourd [24]. Extracts of the ivy gourd's roots, fruit, and leaves are said to offer a range of health benefits. People take ivy gourd for diabetes, gonorrhoea, and constipation. Its fruits have also been used to treat leprosy, fever, asthma, bronchitis and jaundice.

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: dried juice from the leaf and aloe gel. Latex from per cyclic cells obtained beneath the skin of leaves may be evaporated to form

Figure 9 Ivy gourds *(Coccinia indica).*

Figure 10 *Aloe vera.*

a sticky substance known as "drug aloes" or "aloe" **(Figure 10).** This aloe juice contains the cathartic anthraquinone, barbaloin, a glucoside of aloe-emodin, as well as other substances. Aloe gel is obtained from the inner portion of the leaves. It does not contain anthraquinones but does contain a polysaccharide, glucomannan, which is similar to guar gum. Aloe gel is used topically, but it has also been used orally for diabetes.

Although *Aloe vera* gel is better known as a home remedy for minor burns and other skin conditions, recent animal studies suggest that *Aloe vera* gel may help people with diabetes. A Japanese study evaluated the effect of *Aloe vera* gel on blood sugar. Researchers isolated a number of active phytosterol compounds from the gel that were found to reduce blood glucose and glycosylated haemoglobin levels [25].

Fenugreek (*Trigonella foenum-graecum*)

Fenugreek is an herb found all over India and its seeds are usually used as one of the major constituents of Indian spices. Fenugreek, **(Figure 11)** a member of the legume family, has a bitter, maple-like taste.

Fenugreek is used to treat numerous health problems, including insulin resistance, diabetes, poor appetite, inflammation, digestive problems and menopausal symptoms. 4-hydroxyleucine, a novel amino acid from fenugreek seeds increases glucose stimulated insulin release. In animal experiments, it has been shown that oral administration of plant extract decreased the blood glucose levels. Administration of fenugreek seeds improved glucose metabolism and reduced hepatic and renal glucose-6-phosphatase and fructose−1, 6-biphosphatase activity [26].

Chemical constituents of the plant include saponins, many of which are glycosides of diosgenin. The seeds also contain the alkaloids trigonelline, gentianine, and carpaine compounds. Other components of the seeds include several C-glycosides. The seeds contain up to 50% mucilaginous fibre. Other seed constituents include 4-hydroxyisoleucine, an amino acid, and fenugreekine. Fenugreek is thought to delay gastric emptying, slow carbohydrate absorption, and inhibit glucose transport. It has been shown to increase erythrocyte insulin receptors and improve peripheral glucose utilization, thus showing potential pancreatic as well as extrapancreatic effects [27]. Various components of the seeds have varying activities. For example, the component called fenugreekine, a steroidal sapogenin peptide ester, may have hypoglycaemic properties. Trigonelline, another component, may exert hypoglycaemic effects in healthy patients without diabetes, but other studies have shown that fenugreek has no effect on fasting or postprandial blood glucose levels in nondiabetic subjects [28]. There are however studies which exhibit that fenugreek may have side effects in infants of nursing mothers who use this substance.

Figure 11 *Trigonella foenum-graecum.*

Since fenugreek is a member of the Leguminosae family, which includes peanuts, it is theoretically possible for someone with a peanut allergy to react to fenugreek [29]. However, this reaction has never been reported.

Garlic (*Allium sativum*)

It is a bulbous perennial herb **(Figure 12)** that grows up to 1.2 m (4 ft.) in height. It produces hermaphrodite flowers.

Allicin, a sulfur-containing compound is responsible for its pungent odour and it has been shown to have significant hypoglycaemic activity. This effect is thought to be due to increased hepatic metabolism, increased insulin release from pancreatic beta cells and/or insulin sparing effect [30]. Several other researches including studies on effect of garlic extract on blood glucose levels and lipid profiles in streptozotocin/alloxan-induced diabetic rats, alloxan diabetic rabbits have exhibited its antidiabetic activity [31-33]. Apart from this, *Allium sativum* exhibits antimicrobial, anticancer and cardio protective activities also.

