A review on Lifestyle intervention for prevention of Diabetes: Herbal treatment

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Abstract
A metabolic condition known as diabetes mellitus causes an increase in blood glucose levels as a result of increased hepatic glucose synthesis, decreased insulin secretion, and impaired insulin action. The many plants listed in this review that are used to cure diabetes are readily available at home, especially in India. Due to its lower cost, fewer side effects, and longer shelf life, herbal formulations are chosen. These plants' properties may prevent diabetes problems from occurring and repair metabolic irregularities.
Key words: *Diabetes, herbal formulations, home remedies.*

Introduction
Research has shown the effectiveness of herbal medicines in the treatment and prevention of disease. Herbal medicine refers to the use of any plant's seeds, berries, heritages, leaves, bark, or roots for therapeutic purposes. Due to their natural origins and little side effects, these medications are becoming more and more popular in both developed and developing nations.[1,2] Diabetes is a serious condition that affects a large number of people worldwide from all walks of life. It is proven to be a significant health issue in India, particularly in the cities. India is known as the world's botanical garden and is the country that produces the most medicinal herbs. Diabetes mellitus, which is characterised by impaired glucose tolerance that affects the activities and sensitivity of pancreatic beta cells and progresses to

diabetes and its complications, is alarmingly on the rise globally. It is a long-term disorder of the metabolism of carbohydrates, fats, and proteins marked by elevated fasting and postprandial blood sugar levels as well as an elevated risk of vascular issues. It is the most prevalent endocrine illness in both sexes and a serious public health issue of epidemic proportions that was formerly thought to be a western disease but is now becoming endemic to our nation's modernising and urbanising population. Many herbal remedies in modified oral formulations have been recommended for Madhumeha (diabetes mellitus) and have been guaranteed rights of cure since the time of Charak and Sushruta [3].

In herbal medicines utilised in Indian traditional healthcare systems, a variety of therapeutic plants known as Rasayana are found. The focus of the current study is on plants and herbal medicinal preparations used to treat diabetes mellitus, a serious illness that causes enormous economic losses worldwide [4].

How do herbs work?

The precise chemical in the majority of plants that has a medicinal effect is unknown. There are numerous components in whole herbs, and it's likely that these components combine to have the intended medical outcome. A plant's constituents will vary depending on the environment (temperature, pests, soil quality), how and when it was harvested, and how it was processed. [4]

Diabetes signs

- Loss of weight indicates an issue with insulin function and blood sugar control.
- vision that is hazy.
- One of the main signs of diabetes is a frequent urge to urinate.
- Diabetes can also be detected by extremely painful or empty stomachs as well as stress and irritability.
- vomiting and nauseous.
- extreme exhaustion and weakness.
- Dryness unusual.
- Changes in mood, etc. [5]

Causes of Diabetes

- Diabetes is inherited and genetic.
- It is also brought on by illnesses brought on by viruses, high levels of glucose in blood vessels, low levels of glucose in the body, and other factors.
- Other causes of diabetes include stress, obesity, elevated cholesterol, a high intake of sugar and fat, and a lack of exercise.
- According to Ayurveda, all three doshas must be vitiated for it to occur, but vata must be the most vitiated of the three.[5]

Diabetes Dos and Don'ts

Dietary control and healthy nutrition are crucial for the wellbeing of diabetic people. Vegetables like cucumber and spinach should be consumed along with a low-fat diet as they

are beneficial for managing diabetes. Diabetics who consume onions, sprouts, beans, and garlic have lower blood sugar levels. You must consume tomatoes, veggie salad, fruits, and dairy goods like cheese. White bread, rice, and potatoes are examples of starchy foods that should be avoided since they are difficult to digest.

