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A Review on Herbal Hypoglycemic Chocolate

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Abstract: *Diabetes is a chronic metabolic disorder characterized by high blood glucose levels over a prolonged period, resulting from either insufficient insulin production by the pancreas (Type 1 diabetes) or ineffective use of insulin by the body's cells (Type 2 diabetes). Diabetes can lead to severe health complications, including cardiovascular disease, kidney failure, nerve damage, and vision impairment if not managed properly. It is a significant global health issue, impacting millions and associated with lifestyle, genetic factors, and environmental influences. Management of diabetes involves regular monitoring of blood glucose levels, dietary modifications, physical activity, and sometimes medication or insulin therapy. Prevention efforts focus on lifestyle changes, especially in populations at high risk for Type 2 diabetes. Early diagnosis and intervention are crucial for reducing long-term health risks associated with diabetes.*

Keywords: High blood glucose, Type 1 diabetes, Type 2 diabetes

I. INTRODUCTION

Diabetes mellitus is a collection of metabolic disorders marked by persistently high blood sugar levels brought on by deficiencies in either the action or secretion of insulin, or both. Because insulin is a crucial anabolic hormone, it causes irregularities in the metabolism of proteins, fats, and carbs. These metabolic abnormalities are caused by low levels of insulin to achieve adequate response and/or insulin resistance of target tissues, primarily skeletal muscles, adipose tissue, and to a lesser extent, liver, at the level of insulin receptors, signal transduction system, and/or effector enzymes or genes. Diabetes type and duration determine how severe symptoms are. Some people with diabetes have no symptoms at all, especially those with type 2 diabetes in the early stages of the condition. Others have high blood sugar levels, and children with complete insulin insufficiency may experience weight loss, blurred vision, polyuria, polydipsia, and polyphagia. Diabetes that is not under control can cause nonketotic hyperosmolar syndrome, ketoacidosis, stupor, coma, and, in extreme cases, death if left untreated. [1-3]

Out of 828 million people [4] with diabetes worldwide, around 212 million are in India. This means one in four people with diabetes is from India, making it the most affected country in the world. [5] (In November 2024, India's population was about 17.78% of the world's total population. [6])

Approximately 90 to 95 percent of Indians with a diagnosis had type 2 diabetes, and type 1 diabetes is less common in India than in western nations. In India, only around one-third of people with type 2 diabetes have a body mass index higher than 25. [7] According to a 2004 study, industrialization and rural-to-urban migration may have contributed to environmental and lifestyle changes that have increased the prevalence of type 2 diabetes among Indians. [8] As a result of this lifestyle shift, Asian communities are consuming more animal-based meals for energy. [9] In India, people in cities get 32% of their energy from animal fats, while in rural areas, it's 17%. These habits are starting earlier in life, leading to more long-term health problems. [10]

The International Diabetes Federation (IDF) estimates that 88 million people in Southeast Asia and 463 million people worldwide suffer from diabetes in 2020. India is home to 77 million of these 88 million individuals. [11] The IDF reports that the population's prevalence of diabetes is 8.9%. India has the second-highest rate of type 1 diabetes in children, after the United States, according to IDF estimates. among the SEA area, it also accounts for the highest percentage of incidence cases of type 1 diabetes among children. [12]

Per the World Health Organization, 2% of all deaths in India are due to diabetes. [13]

In 1990, 26 million Indians had diabetes; by 2016, that figure had risen to 65 million. The Ministry of Health and Family Welfare reported that the prevalence among those over 50 was 11.8% in the 2019 National Diabetes and Diabetic Retinopathy Survey.

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[14] The prevalence of diabetes is 6.5% and prediabetes 5.7% among the adults below the age of 50 years, according to the DHS survey. [15] The prevalence was similar in both male (12%) and female (11.7%) populations. It was higher in urban areas. [16] It was shown that 16.9% of diabetics up to 50 years old had diabetic retinopathy, a condition that endangers vision. Diabetic retinopathy was 18.6% in the 60–69 age group, 18.3% in the 70–79 age group, and 18.4% in the 80+ age group, according to the report. The age group of 50–59 years had a lower frequency of 14.3%. [14] States like Tamil Nadu and Kerala, which are economically and epidemiologically developed, have high rates of diabetes, and there are numerous research institutes there that carry out prevalence investigations. [17]

In India, there are four subgroups or clusters of individuals with type 2 diabetes, two of which are specific to the nation. These subgroups may require different treatments and have varying levels of risk for problems. [18][19]

Classifying diabetes is important for choosing the right treatment, but it can be difficult. Many patients, especially younger adults, don't fit neatly into one category, and about 10% may need their diagnosis updated later. The American Diabetes Association (ADA) created a classification in 1997 that divides diabetes into type 1, type 2, other types, and gestational diabetes (GDM). This system is still widely used today.

Wilkins introduced the accelerator hypothesis, which suggests that type 1 and type 2 diabetes are essentially the same condition caused by insulin resistance, but with different genetic factors. The main difference lies in the speed of onset. A faster onset, seen in more genetically vulnerable individuals, often occurs earlier and is linked to obesity and insulin resistance, which are central to this theory.

Other factors linked to type 1 diabetes include faster growth in height and reduced sensitivity of β cells (the cells that produce insulin) to glucose. High levels of free radicals, oxidative stress, and other metabolic stressors strongly contribute to the development, progression, and complications of diabetes, although clinical trials using antioxidants to treat diabetes have shown mixed results.

