

Herbal Plants as an alternative Source for Anti-diabetes: A Review

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Abstract:

Diabetes mellitus remains a global problem as of 2021, approximately 537 million adults (aged 20-79) worldwide were living with diabetes. By 2045, this number is expected to rise to 783 million. The treatment for diabetes remains a concern with pharmacotherapy. Currently, herbal products are being used to treat diabetes mellitus alongside pharmacotherapy. The article reviews the efficacy and mechanisms of various herbal plants as an alternative source for controlling diabetes. Herbal plants such as Hibiscus (*Hibiscus Rosasinensis*), Bitter Gourd (*Momordica Charantia*), Fenugreek (*Trigonella Foenum-Graecum*), Cinnamon (*Cinnamomum verum*), and Tender Guava Leaf (*Psidium guajava*). These plants contain antioxidant, anti-diabetics properties and clinical studies suggest that incorporating of these herbs into the patient diet may help to control the blood glucose levels and mitigate diabetic symptoms, albeit with varying degrees of evidence and efficacy. However, this article specifies a comparative study of anti-diabetic herbal plants, plant morphology, their phytochemical activities, and the potency against diabetes are discussed.

Keywords: Blood-sugar, diabetes mellitus, herbal plants, *Psidium guajava*, *Trigonella Foenum-Graecum*, *Cinnamomum Verum*, *Momordica Charantia*, *Hibiscus*

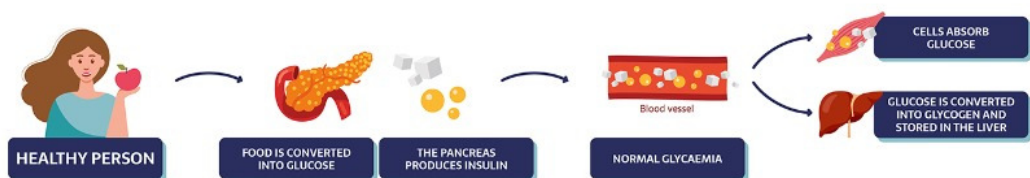
Introduction:

In the present world, there is a huge surge in the rise of patients who are treated for blood sugar treatment. Diabetes is a chronic metabolic disease with the rapid elevation of blood glucose, which leads to serious damage in the heart, blood vessels and other parts of the body.

Type 1 Diabetes: Type 1 diabetes is a chronic autoimmune condition characterised by the destruction of insulin-producing beta cells in the pancreas. Without enough insulin, glucose accumulates in the bloodstream, leading to high blood sugar levels, which can cause various complications over time.

Type 2 Diabetes: Type 2 diabetes is a complex condition that requires comprehensive management strategies tailored to individual needs. With proper management and support, many people with type 2

diabetes can lead active, healthy lives and reduce their risk of complications. One approach to managing diabetes is to slow down the absorption of glucose and lipids in the digestive organs.



Type 3 Diabetes: (Gestational): "Type 3 diabetes" is a term that has been proposed to describe a condition in which insulin resistance and insulin deficiency affect the brain, leading to cognitive impairment and an increased risk of developing Alzheimer's disease or other forms of dementia. However, it's important to note that "type 3 diabetes" is not an officially recognized medical term, and its use remains somewhat controversial. Gestational diabetes mellitus (GDM) is the type 3 diabetes that develops during pregnancy. It is characterized by high blood sugar levels that typically occur in the second or third trimester and usually resolves after childbirth. GDM is caused by hormonal changes and metabolic demands associated with pregnancy, which can lead to insulin resistance and impaired glucose tolerance in some women.