- Patients with diabetes shouldn't be concerned about consuming sugar-rich fruits. These are secure and do not boost the synthesis of insulin.
- Less oil should be consumed, and heavy metals, refined sugar, caffeine, and refined flour should all be avoided.
- Meals should be small because foods are easily absorbed and beneficial for diabetics' health.
- Avoiding mutton and too much salt in meals will help you manage your weight and diabetes.
- Avoiding fast food and fatty foods lowers blood pressure, controls cholesterol levels, and prevents diabetes.[5]

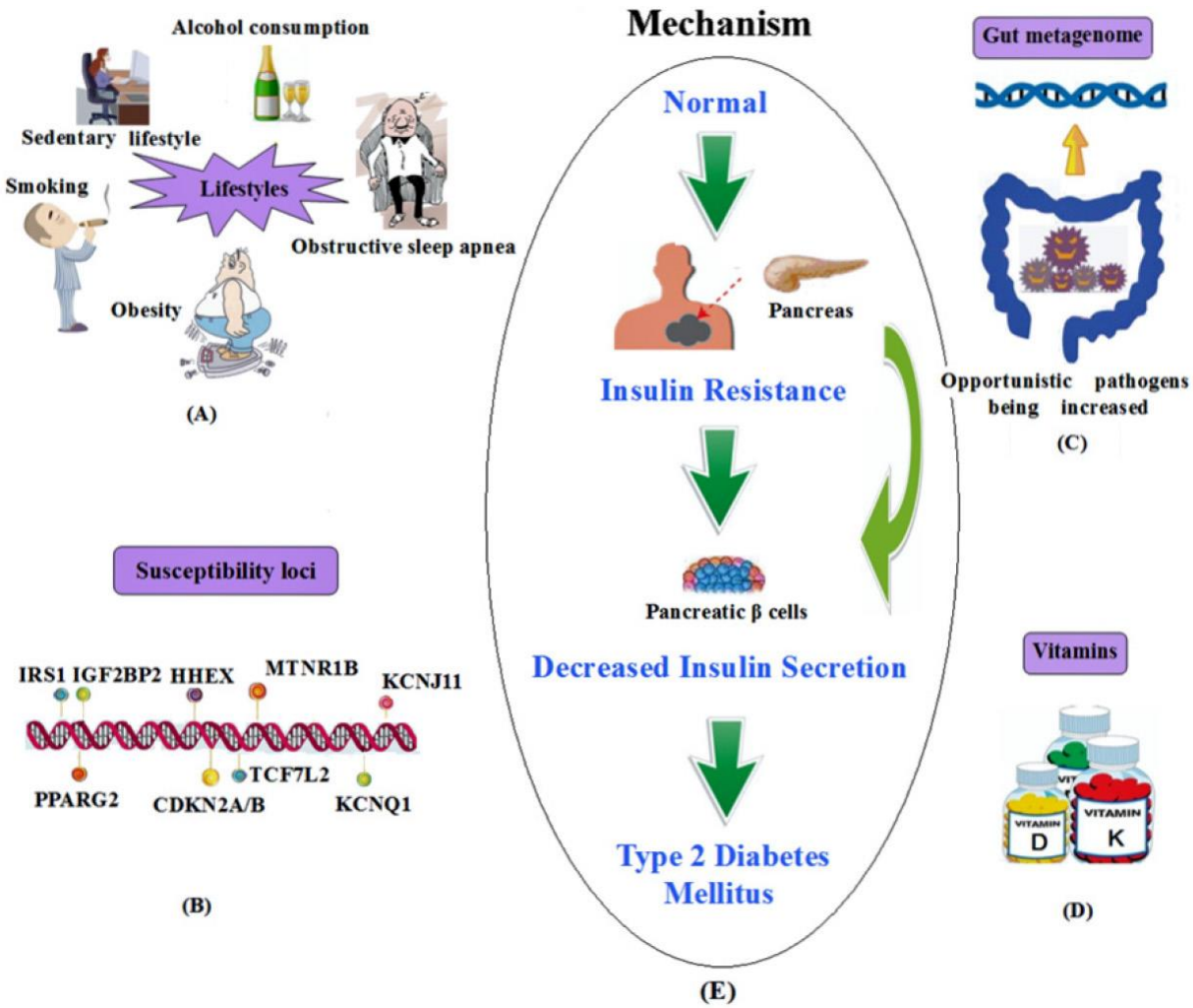

Figure 1. A summary of the influencing factors and mechanism of T2DM. (A) Lifestyles; (B) Susceptibility loci; (C) Gut metagenome association; (D) Vitamins. (E) The mechanism of T2DM.