The female hormone 17-β estradiol, acting through the ER-α receptor, plays a critical role in maintaining and protecting pancreatic β cells. Studies have shown that oxidative stress can destroy β cells in mice lacking the ER-α receptor. The activity of the ER-α receptor shields pancreatic islets from damage caused by excess fat and glucose, preventing β-cell dysfunction. [20]

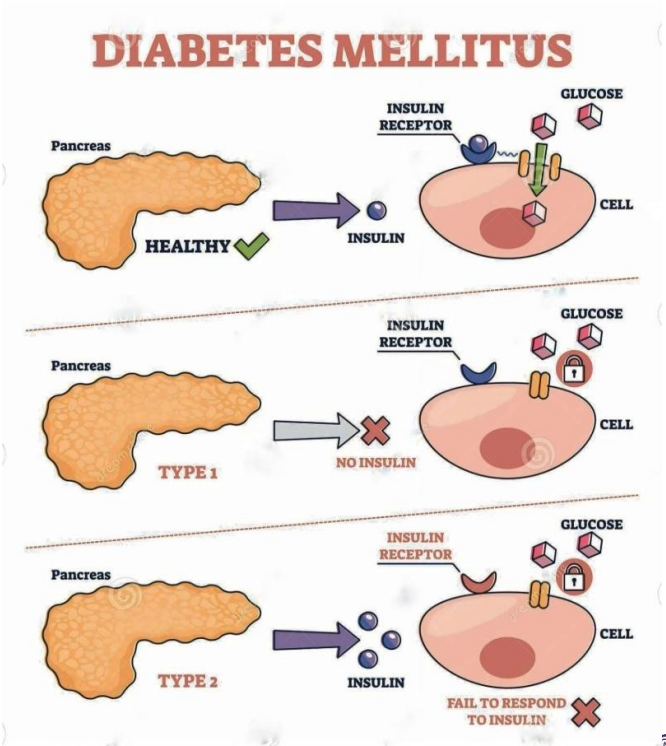

Fig1. Diabetes Mellitus

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Need of work:

- Cocoa may help the pancreas grow new insulin-producing cells, increase insulin release, lower blood sugar, and improve the body's ability to handle sugar.
- Moringa contain chromogenic acid which is an antioxidant, stabilizes blood sugar level
- Fenugreek seeds contain soluble fiber which delays intestinal absorption of ingested sugar
- Lowered Risk Of Sugar Crashes And Cravings
- Growings Interest In Functional Foods.

HISTORY:

- ARETAEUS OF CAPPADOCIA [2nd century]: Aretaeus, born in Cappadocia, was the greatest physician of Greco-Roman antiquity, surpassing Galen. He studied medicine in Alexandria and practiced in Rome during the 2nd century AD. Aretaeus' medical practice was based on the Pneumatic school, emphasizing the role of pneumatic and the theory of the four humors. He accurately described diseases like leprosy, asthma, pneumonia, tetanus, hysteria, epilepsy, and gout.
- THOMAS WILLIS (1621-1675): physician, studied classics and medicine at Oxford. He was appointed Professor of Natural Philosophy and wrote numerous books on the anatomy of the brain and nervous system, including the autonomic nervous system, spinal cord, vasculature, and cranial nerves.
- OSKAR MINKOWSKI (1858-1931) AND JOSEPH VON MERING (1849-1908): **In** 1889, Minkowski and von Mering conducted a ground-breaking experiment on diabetes mellitus, discovering that polarizing caused transient glucuresis in a dog. They repeated the experiment on three more dogs, all developing glycosuria.
- FREDERICK BANTING (1891-1941), CHARLES BEST (1899-1978), JAMES BERTRAM COLLIP (1892-1965) AND JOHN MACLEOD (1876-1935): **In 1923,**
  Frederick Banting and John MacLeod were awarded the Nobel Prize in Medicine for discovering insulin. Banting focused on diabetes studies, experimenting with pancreatic ducts and administering insulin extracts to depangreatized dogs and fetal calf pancreas.[21]

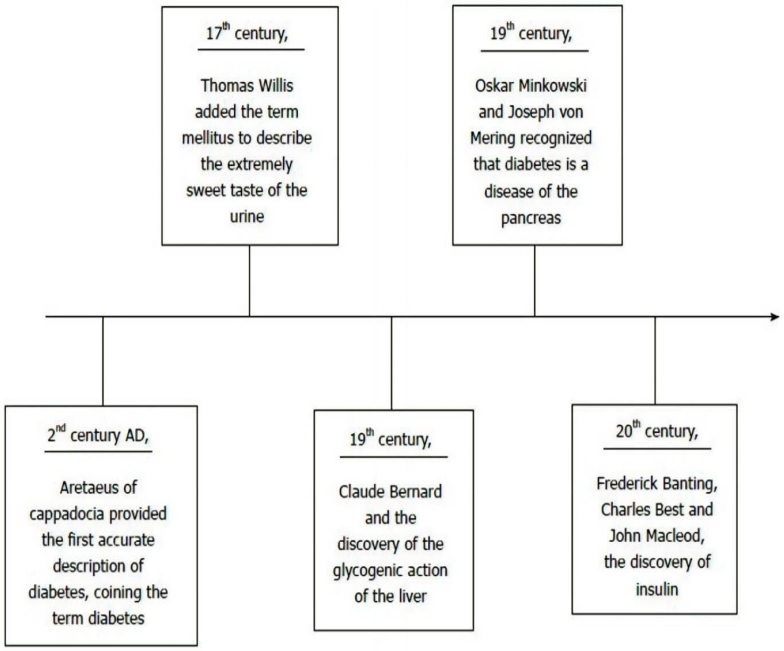

Fig2. History of Diabetes

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Type of Diabetes Mellitus:

There are primarily three types of diabetes

Type 1 Diabetes:

Type 1 diabetes affects 5%-10% of people with diabetes and happens when the pancreas's β cells are destroyed. It makes up 80%-90% of diabetes cases in children and teenagers. In 2013, the International Diabetes Federation (IDF) reported that 497,100 children aged 0-14 worldwide had type 1 diabetes, and 78,900 new cases were diagnosed each year. These numbers don't include all type 1 diabetes cases because it is also common in teens and adults over 14 years old.

In 2010, it was estimated that 3 million people in the United States had type 1 diabetes. In 2009, about 166,984 young people under 20 years old in the U.S. were living with type 1 diabetes. The global prevalence of type 1 diabetes is not known, but in the U.S., it affected 1.93 per 1,000 young people under 20 in 2009. This rate varied between 0.35 and 2.55 per 1,000 across different ethnic groups and was increasing by 2.6%-2.7% each year.

The autoimmune destruction of the pancreatic β cells through humoral (β cell) and T-cell-mediated inflammatory responses (insulitis) is the primary cause of type 1 diabetes. Autoantibodies against the pancreatic islet cells are a hallmark of type 1 diabetes, albeit it is unknown how these antibodies contribute to the pathogenesis of the condition. These autoantibodies include those to zinc transporter protein (ZnT8A), protein tyrosine phosphatase (IA2 and IA2β), insulin (IAA), glutamic acid decarboxylase (GAD, GAD65), and islet cell autoantibodies. The presence of these pancreatic autoantibodies in the serum of patients with type 1 diabetes may be identified months or years prior to the development of the disease.

DR and DQ genes are linked to autoimmune type 1 diabetes, which has substantial HLA connections. Both protecting and predisposing HLA-DR/DQ alleles are possible. The hallmark of this autoimmune type 1 diabetes is the lack of insulin secretion, and it is more common in kids and teenagers. [20]

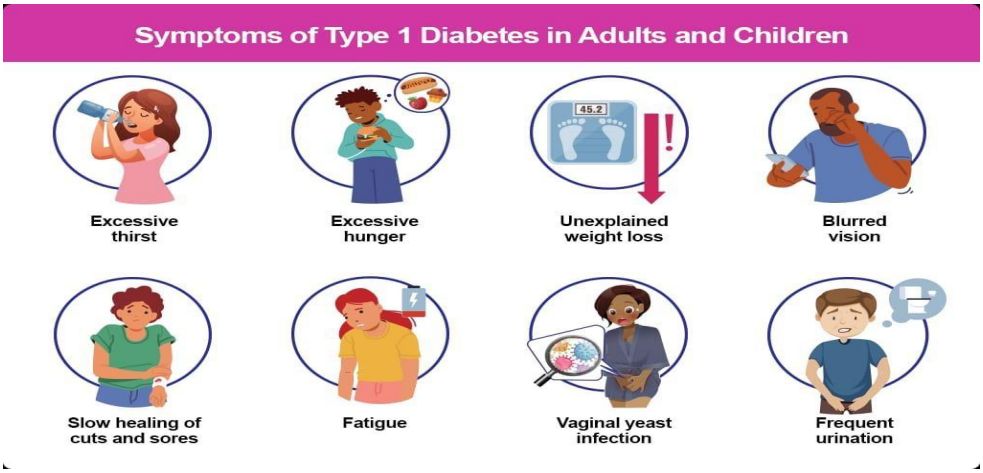

Fig. 3 Symptoms of Type 1 diabetes

Type 2 Diabetes Mellitus:

Over 90% to 95% of people with diabetes have this kind of diabetes, and the majority of them are adults. In 2009, 0.46 out of 1000 people in the United States were under the age of 20, making up around 20% of all type 2 diabetes cases in this age group.

The primary cause of the rise in type 2 diabetes in young people is the shift in children's lifestyles toward less nutritious eating and a more sedentary lifestyle. Type 2 diabetes is mostly caused by insulin resistance, which is primarily brought on by obesity. In order to identify type 2 diabetes, the American Diabetes Association advises screening overweight children and adolescents. The growth in childhood obesity is likely the primary cause of the higher incidence of type 2 diabetes in young people (30.3% increase in type 2 diabetes in children and adolescents overall between 2001 and 2009).