It is managed with drugs and lifestyle changes, but these methods are not completely successful. Diabetes can lead to complications such as nerve damage, heart attacks, kidney failure, blindness, and limb amputation. Currently, insulin and oral hypoglycaemic medications are used as pharmacotherapy to treat diabetes mellitus. These medications work by either raising the pancreatic secretion of insulin or by lowering gluconeogenesis and increasing glucose absorption, which lowers plasma glucose level. Diabetes affects half a billion people globally and is expected to rise by 25% in 2030 and by 51% in 2045¹. According to WHO, diabetes or hyperglycemia can be defined as a chronic, metabolic disease that is characterized by a persistent increased level of blood glucose (1). It is currently the 16th leading cause of death globally. The number of people with diabetes is expected to reach 300 million or more by 2025. The prevalence of diabetes is expected to double between 2005 and 2030, with the greatest increases in developing countries. The healthcare costs for diabetes are significant, accounting for 11.6% of the world's total healthcare costs in 2010. The majority of people with diabetes live in low- to middle-income countries, which puts a strain on their economies. Diabetes is also associated with life-threatening complications and can result in lost productivity and permanent disability. Plants have been used for medicinal purposes since ancient times. The ethnobotanical knowledge has a possible antidiabetic potential of approximately 800 plants (5) Chinese, ayurvedic, and folk medicine have extensively utilized natural products. Even today, a significant portion of the world's population relies

on herbal medicine. Diabetes is a common condition that affects around 463 million people worldwide. However, the current medications for diabetes often have harmful side effects, whereas herbal medicines have fewer adverse effects. Plants contain various secondary metabolites like alkaloids, flavonoids, tannins, and steroids, which have numerous beneficial effects on health. Over the years, extensive research has been conducted to explore the hypoglycemic potential of different plants. Herbal medicine is a growing area of health care that demands attention. Plants have played a significant role in maintaining human health and improving the quality of human life for thousands of years, and have served humans as valuable components of medicines (2). 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 treatments of diabetes, especially in India. In India it is proving to be a major health problem, especially in the urban areas. 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. A list of medicinal plants with proven antidiabetic and related beneficial effects and of herbal drugs used in treatment of diabetes is compiled. Many Indian plants have proved useful for controlling diabetes effectively. One of the main benefits of medicinal plants is that they are available conveniently and with relatively low side effects (4). The various factors that affect and cause diabetes mellitus are listed, the hormone insulin secretion by the beta cells and its abnormalities cause diabetes and the autoimmune destruction of these beta cells causes deletion in the beta cells and the lack of beta cells lead to the diabetes in the person.

Table 1. shows, the properties and anti-diabetic activities of the herbal plants.

Herbal Plants	Uses in Diabetes
Fenugreek	It helps in blood sugar control, Improved Insulin Sensitivity, reduced HbA1c Levels, Decreased Cholesterol Levels.
Cinnamon	It helps in lowering blood sugar levels, improves insulin sensitivity and reduces insulin resistance. There are two types of cinnamon, Ceylon and Cassia.
Tender Guava Leaf	Guava leaf was reported to exhibit antidiabetic effects including decreasing blood glucose.

Hibiscus	It contains bioactive compounds such as anthocyanins and polyphenols, which have been shown to have potential blood sugar-lowering effects. Hibiscus supplementation may lead to improvements in lipid metabolism, including reductions in total cholesterol.
Bitter gourd	Bitter gourd contains compounds such as charantin, polypeptide-p, and vicine that are believed to have hypoglycemic effects, meaning they can lower blood sugar levels. These compounds may work by increasing insulin secretion, improving insulin sensitivity, and inhibiting glucose absorption in the intestines.

Insulin is an essential hormone produced by the pancreas gland which has a role in controlling blood sugar levels by playing a role in the process of glucose absorption in the body (3). Enzymes such as Hexokinase and Glucokinase initiate the metabolism of glucose by phosphorylating and traps the glucose inside cells. They play a vital role in the glucose utilisation and regulation of blood glucose levels. Glycogen Synthase and Glycogen Phosphorylase control synthesis and breakdown of glycogen. Improper regulation will cause blood-sugar. Lipoprotein Lipase, this enzyme plays a role in lipid metabolism, particularly in breaking down triglycerides from circulating lipoproteins. Dysregulation of lipid metabolism can contribute to insulin resistance, a key feature of type 2 diabetes. Proteolytic Enzymes and Inflammatory Pathways, Inflammation and immune responses mediated by enzymes such as proteases can influence insulin sensitivity and beta cell function. Chronic inflammation is associated with insulin resistance and the progression of diabetes. Dysfunction or dysregulation of these enzymes, often influenced by genetic predisposition, lifestyle factor such as diet, exercise, etc., and other health conditions, develop and influence progression of diabetes mellitus. In this research review, we have gone through lots of literature studies about the effectiveness of herbal plants to reduce the diabetics and discussed the most common problem found in existing allopathy medicines as well as their photochemical properties. Hibiscus (*Hibiscus Rosasinensis*), Bitter Gourd (*Momordica Charantia*), Fenugreek (*Trigonella Foenum-Graecum*), Cinnamon (*Cinnamomum verum*), and Tender Guava Leaf (*Psidium guajava*) are the most popular and efficient herbal plants, according to a pervious literature study that examined the effectiveness of the phytochemical present in the herbal plant.