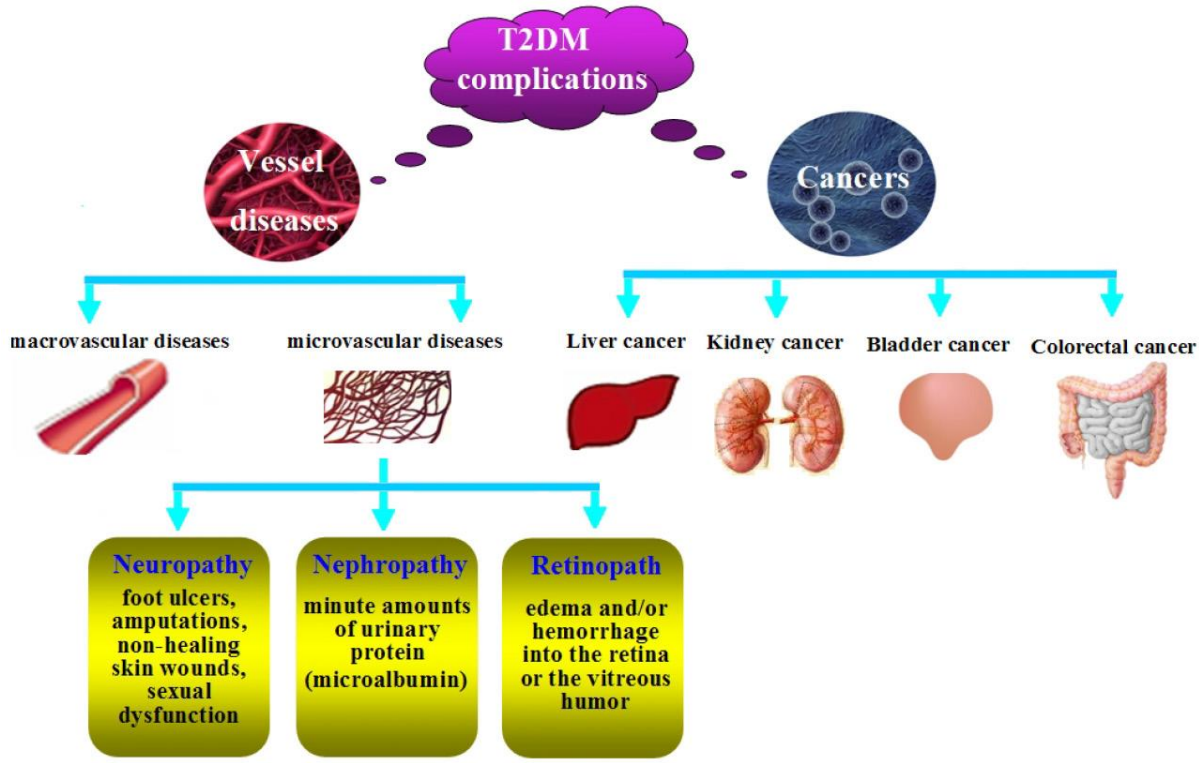

Figure 2. The complications of T2DM.