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Some people with type 2 diabetes show characteristics of type 1 diabetes, such as the presence of islet cell autoantibodies or GAD65 autoantibodies. These cases are classified as Latent Autoimmune Diabetes in Adults (LADA). People with LADA do not need insulin treatment initially. A recent study by Hawa and colleagues found that 7.1% of European patients with type 2 diabetes, with an average age of 62, tested positive for GAD autoantibodies. LADA was more common in people diagnosed with diabetes at a younger age. [21]

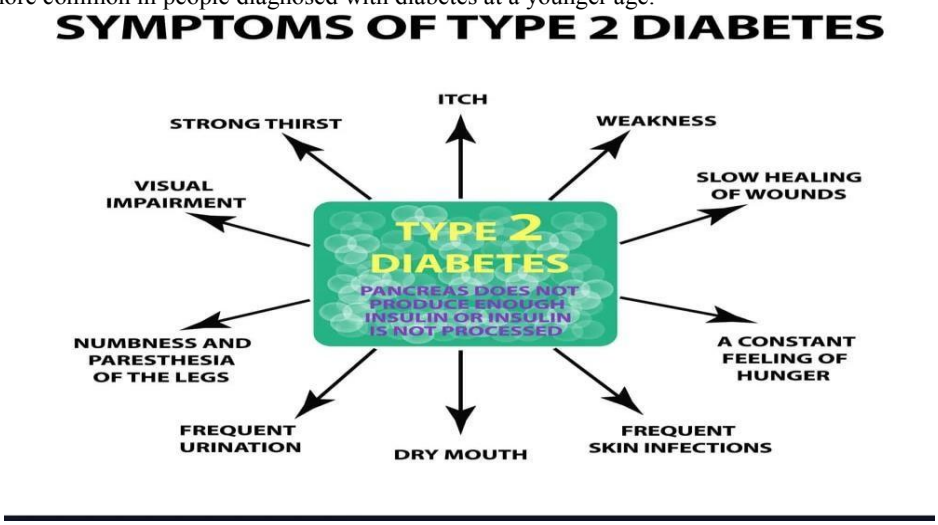

Fig 4. Symptoms of Type 2 Diabetes

Gestational Diabetes:

Gestational diabetes is a condition where a pregnant woman has high blood sugar during pregnancy, often caused by factors like obesity, diabetes family
history, and maternal age. It is the most common pregnancy complication and can be managed with insulin therapy and lifestyle modifications. Over half a billion people worldwide live with diabetes. [22]

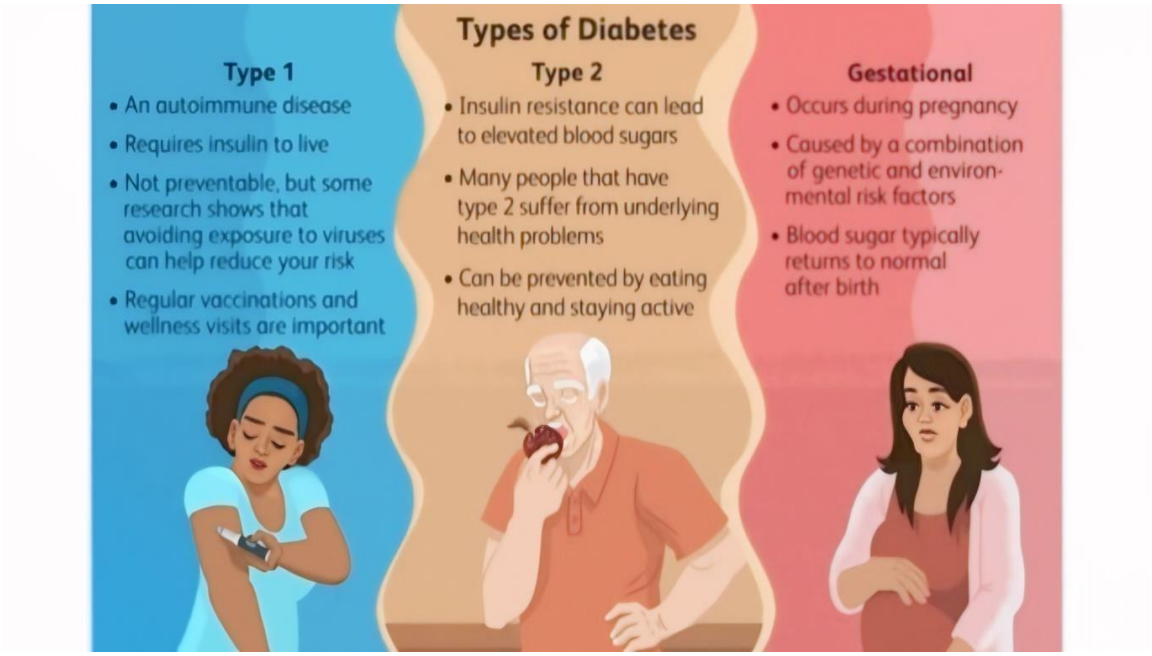

Fig 5. Type of Diabetes

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Pathophysiology of Diabetes:

Diabetes develops through a combination of genetic, environmental, and lifestyle factors. Here's a simpler explanation:

Type 1 Diabetes:

Type 1 diabetes mellitus progresses due to autoimmune destruction of pancreatic β-cells, leading to diabetic ketoacidosis (DKA). This syndrome causes faster fat breakdown, leading to liver processing and blood acidity. DKA typically occurs in children and young adults. As insulin deficiency increases, patients become insulin- dependent, resulting in severe hyperglycaemia and ketoacidosis. [23]

Type 2 Diabetes:

Type 2 diabetes mellitus is characterized by insulin deficiency and resistance, linked to inflammatory cytokines and high fatty acid levels. This leads to deficient glucose transport, fat breakdown, and increased hepatic glucose production, resulting in hyperglycaemia due to over-secretion of glucagon and insulin deficiency. [24]

Type 2 diabetes often goes undiagnosed early due to its slow, asymptomatic progression. Symptoms like polydipsia, weight loss, and vision impairment appear later. The disease's etiology is influenced by genetic and environmental factors, lifestyle choices, family history, obesity, and pathophysiological conditions. [23]