Morphology & Phytochemistry of *Trigonella Foenum-graecum*

Fenugreek seeds possess galactomannan. These are rich in soluble fibres, and it helps in reducing blood sugar level by paring down the digestive process and inhibiting the absorption of carbohydrates. (Fenugreek: diabetes and periodontal diseases.) The seeds are also rich in minerals such as iron,

potassium, calcium, copper, zinc, selenium, magnesium, and manganese. Many human and animal trials have shown the antidiabetic and hypolipidemic effect of oral fenugreek powder. Fenugreek (also known as *Trigonella foenum-graecum* of Fabaceae family) is used widely over the world, particularly in India, Egypt, China, and Middle Eastern nations, for both cooking purposes and the treatment of T2DM.

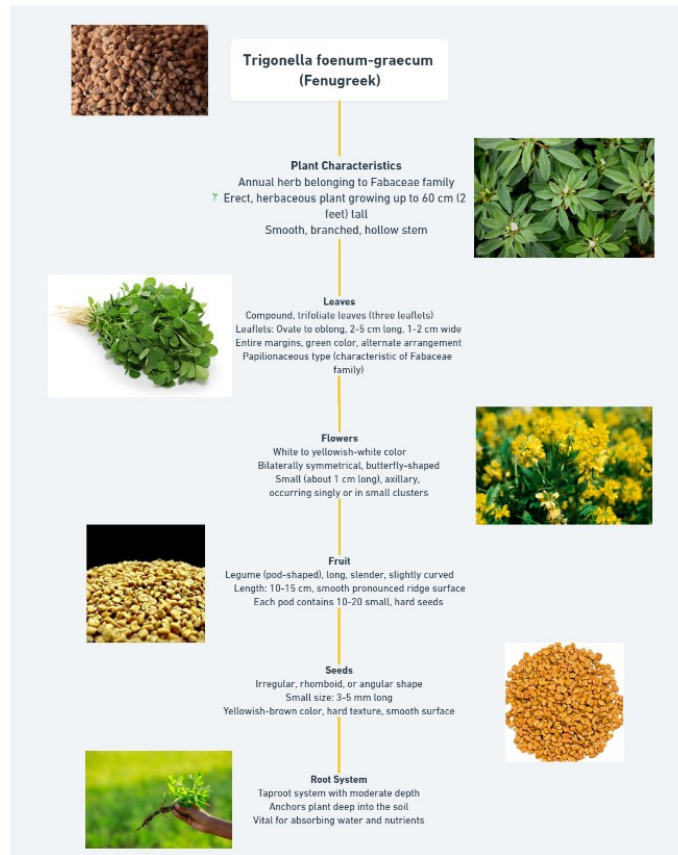


Figure 1 shows, the properties and anti-diabetic activities of the *Trigonella Foenum-graecum*

Alkaloids such as trigonelline and Fenugrecin present in fenugreek have been shown to have hypoglycaemic activity, whereas soluble fibres such as glucomannan fibre and 4-hydroxyisoleucine (4-OH Ile) amino acids stimulate the production of insulin from the pancreas. There are several reasons behind the antidiabetic effects of fenugreek. It is credited mainly to galactomannan and 4-hydroxyisoleucine (4-OH-Ile). 4-OH-Ile is a natural nonproteinogenic amino acid possessing noninsulinotropic activity, which has a direct effect on the individual islets of Langerhans causing increased glucose-induced release of insulin. Glucose-dependent insulin from pancreatic beta-cells is stimulated by the hypoglycemic effects of fenugreek, and also, it inhibits the activities of two intestinal enzymes involved in carbohydrate metabolism, namely, alpha-amylase and sucrase.