Some important anti-diabetic herbal plants and food that are easily available at home:

1. *Allium cepa:* Pyaaz, Onion

There are linked wild species in central Asia, but Allium cepa Family Liliaceae is only known through cultivation. Different ether soluble fractions of dried onion powder as well as its insoluble fractions exhibit anti-hyperglycemic effect in diabetic rabbits. Alloxan-induced diabetic rats received S-methyl cysteine sulphoxide (SMCS) (200 mg/kg for 45 days), an amino acid that contains sulphur, and this drastically reduced blood glucose levels as well as lipid levels in serum and tissues. Hexokinase, glucose 6-phosphatase, and HMG Co-A reductase activity are all controlled by it.[6]

2. *Allium sativum:* Lahsun, Garlic

Lilacaceae Family: Allium sativum. This perennial herb is grown all over India. The sulfur-containing component allicin, which gives garlic its strong aroma, has also been found to have strong hypoglycemia effects.[6] enhanced hepatic metabolism, enhanced pancreatic beta cell insulin release, and/or an insulin-sparing impact are suggested to be the causes of this effect. In comparison to rabbits fed sugar controls, an oral dose of an aqueous homogenate of garlic (10ml/kg/day) significantly boosted hepatic glycogen and free amino acid content, decreased fasting blood glucose, and reduced serum triglyceride levels.[7]

3. *Acacia arabica* (Babul)

It is primarily found in untamed habitat throughout all of India. The plant extract combats diabetes by secreting insulin through secretagogues. In control rats, it causes hypoglycemia, but not in alloxanized animals. When normal rabbits received 2, 3, and 4 g/kg of powdered Acacia Arabica seeds, the release of insulin from the pancreatic beta cells resulted in a hypoglycemic effect.[8]

4. *Aloe Vera* and *Aloe barbadensis*: (Ghritakumari)

Aloe has a long history of use as a folk medicine with several uses. Gel and latex are the two fundamental compounds that can be extracted from the plant. Aloe latex, sometimes known as "aloe juice," is a bitter yellow secretion that comes from the pericyclic tubules just below the leaf's outer epidermis. Aloe Vera gel is the leaf pulp or mucilage. Aloe gum extracts successfully improve glucose tolerance in both healthy and diabetic rats. In alloxanized diabetic rats, treatment with exudates from Aloe vera leaves demonstrated a hypoglycemic effect but not with a single dosage. In diabetic rats, both acute and chronic administration of the bitter component of the same plant produced a hypoglycemic response.

Aloe Vera's activity and bitter principle stimulate the production and/or release of insulin from pancreatic beta cells. Aloe Vera used orally may be an effective adjuvant in the treatment of diabetes patients' high blood sugar levels.[6,7]

5. *Azadirachtaindica*: Neem

Azadirachtaindica Family: *Meliaceae*.

The entire plant is utilised. The primary source of seed oil is nimbidin, a basic bitter component. Additionally, it contains nimbilic acid, nimbin, nimbidinin, and nimbolide. derived from neem seed is gedunin. Azadirachtin and mahmoodin are also present. Gallic acid, which is similar to tannin, is also present. Additionally, margolonon, a polysaccharide, is found.[8] In streptozotocin-treated rats, hydroalcoholic extracts of this plant exhibited anti-hyperglycemic activity. This effect is due to an increase in glucose absorption and glycogen deposition in an isolated rat hemidiaphragm. This plant also contains anti-bacterial, anti-malarial, anti-fertility, hepatoprotective, and antioxidant activities in addition to its anti-diabetic properties.[9]

6. *Curcuma longa*: Haldi, Turmeric

Curcuma longa Family: Zingiberaceae.