Gestational Diabetes Hormonal changes:

In the second or third trimester of pregnancy and gestation, diabetes or glucose intolerance is measured and known as gestational diabetes mellitus. It is seen that random blood and fasting blood concentrations are below the normal value at the beginning of pregnancy, and an exponential rise in blood glucose levels during the third trimester validates gestational diabetes mellitus. [23]

Risk factors:

- Being overweight,
- A family history of diabetes,
- Lifestyle factors,
- Environmental factors. [23]

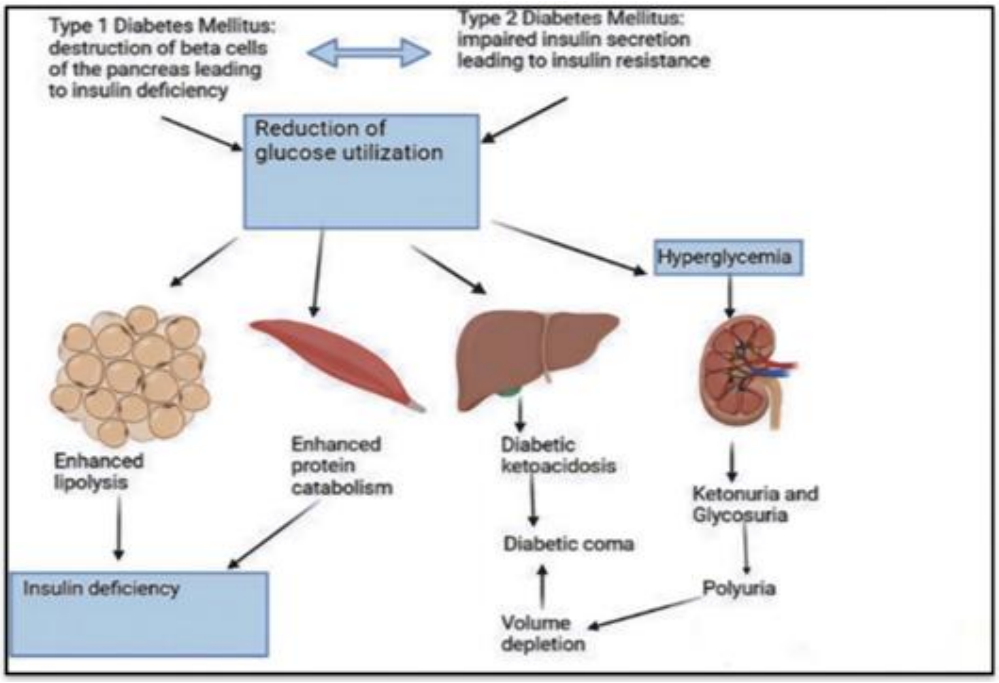

Fig 6. Pathophysiology of Diabetes

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Diet for Diabetes:

Type 1 Diabetes	Type 2 Diabetes
Fruits (cherries ,kiwi)	Fruits (apples, oranges)
Vegetables (tomatoes , bell papers)	Vegetables (cauliflower, spinach)
Seeds (flaxseeds ,fenugreek)	Seeds (pumpkin seeds,chia seeds)
Healthy fats (fatty fish)	Healthy fats (olive oil, sesame oil)
Whole grains (Brown rice,)	Whole grains (oats, brown rice)
Nuts (peanut)	Nuts (almonds, walnuts)

Table 1. Diet For Diabetes

Foods to Avoid :

Type 1 diabetes	Type 2 diabetes
Added sugar	High fat meat
Refined grains	Sweets
Juice drinks	Full fat dairy
Sugary breakfast cereals	Potato chips
Processed foods	Butter,Cheese

Table 2. Foods To Avoid

Treatment:

Tolbutamide :

MOA:

ATP-sensitive Potassium (K-ATP) Channel Binding: Tolbutamide binds to and blocks ATP- sensitive potassium channels on the beta cell membrane.

↓

Cell Depolarization: By blocking these potassium channels, tolbutamide causes a build-up of potassium inside the cell, leading to depolarization of the cell membrane.

↓

Calcium Influx: Calcium can enter beta cells when voltage-gated calcium channels are opened by depolarization.

↓

Insulin Release: The influx of calcium triggers the release of insulin-containing vesicles from the beta cells into the bloodstream.

Dose: 0.5 – 3 g/day. [25]

Metformin: MOA:

Inhibition of Hepatic Gluconeogenesis: Metformin decreases the production of glucose by the liver (hepatic gluconeogenesis). It does this by activating an enzyme called AMP-activated protein kinase (AMPK), which reduces the expression of enzymes involved in glucose production.

↓

Enhanced Insulin Sensitivity: Metformin increases insulin sensitivity in peripheral tissues, especially muscle and fat, which allows cells to take in glucose more effectively.

↓

Reduced Intestinal Glucose Absorption: Metformin also slightly decreases glucose absorption from the intestines, contributing to lower blood glucose levels.

Dose: 0.5 – 2.5 g/day. [25]

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Medicinal Plants For Diabetes Mellitus :

	Type 1 diabetes	Type 2 diabetes
1.	Jamun	Fenugreek
2.	Turmeric	Garlic
3.	Bel	Moringa oleifera
4.	Tulsi	Aloe
5.	Better Melon	Ginger
6.	Berberine	Cinnamon
7.	Gulvel	Gava

Table 3. Medicinal Plants for Diabetes Mellitus

Plant profile:

Moringa oleifera:

Synonyms : Drumstick tree, Saijihan tree, Sajna tree, and Mulangay tree.