Cinnamon *(Cinnamomum)*

Cinnamon is a spice obtained from the inner bark of several trees from the genus *Cinnamomum* **(Figure 13)**. It is commonly known

Figure 12 Garlic (*Allium sativum).*

Figure 13 Cinnamon (*Cinnamonam*).

as dal chini, korunda, kurandu, kayu manis.

Cinnamon improves blood glucose control in people with type 2 diabetes. The most active compound in cinnamon, known as methylhydroxy chalcone polymer; mimics insulin increases glucose metabolism and effectively lowers blood glucose levels [34]. Cinnamon also reduces serum triglycerides, LDL cholesterol, and total cholesterol.

Indian Kino (*Pterocarpus marsupium*)

It is also known as Vijayasar, Indian Kino, Malabar Kino, Benga, Bijiayasal, Piasal, Venkai **(Figure 14).** It is a deciduous moderate to large tree that can grow up to 30 meters tall found in India mainly in hilly region.

Pterostilbene, a constituent derived from wood shows hypoglycemic activity because of presence of tannates in the extract. Flavonoid fraction from *Pterocarpus marsupium* has been shown to cause pancreatic beta cell regranulation [35]. Epicatechin, its active principle, has been found to be insulinogenic, enhancing insulin release and conversion of proinsulin to insulin *in vitro*.

Ginseng *(Panax/Eleutherococcus)*

Ginseng is a slow-growing perennial plant with fleshy roots, belonging to the genus *Panax* **(Figure 15)** of the family Araliaceae. A variety of products are called "ginseng." The most commonly used are three different botanicals: Asian or Korean ginseng (*Panax ginseng* C.A. Meyer), American ginseng (*Panax quinquefolius* L.), or Russian or Siberian ginseng (*Eleutherococcus senticosus Maximum*). Root of Asian ginseng is useful in reducing the level of glucose in the blood [36,37]. It has the ability to enhance the release of insulin from the pancreas and increase the number of insulin receptors. In clinical studies, Asian ginseng has demonstrated a direct blood-sugar lowering affect. American ginseng has also been demonstrated to reduce postprandial glycemia in nondiabetic subjects and subjects with type 2 diabetes mellitus [38].

Previous study designed to screen the effect of syringin; an active principle purified from the rhizome and root parts of *Eleutherococcus senticosus*, on the plasma glucose demonstrated decrease in plasma glucose in a dose-dependent manner 1 hr after intravenous injection of syringin into fasting wistar rats. The results suggest that syringin has an ability to raise the release of acetylcholine from nerve terminals, which in turn stimulate muscarinic M3 receptors in pancreatic cells and augment the insulin release to result in plasma glucose lowering action [39].

Ginseng contains a family of steroid-like compounds called ginsenosides. Although there are many subtypes, ginsenosides are tetracyclic triterpenoid saponin glycosides thought to have various hormonal and central nervous system (CNS) effects. Some ginseng compounds show contradictory effects; for example, ginsenoside Rg1 has hypertensive and CNS-stimulant effects, whereas ginsenoside Rb1 has hypotensive and CNS-depressant effects. "Ginseng abuse syndrome" is a controversial adverse effect that was reported in 14 of 133 long-term users of high daily doses [27]. This syndrome consisted of hypertension, nervousness, sleeplessness, skin eruptions, increased libido, and morning diarrhea. The most commonly reported side effects include nervousness and excitation [29]. Other effects include headache, hypertension, insomnia, estrogenic effects including mastalgia, vaginal bleeding, and cerebral arthritis.

Blueberry *(Vaccinium myrtillus)*

It is a low-growing shrub belonging to the genus *Vaccinium* (family Ericaceae) **(Figure 16),** bearing edible, nearly black berries. They are closely related to the European bilberry. There are several species of blueberries exist- including *V. pallidum* and *V. corymbosum* and grow throughout the United States. Its leaves are the primary part of the plant used medicinally. Blueberry is a natural method of controlling or lowering blood sugar levels the leaves have an active ingredient with a remarkable ability to get rid the body of excessive sugar in the blood. It is a good astringent and helps relieve inflammation of the kidney, bladder and prostate [40].