Acute and chronic incubations under both basal and hyperglycemic settings were used to test the effect of Aqueous Extract of Curcuma Longa (AEC) on insulin secretion in pancreatic tissues in vitro. All dosages of AEC used in hyperglycemic culture revealed a suppressed insulin release after 30 min of incubation, which was substantially different from the control (p 0.05). The highest dose of AEC (100 mL) was substantially different from the control and the other doses of AEC (p 0.05), although there was no discernible difference between the 0.1, 1 and 10mL doses of AEC ($p > 0.05$). On the other hand, tolbutamide considerably increased insulin secretion. Insulin release from pancreatic tissues in hyperglycemic culture conditions after 15 min of incubation with various dosages of AEC was not substantially different from the control.[10]

7. *Ocimum sanctum*: (Holy Basil)

It is typically referred to as Tulsi.This plant has a long history of being valued for its healing abilities. Both normal and alloxan-induced diabetic rats significantly reduced their blood sugar levels when given an aqueous extract of Ocimum sanctum leaves. In diabetic rats, tulsi had hypoglycemic and hypolipidemic effects as evidenced by significant drops in fasting blood glucose, uronic acid, total amino acids, total cholesterol, triglycerides, and total lipid. On days 15 and 30 of the experiment, oral administration of plant extract (200 mg/kg) for 30

days caused a drop in plasma glucose of about 9.06 and 26.4%, respectively. When compared to control rats, diabetic rats had a ten-fold increase in renal glycogen content but a drop in skeletal muscle and hepatic glycogen levels of 68 and 75%, respectively.[11]

8. *Mangiferaindica*: Mango

When compared to an oral dose of chlorpropamide, the aqueous extract lowers blood glucose levels in normoglycemic and glucose-induced hyperglycemia but has no effect on diabetic mice generated by streptozotocin under the same circumstances. The outcome suggests that the M. indica leaf aqueous extract has hypoglycemic action.[12]

9. *Syzigiumcumini* (Eugenia Jambolana): Jamun

On streptozotocin-induced diabetic rats, the current study assessed the hypoglycemic activity of various Eugenia jambolana seed components, including the total seed, kernel, and seed coat. In experimental diabetic rats, administration of the ethanolic extract of the kernel at a concentration of 100 mg/kg of body weight significantly decreased blood glucose, blood urea, and cholesterol levels, increased glucose tolerance and levels of total proteins and liver glycogen, and decreased glutamate oxaloacetate transaminase and glutamate-pyruvate transaminase activities. It also increased glucose tolerance and levels of total proteins and liver glycogen. A modest hypoglycemic effect was seen in the whole seed, but not in the seed coat. A common hypoglycemic medication called glibenclamide was used to compare the hypoglycemic efficacy.[13]

10. *Ipomoea batatas*: Sakkarkand or Mitha Alu

a trailing herb grown for its sweet, tuber-like roots.After 3, 4, 6, and 8 weeks, oral dose of Ipomoeabatatas decreases hyperinsulinemia in Zucker fatty rats by 23, 26, 60, and 50%, respectively. In addition, suppression of blood glucose level following glucose loading, granulation of pancreatic beta cells, and a decrease in insulin resistance were seen after 7 weeks of treatment.[14]

11. *Momordicacharantia*: Karela, Bitter Gourd

In rats, the mechanism of action of juice was investigated by Ahmed et al. (1999). A single injection of streptozocin (60 mg/kg body weight) made rats diabetic. Treatment mice were given M. charantia juice (10 ml/kg) daily for three days following injection, which reduced the insulin-induced increase in glucose absorption.[15]

12. *Trigonellafoenumgraecum*: MethiOrmutti, Fenugreek

Both cultivated and wild versions of the plant are found throughout northern India. It has been demonstrated that fenugreek seeds produce hypoglycemic effects in diabetic rats, dogs, mice, and healthy individuals (both IDDM and NIDDM).[16] For 21 days, separated fibres, saponins, and other proteins from fenugreek seeds were given to alloxan-diabetic dogs with their meals. This had an antihyperglycemic and anti-glycosuric effect in addition to significantly lowering high plasma glucagon and somatostatin levels. Following oral treatment of 2 and 8 g/kg of plant extract, blood glucose levels in both normal and diabetic rats (PB/0.05) decreased in a dose-dependent manner.[17]