Morphology & Phytochemistry of *Momordica Charantia*

Bitter melon or Bitter Gourd has always been a medicine and an alternative intrinsic therapy for diabetes. It is a tropical and subtropical vine that is edible. Few bioactive compounds that play a significant role in the anti-diabetic work are, Charatin, Polypeptide-p, Vicine, Momordicin and Lectins. A special protein a 30-kDa protein isolated from bitter melon seeds, MAP30 has shown promise (Bitter Melon: A review of efficacy and safety). The mechanism of action is that it enhances insulin secretion, improves insulin sensitivity, inhibition of glucose absorption, anti-oxidative stress and modulation of lipid metabolism. It holds a significant promise as a natural remedy for diabetes management. Ongoing exploration and formulation can lead to optimal therapeutic effects. The fruit contains almost 93.2% water, added with protein and fat accounting for 18.02 and 0.76 percent of its dried weight, respectively.

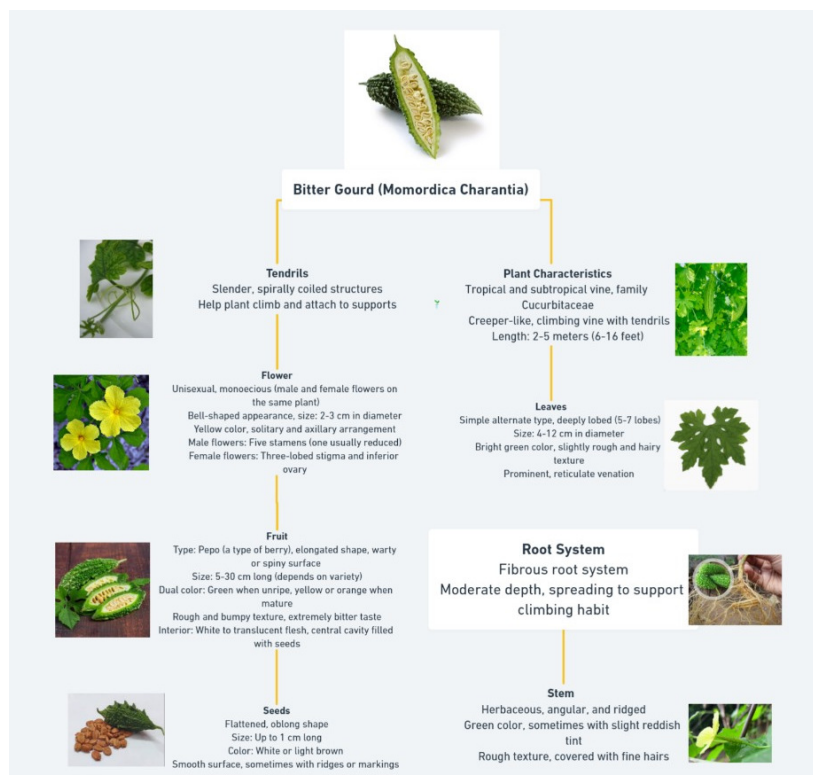


Figure 2 shows, the properties and anti-diabetic activities of the *Momordica Charantia*

However, 45% of the plant is seed constitutes 63-68% elestearic acid and 22-27% stearic acid. seed: composition and potential use. J Am Oil Chem Soc 73, 263–265) The stem contains glycosides which is classified as cucubitane-type triterpenoids. Four triterpenoids have AMP-activated protein kinase activity, potentially contributing to MC's hypoglycemic effects.

Morphology & Phytochemistry of Hibiscus

Hibiscus rosasinensis is an evergreen woody, glabrous, showy shrub, distributed throughout India and called as shoe flower plant or Chinese hibiscus. (Anti-diabetic activity of flowers) The flower, leaves and calyces of hibiscus are rich in bio—active compounds, the regulate blood glucose and have great health benefits.