Biological source: It can consist of dried long, slender, triangular seed –pods of Moringa Oleifera.

Family *: Moringaceae*

Chemical Constituents: Alkaloids, Saponins, Fatty Acids, Tannins, Amino Acids.

Biological Activity - Antioxidant, Anticancer, Antihypertensive, Hepatoprotective, and Nutritional effects. [26]

Fig 7.Moringa *oleifera*

Moringa oleifera may have a number of different ways of working, such as increasing insulin secretion, inhibiting the activities of α-amylase and α-glucosidase, decreasing gluconeogenesis in the liver, increasing the uptake of glucose in the muscles and liver, inhibiting the uptake of glucose from the intestine, and having ant oxidative qualities. This plant's antidiabetic properties may be due to its ability to reduce insulin resistance by either reducing inflammation or oxidative stress. There is relatively little information in the literature about this antidiabetic plant's phytochemicals directly influencing insulin activation signaling. [27]

Phytochemistry:

It is a storehouse of ingredients, among which major ones are carotenoids, [28] tocopherols (α, γ, δ), [29] flavonoids, phenolic acids,[30,31] folate, [32] polyunsaturated fatty acids,[33] and various minerals.[34] E-lutein was found to be the most abundant carotenoid found in leafage. The root of the plant contains compounds called 4-(α-l-rhamnopyranosyloxy)-benzylglucosinolate and benzylglucosinolate. These help fight bacteria. Other compounds like β-sitosterol, vanillin, 4-hydroxymellein, and octacosanoic acid are found in the stem, while the outer layer of the plant contains 4-(α- l-rhamnopyranosyloxy)-benzylglucosinolate. [35]

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Ayurvedic Remedies:

Moringa (*Moringa oleifera),* known as the "drumstick tree" or "miracle tree," is highly valued in Ayurveda for its numerous medicinal properties, including antidiabetic effects. Different parts of the moringa plant, such as leaves, seeds, pods, and bark, have traditionally been used in Ayurvedic remedies to help manage diabetes. Here's how each part is used:

Moringa Leaves :

Antidiabetic Properties: Moringa leaves are rich in polyphenols, flavonoids, and essential micronutrients, which help reduce blood sugar levels. The leaves help improve insulin sensitivity and decrease glucose absorption in the intestines.

Ayurvedic Remedy:

Leaf Powder: Dried moringa leaf powder is commonly used for diabetes management. About 1–2 teaspoons of powder can be taken daily, mixed in water or added to smoothies and foods.

Juice: Fresh moringa leaf juice, taken on an empty stomach, can also help reduce blood glucose levels.

Tea: Moringa leaf tea is another gentle way to consume the leaves. The tea can be consumed once or twice daily to help control blood sugar.

Moringa Seeds :

Antidiabetic Properties: Moringa seeds contain bioactive compounds, including glucosinolates and isothiocyanates, which exhibit antidiabetic effects. These compounds help regulate blood sugar by enhancing insulin secretion and lowering insulin resistance.

Ayurvedic Remedy:

Seed Powder: The seeds are often dried and ground into a fine powder. One can take a small amount (1/4 to 1/2 teaspoon) daily, mixed in water or juice. However, since the seeds are potent, they should be used in moderation

Seed Extracts: Some Ayurvedic practitioners recommend extracts made from moringa seeds for a concentrated antidiabetic effect, but these should be used under professional guidanc.[36]

Fenugreek:

Synonyms: Fenugreek, Methi, Bird's foot, Greek Hay. **Biological source:** Dried seeds of Trigonella foenum **Family:** *Trigonella foenum graecum*

Chemical Constituents : Alkaloids ,Saponins ,Fatty Acids , Tannins ,Amino Acids phospholipids, glycolipids, oleic acid, linoleic acid, linoleic acid, choline, vitamins A, B1, B2, C, nicotinic acid, niacin,.

Biological Activity-Antidaibetic, Antioxidant, Anticancer, Antihypertensive, Weight management, Antimicrobial. [37]

Fig 8. Fenugreek

Although fenugreek's anti-diabetic properties have been known for centuries, the mechanisms have not been thoroughly investigated until a number of recent researches took the matter into consideration. Research has demonstrated that

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fenugreek seeds increase the expression of important proteins involved in glucose metabolism, which results in insulin-sensitizing effects. This would enhance the transfer of glucose and boost the storage of glycogen, suggesting its application in diabetes treatment. Although fenugreek's anti-diabetic properties have been known for millennia (Al-Habori et al., 2001), their entire significance is still unknown; this study presents some findings from recent research in this field. Recent research has demonstrated that fenugreek seeds have insulin-sensitizing effects and up-regulate key proteins involved in glucose metabolism, which may enhance glucose transport and boost glycogen storage and suggest the use of fenugreek therapy for diabetes (Kiss et al., 2018).