13. *Cyamopsistetragonoloba*: guar, gawar,

Alloxan-induced diabetic rats received an ethanol extract of C. tetragonoloba (Fabaceae) beans, which significantly lowered blood glucose levels.[18] which can be achieved by lowering gastrointestinal glucose absorption and increasing gastrointestinal glucose utilisation.[19]

14. *Cinnamomumzeylanicum*

It is frequently used in East Asia and Europe and is referred to as cinnamon (Lauraceae). It is often used to treat diabetes in folk medicine. There are volatile oils in it, primarily cinnamaldehyde. Consuming cinnamon reduced total plasma sugar levels while improving insulin sensitivity. Additionally, it drastically decreased postprandial glycemic response and significantly decreased stomach emptying.[20] Additionally, the up-regulation of uncoupling protein-1 (UCP-1) and the enhancement of GLUT4 translocation in the muscle and adipose tissues by cinnamon aqueous extract demonstrated a potent anti-diabetic activity.[21]

In a dose-dependent manner, oral administration of cinnamaldehyde, its main active component, caused a marked increase in serum insulin, hepatic glycogen, and high-density lipoproteins as well as a significant decrease in serum glucose, glycosylated haemoglobin, total cholesterol, and triglyceride levels.[22]

15. *Brassica nigra*: Black Mustard

It is a member of the Brassicaceae family and native to the Mediterranean. In STZ-induced diabetic rats, the aqueous B. nigra seeds extract significantly reduced fasting serum glucose, glycosylated haemoglobin, and serum lipids, outperforming the effects of ethanol, acetone, and chloroform extracts.[23]

In order to improve glucose homeostasis in the liver and kidney, its mode of action is primarily attributed to increasing insulin secretion from the pancreas and controlling the effects of glucose metabolising enzyme.[24]

16. *Zingiberofficinale*: Ginger

It is a member of the Zingiberaceae family and is generally referred to as ginger. In STZ-induced diabetic rats, the juice of Z. officinale rhizome showed a notable decrease in FBG levels and a considerable increase in serum insulin. In diabetic rats, it is also effective in destroying serum triglycerides, blood pressure, and cholesterol. Serotonin (5-HT) receptors are particularly important for this diabetic regulation.[25] The differentiation of 3T3-L1 preadipocytes is induced by ginger extracts. Recent research has shown that gingerol, the primary active component, improves chronic diseases like diabetes by enhancing insulin sensitivity and cell-mediated glucose uptake.[26]

17. *Psidiumguajava*: Guava

It is known as guava and is a member of the Myrtaceae family. It has high concentrations of carotene, free sugars (glucose, fructose, and sucrose), vitamin C, and the B vitamins B1, B2, and B6. Aqueous leaf extract administered orally or intravenously to rats with alloxan-induced hyperglycemia has demonstrated positive effects on body weight, urine glucose and ketone levels, and pancreatic tissue, which exhibits a strong inhibitory activity on protein

tyrosine phosphatase1B.[27] While in type II diabetes, the methanol extract had a hypoglycemic impact. The powerful components, such as pedunculagin, isostrictinin, and strictinin, have been employed in clinical treatments for diabetes to increase insulin sensitivity.

Furthermore, the ethanol extract from the stem bark of P. guajava showed a notable hypoglycemic effect, which might not be attributable to boosting insulin release from pancreatic -cells but rather to an extrapancreatic mechanism demonstrated by improving peripheral glucose metabolism.[28]

Conclusion

An effort has been made in the current review to explore the readily accessible anti-diabetic herbal plants. Allopathic treatments, which are created using the principles of western medicine, are frequently inefficient, carry the danger of side effects, and are frequently excessively expensive. Herbal plants have no negative side effects, have a longer shelf life, and are crucial in the treatment of many diseases [29].

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Consent for publication

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Competing interests

The authors declare that they have no competing interests.

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