Various independent studies have concluded bilberry as a possibly effective use for treatment of eye problems linked to diabetes [27]. Bilberry may help prevent diabetes related

Figure 14 Indian Kino (*Pterocarpus marsupium).*

Figure 15 Asian ginseng *(Panax ginseng).*

Figure 16 Blueberry *(Vaccinium myrtillus).*

blood vessel damage known to affect the retina nerve and vessel functions. Anthocyanosides are bioflavonoids, chemical constituents in bilberry fruit thought to be responsible for some of its vascular effects. Anthocyanosides are thought to decrease vascular permeability and redistribute micro vascular blood flow [41]. They are similar to some of the agents in grape seed. The mechanism in diabetes may be related to the high chromium content in bilberry leaf (9 parts per million), but further research is needed to determine this.

Collards

Collard greens are the American English term for various loose-leafed cultivars of *Brassica oleracea* **(Figure 17).** The plants are grown for their large, dark-coloured, edible leaves. These leaves offer high absorbable calcium, iron, fibre, high in many essential vitamins like vitamin C, vitamin A, vitamin E.

Collards are a good source of niacin that helps to reduce high cholesterol and reduce the threat of getting diabetes. As with most all veggie, collards have a very low glycemic index-slow release carbohydrates and no quick sugar spikes. Studies have shown that type 1 diabetics who consume high-fibre diets have lower blood glucose levels and type 2 diabetics may have improved blood sugar, lipids and insulin levels. One cup of boiled collard greens provides about 8 grams of fibre. The Dietary Guidelines for Americans recommends 21-25 g/day for women and 30-38 g/day for men.

Collard greens also contain an antioxidant known as alpha-lipoic acid, which has been shown to lower glucose levels, increase insulin sensitivity and prevent oxidative stress-induced changes in patients with diabetes. Studies on alpha-lipoic acid have also shown decreases in peripheral neuropathy and/or autonomic neuropathy in diabetics [42].

Figure 17 Collard greens.

Figure 18 Curry leaves (*Murraya koenigii).*

Curry leaves *(Murraya koenigii)*

The curry tree (*Murraya koenigii*) is a tropical to sub-tropical tree in the family Rutaceae **(Figure 18).** Its leaves are used in many dishes in India and neighboring countries. The leaves are generally called by the name "curry leaves" or "Sweet Neem leaves" in most Indian languages.

Eating curry leaves twice a day has proven to reduce blood sugar levels for non-diabetics and diabetics alike. This is a good herb to include as part of one's regular diet. Studies on antidiabetic activity of leaf extracts of *Murraya koenigii* on alloxan induced diabetic rats revealed that it exerts hypoglycemic effect by increased insulin secretion and enhancement of the glycogenesis process. The extracts were effective in regulating the biochemical indices associated with diabetes mellitus such as activities of glucokinase and glucose-6-phosphatase. Histological studies showed that *Murraya koenigii* had protective effects on damages caused by alloxan to pancreas, spleen, liver and kidney, possibly by decreasing oxidative stress and preservation of pancreatic cell integrity [43].

Dandelion *(Taraxacum officinale)*

Commonly known as dandelion**,** is a flowering herbaceous perennial plant of the family Asteraceae **(Figure 19).** While the dandelion is considered a weed, the plant has several medicinal uses. Its leaves have been known diabetes prevention herbs to lower blood sugar levels. Use it in salads and green smoothies. Dandelion root stimulates the pancreas to make more insulin. Its root has a nutrient called inulin (not Insulin) that helps the body control blood sugar. The chemical constituents include sesquiterpene lactones (bitters), taraxinic acid (taraxacin), tetrahydroridentin B, triterpenoids and sterols: (taraxasterol, taraxerol, cycloartenol, beta-sitosterol) besides Vitamin A, Vitamin C, tannins, alkaloids, pectin, inulin, starch, potassium, beta carotene, caffeic acid, and flavonoids (apigenin) [44]. It is a good antidiabetic drug and can lower the blood glucose level. Tests on diabetic mice show that dandelion extract may help regulate blood sugar and keep cholesterol in check [45].