According to research on animals, fenugreek seeds have an anti- hyperglycaemic effect via enhancing insulin sensitivity, reducing the amount of glucose produced by the liver, and preventing the absorption of carbohydrates after oral administration. This allows fenugreek extract to influence three distinct and important physiological processes that may be involved in blood glucose balance maintenance. When it comes to regulating blood sugar, fenugreek can affect several objectives. An herbal supplement that addresses both of these processes will be more successful in maintaining blood glucose homeostasis at appropriate levels because Type 2 diabetes is caused by a combination of inadequate insulin action and increased hepatic glucose production (Neelakantan et al., 2014). [38]

Ayurvedic Remedies:

Fenugreek *(Trigonella foenum-graecum),* or Methi, is widely used in Ayurveda for its beneficial effects on managing diabetes due to its ability to lower blood sugar levels, improve insulin sensitivity, and enhance overall metabolic function. The different parts of fenugreek—seeds, leaves, and roots—are used in specific remedies to manage diabetes and improve glycemic control. Here are the Ayurvedic remedies for diabetes using different parts of fenugreek:

Fenugreek Seeds :

Fenugreek seeds are particularly effective in managing blood sugar levels due to their high content of soluble fiber and compounds like 4-hydroxyisoleucine, which enhance insulin sensitivity.

Soaked Fenugreek Seeds (for Blood Sugar Control):

Remedy: Soak 1–2 teaspoons of fenugreek seeds in a glass of water overnight. Strain and drink the water on an empty stomach the next morning.

Benefits: Soaked seeds contain mucilage, which helps slow down the absorption of carbohydrates, thus lowering post-meal blood sugar spikes. It also improves insulin function.

Dosage: Take it every morning for at least 1–2 months for visible results.

Fenugreek Seed Powder (for Blood Sugar Regulation):

Remedy: Dry roast fenugreek seeds and grind them into a fine powder. Take 1/2 teaspoon of the powder with warm water after meals.

Benefits: The powder helps in controlling blood sugar levels and reducing insulin resistance. Fenugreek seeds are rich in fiber and saponins that help regulate glucose metabolism.

Dosage: This remedy can be taken once or twice daily as per Ayurvedic guidance.

Fenugreek Seed and Cinnamon Mix:

Remedy: Mix 1/2 teaspoon of fenugreek seed powder with 1/2 teaspoon of cinnamon powder. Take this combination with warm water before meals.

Benefits: This combination is known to help balance blood sugar levels by enhancing insulin sensitivity and reducing glucose levels in the blood.

Fenugreek Leaves:

Fenugreek leaves are rich in antioxidants and dietary fiber, which can assist in managing blood sugar levels and promoting overall health.

Fenugreek Leaf Juice (for Blood Sugar Control):

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Remedy: Crush fresh fenugreek leaves to extract the juice. Drink 1 tablespoon of fenugreek leaf juice on an empty stomach every morning.

Benefits: Fenugreek leaves help reduce blood sugar by improving insulin sensitivity. They also have antioxidant properties that help protect the pancreas and improve its function in insulin secretion.

Dosage: Take this remedy daily for 2–3 months for better glycemic control.

Fenugreek Leaf Powder (as a Supplement):

Remedy: Dry fenugreek leaves in the shade and grind them into a powder. Add 1/2 teaspoon of this powder to warm water and drink it after meals.

Benefits: The powdered leaves help regulate blood sugar levels, reduce inflammation, and improve overall digestion, which is often a concern in diabetes.[39]

Ficus Racemosa:

Synonyms: cluster fig, *Indian fig tree, umbar.*

Biological source: Native to India, Australia and Southeast Asia

Family: *Moraceae*

Chemical Constituents: Alkaloid, Saponins, Fatty Acids, Tannins, Amino Acids.

Biological Activity - Antidaibetic, Antioxidant, Anticancer, Antihypertensive, Weight Management, Antimicrobial. [40]

Fig 9. Ficus Racemosa

Strong antidiabetic effects have been documented for β-Sitosterol that was extracted from stem bark. [41] In alloxan-induced diabetic albino Wistar rats, Kar et al. found that ethanol extract (250 mg/kg/day, once, twice, and three times daily, oral [PO]) stabilized blood glucose, decreased urine sugar, and assisted in bringing it down to zero within two weeks. [42] In a different trial, a researcher suggested that methanol extract from the stem bark (200 and 400 mg/kg, PO) had an effect that was comparable to that of the common medication glibenclamide (10 mg/kg) in both normal and alloxan-induced rats.[43] In both normal and alloxan-induced diabetic rats, a different experiment also showed that fruit methanol extract had good hypoglycemic efficacy at dosages of 1, 2, 3, and 4 g/kg, p.o.
[44] The stem bark aqueous extract had greater glucose adsorption activity and a lower glucose retardation index, which were similar to those of wheat bran and acarbose, according to another study by Ahmad and Urooj. [45]

Ayurvedic Remedies:

Ficus Racemosa (cluster fig, Gular) is valued in Ayurvedic medicine for its various healing properties. Different parts of the plant—such as the bark, leaves, fruit, and roots—are used in remedies to treat conditions like diabetes, digestive issues, skin disorders, and inflammation. Here are some Ayurvedic remedies using different parts of *Ficus Racemosa:*

Leaves

For Diabetes Management:

Crush fresh *Ficus Racemosa* leaves to extract the juice. Take 1 tablespoon of the juice daily on an empty stomach.

Benefits: The leaf juice helps lower blood sugar levels and provides antioxidants to support pancreatic health.