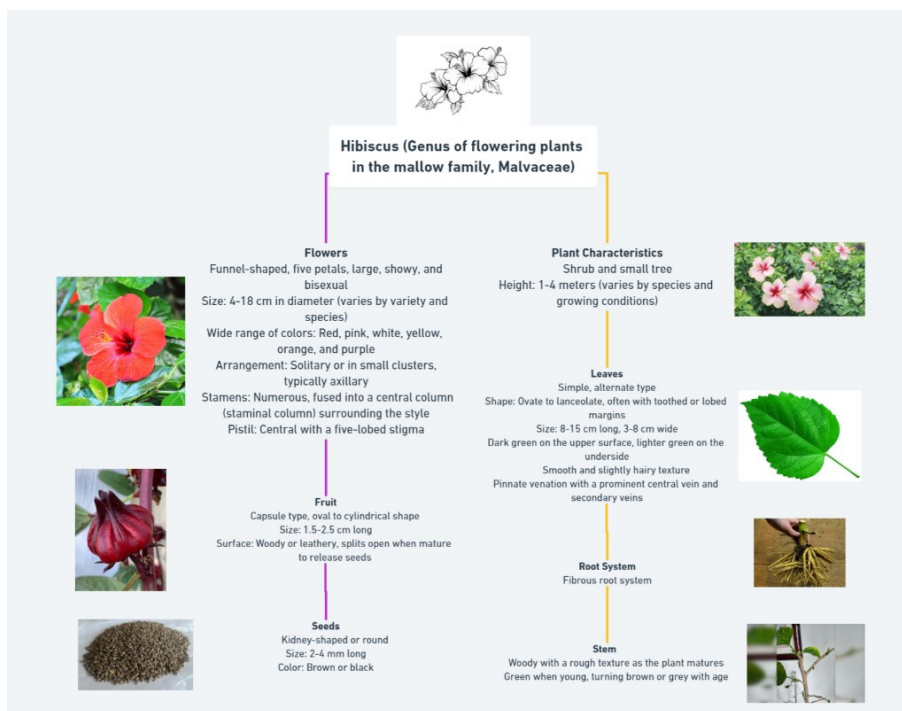


Figure 3 shows, the properties and anti-diabetic activities of the Hibiscus

Anthocyanins, Flavonoids, Organic acids, Polysaccharides and Phenolic compounds like chlorogenic acid, caffeic acid and protocatechuic acid which contribute to better glucose metabolism. Flowers of the plant are used in epilepsy, leprosy, bronchial catarrh and diabetes. This can be consumed as a tea, extract or supplement. Hibiscus offers potential anti-diabetic benefits through its rich array of bioactive compounds.

Morphology & Phytochemistry of Cinnamomum Verum

Cinnamon, a spice derived from the inner bark of trees belonging to the genus *Cinnamomum*. It has great medicinal properties. Cinnamon is among the many herbal medicines used for the treatment of DM. It has two main varieties, *Cinnamomum cassia* (also known as *Cinnamomum aromaticum*) and *Cinnamomum zeylanicum*

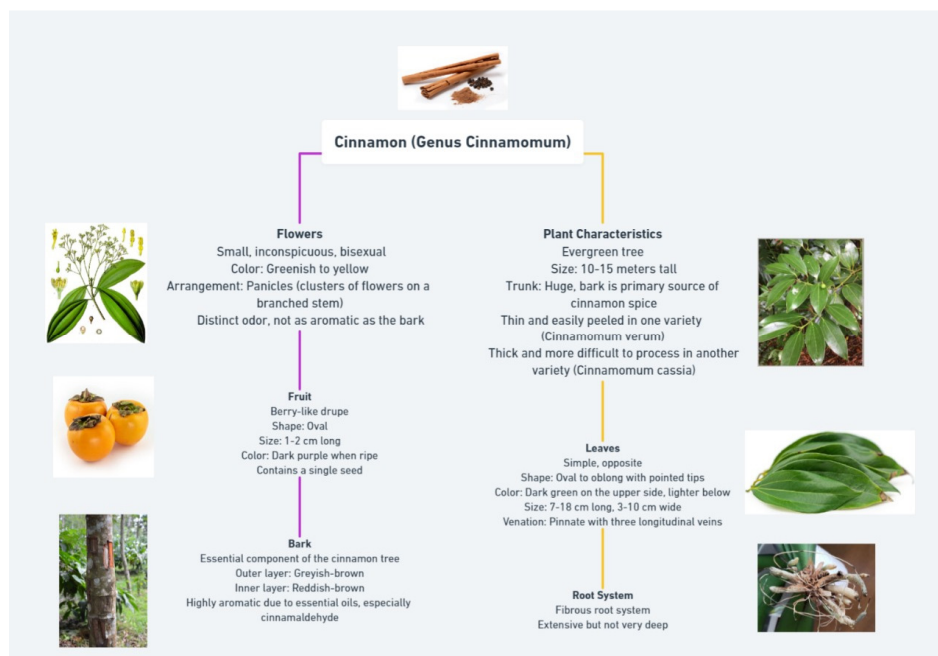


Figure 4 shows, the properties and anti-diabetic activities of the Cinnamomum Verum