Gumar (*Gymnema sylvestre*)

This plant's Hindi name translates as "sugar destroyer" **(Figure 20).** It is a native herb of the tropical forests of southern and central India and Sri Lanka. Chewing its leaves suppresses the sensation of sweet. This effect is attributed to the eponymous gymnemic acids. *G. sylvestre* has been used in herbal medicine to prevent diabetes [46].

Figure 19 Dandelion (*Taraxacum officinale).*

It has herbal properties that help to reduce and lower blood sugar levels. Even in type 1 diabetics, using *Gymnema* can even reduce insulin requirements. *Gymnema* removes sugar from pancreas, restores pancreatic function [44]. Studies have demonstrated that it exerts enzyme changes and glucose utilization [47] and has effect in controlling blood glucose level [48].

Prickly pear cactus (*Opuntia dillenii*)

Prickly pears are also known as "tuna", "nopal" or *nopales* **(Figure 21).** Prickly pears are reddish fruits of common cactus that typically grow with flat, rounded cladodes (also called platyclades) that are armed with two kinds of spines; large, smooth, fixed spines and small, hair like prickles called glochids. It is a traditional herb used as a folk remedy for high blood sugar.

The most effective hypoglycemic component of polysaccharides from *Opuntia dillenii* was determined by preliminary screening and specifically studied for the antidiabetic effects of *O. dillenii* polysaccharide (ODP)-Ia in mice with streptozotocin (STZ)-induced diabetes [49]. It was proposed that ODP-Ia exerts its antihyperglycemic effect by protecting the liver from peroxidation damage and by maintaining tissue function, thereby improving the sensitivity and response of target cells in diabetic mice to insulin [49].

Figure 20 Gumar (*Gymnema sylvestre).*

Figure 21 Prickly pear cactus *(Opuntia dillenii).*

Chamomile *(Matricaria chamomilla)* and chamomile tea

Chamomile or camomile is the common name for several daisy-like plants of the family Asteraceae **(Figure 22).** Chamomile tea has shown some evidence of being able to lower blood sugar and thus prevent the progression of type-2 diabetes and prevent some of the damage associated with high blood sugar levels. Studies have exhibited the effects of chamomile hot water extract and its major components on the prevention of hyperglycemia and the protection or improvement of diabetic complications in diabetes mellitus [50]. Chamomile extract showed potent inhibition against aldose reductase (ALR2), and its components, umbelliferone, esculetin, luteolin, and quercetin, have been shown to significantly inhibit the accumulation of sorbitol in human erythrocytes. These results clearly suggested that daily consumption of chamomile tea with meals could contribute to the prevention of the progress of hyperglycemia and diabetic complications [50].

Conclusion

There is a continuous rise in the prevalence of diabetes cases. Major cause is our eating habits and sedentary lifestyle, even gestational diabetes is not uncommon. Active lifestyle and proper medical intervention can prevent progression to diabetes. Natural God gifted herbs that prevent diabetes have no ill side effects unlike the man-made market pharmaceuticals and food enhanced chemicals. Incorporating these herbs in our daily routine can surely help pre-diabetics stay healthy for longer time without progressing to type-2 diabetes.

Although the above described herbs have potential to help pre-diabetics maintain lower blood sugar and reach a Hemoglobin A1c goal of <7.0, but much more research is needed. Many different plants have been used individually or in formulations for treatment of diabetes and its complications. One of the major problems with herbal formulation is that the active ingredients are not well defined. It is important to know the active component and their molecular interaction, which will help to analyse therapeutic efficacy of the product and also to standardize the product. Major hindrance in amalgamation of herbal medicine in modern medical practices is lack of scientific and clinical data proving their efficacy and safety. Efforts are now being made to investigate mechanism of action of some of these plants using

Figure 22 Chamomile *(Matricaria chamomilla).*

model systems. Though information is available about some of the herbs included in the text, there is a need for conducting clinical research in herbal drugs, developing simple bioassays for biological standardization, pharmacological and toxicological evaluation, and developing various animal models for toxicity and safety evaluation of most of them.

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