Root

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For Diabetes Management:
Boil a small piece of *Ficus Racemosa* root in water to prepare a decoction. Take one dose of the decoction every day.
Benefits: The root contains compounds that may help lower blood sugar and improve metabolic health. [46]

Theobroma Cacao:
Synonyms: Chocolate Tree, Cacao, Erythroxylom Cacao.
Biological source: Theobroma cacao tree originated in the upper Amazon basin region (Brazil, Colombia, and Peru).
Family: *Sterculiaceae*
Chemical Constituent: Alkaloids, Polyphenol, Lipids, flavonoid, Amino Acids.
Biological Activity- Antidaibetic, Antioxidant, Anti-Obesity Effects, Anticancer, Antihypertensive, Weight management, Antimicrobial. [47]

Fig 10. Theobroma Cacao

Another name for cacao powder is "cocoa solids," which is an unsweetened product made by removing the cocoa butter from cacao beans. The resulting powder has a bitter flavor and is rich in minerals, fiber, and antioxidants. The cocoa powder has a flavor that is similar to dark chocolate but less sweet, even though it doesn't have the creamy texture of regular chocolate because the fat from the cocoa beans is removed. Theobroma cacao, a tropical tree, is the biological source of cocoa beans, which are made from the seeds of this plant.
Cacao powder has several health advantages and is a strong source of antioxidants. However, how does cacao powder reduce the chance of developing diabetes? Because cacao powder has a low glycaemic index, it helps avoid sugar surges. Epicatechin monomer molecules found in cocoa powder have been shown in studies to enhance insulin synthesis and control blood sugar levels. Because cacao powder has a low glycaemic index, it helps avoid sugar surges. [48]

Preparation of cacao powder:

Harvesting: When the cacao pods are ready, they are taken from the cacao tree (Theobroma cacao). In order to prevent tree damage, pods are typically removed from the tree using blades or other instruments

↓

Pod Opening: The cacao beans, which are encased in a sticky, delicious pulp, are extracted by delicately opening the harvested pods.

↓

Fermentation: The extracted beans are put in shallow wooden boxes, baskets, or banana leaves, together with the pulp that surrounds them. The pulp's sugars can be converted to acids over the five to seven days of fermentation. This technique makes the cacao taste better.

↓

Drying: The beans are laid out to dry in the sun following fermentation. It usually takes 5 to 10 days for them to dry evenly, therefore they are flipped frequently. Drying properly lowers moisture content and stops mold from growing.

↓

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Roasting: The dried beans are roasted to develop their chocolatey flavor. Roasting temperatures and times vary depending on the desired flavor profile, usually between 120°C and 150°C for 15–30 minutes.

↓

Winnowing: After roasting, the beans are cracked open to remove the outer shells. This process separates the cacao nibs (the edible part) from the husk.

↓

Grinding: The cacao nibs are ground into a paste called cocoa mass or chocolate liquor. This paste contains both cocoa solids and cocoa butter.

↓

Pressing: To extract the cocoa butter from the cocoa solids, the mass of cocoa is compressed. Cacao powder is made from the waste solids.

↓

Grinding into Powder: The cocoa solids are further ground into a fine powder, resulting in cacao powder. This powder can be natural or alkalized (Dutch-processed) to reduce acidity and alter the flavour

↓

Packaging: The final cacao powder is packaged and stored in airtight containers to preserve its quality. [49]

Ayurvedic Remedies:

In Ayurveda, the cacao plant is considered beneficial for health due to its numerous medicinal properties, some of which may aid in managing diabetes. Here's a look at how various parts of the cacao plant may be used for diabetes.

Cacao Powder (Seeds):

For Blood Sugar and Insulin Sensitivity: Cacao powder is rich in flavonoids like epicatechin, which may support insulin sensitivity and stabilize blood glucose levels. In Ayurveda, bitter flavours are thought to support liver function and balance blood sugar.

Remedy: Mix 1 teaspoon of unsweetened cacao powder with cinnamon (dalchini) and fenugreek (meth) powders in warm water or almond milk. These herbs enhance cacao's benefits as they also help lower blood sugar levels and improve insulin sensitivity.

Benefits: This combination may improve post-meal blood sugar regulation, reduce cravings, and provide antioxidant support, especially helpful for managing vata and kapha imbalances common in diabetes.

Cacao Leaves

For Metabolism and Glucose Control: Cacao leaves, though less commonly used, can be prepared as tea to support metabolism and blood sugar control. Ayurvedic tradition includes the use of herbal teas to support balanced blood sugar.

Remedy: Brew a tea with cacao leaves and add a pinch of dried neem leaf or tulsi (holy basil), both renowned in Ayurveda for their anti-diabetic properties.

Benefits: This tea can help reduce blood sugar spikes and calm the mind. Neem and tulsi have a long history in Ayurveda for supporting glucose metabolism and reducing blood sugar fluctuation. [50]

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Fig 11: Health Benefits of Dark chocolate

II. CONCLUSION

Diabetes is a chronic medical condition where the body either does not produce enough insulin or cannot effectively use the insulin it produces. This results in elevated blood sugar levels, which can lead to serious complications if not managed. Proper management through a healthy diet, regular exercise, medication and regular monitoring can help individual's live healthier lives and reduce the risk of complications. Fenugreek, moringa, Ficus racemosa, and coca plants have shown potential Antidaibetic properties due to their ability to regulate blood sugar levels, improve insulin sensitivity, and reduce oxidative stress. These plants contain bioactive compounds that may complement diabetes management, but further research and clinical studies are needed for confirmation and safe therapeutic use.

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