The compounds present in Cinnamomum is Cinnamaldehyde, cinnamic acid, Polyphenols, Coumarin, Chromium. Cinnamon was the most bioactive product. The glucose oxidation enhancing bioactivity was lost from cinnamon by polyvinylpyrrolidone (PVP) treatment, indicating that the active phytochemicals were likely to be phenolic in nature. They concluded that the extract of cinnamon had improved the glucose and insulin metabolism.

Morphology & Phytochemistry of Psidium Guajava

Guava leaf, a traditional anti-inflammatory, anti-microbial, anti-oxidant and anti-diabetic herbal drug, is widely applied as a folk medicine for tropical and subtropical countries. (Guava Leaf Extract Attenuates Insulin Resistance). Different parts of Guava are reported to be used in folk medicine. In particular, the leaf extract of guava has traditionally been used for the treatment of diabetes in East Asia and other countries. Soman et al have shown that the extracts from guava leaves (GLE) could significantly decrease the levels of blood glucose, glycated hemoglobin and fructosamine in treated groups.

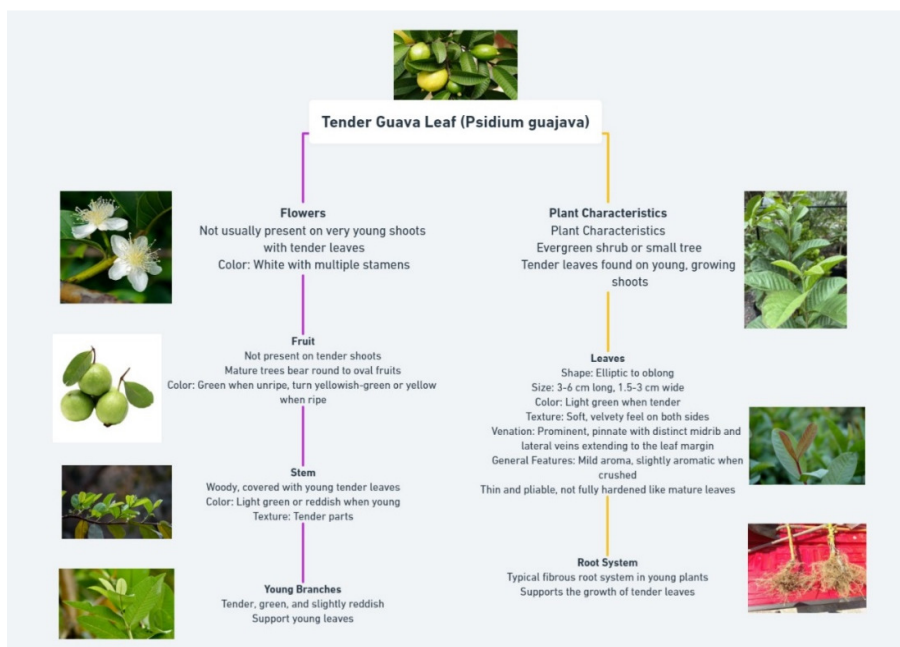


Figure 5 shows, the properties and anti-diabetic activities of the *Psidium Guajava*

Shen et al 12 also reported that GLE could improve hexokinase and phosphofructokinase activities in diabetic rats. In addition, the ability of cellular glucose uptake and glycogen synthesis were also significantly upregulated in the diabetic rats receiving GLE.

Conclusion:

Diabetes type 2 is an ongoing metabolic condition influenced by elevated blood sugar levels due to insulin resistance and impaired insulin production. Numerous physiological effects are observed in the body, such as nephropathy, neuropathy, and cardiovascular disease. The herbs that were addressed in the review above have remarkable anti-diabetic properties. Patients may control their diabetes more easily if they understand and use plants in an appropriate way. Additionally, this will improve the diabetic patients' quality of life. We conclude that adding this herbal plant to our regular diet is a simple and effective way to minimise the risk of type 2 diabetes.

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