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Formulation and Evaluation of Herbal Hypoglycemic Chocolate

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Abstract: ***Diabetes is a chronic metabolic disorder characterized by high blood glucoselevels overaprolongedperiod, resultingfromeitherinsufficientinsulin productionbythepancreas (Type1 diabetes)orineffectiveuseofinsulin bythebody's cells (Type2 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, dietarymodifications, 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: Highbloodglucose,Type1diabetes,Type2diabetes.

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 themetabolism 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 durationdeterminehowseveresymptomsare.Somepeoplewithdiabetes haveno 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 millionare 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 oftype 2 diabetes among Indians. [8] As a result of this lifestyle shift, Asian communities are consumingmoreanimal-basedmealsforenergy. [9]In India,peoplein citiesget32%oftheir energy from animal fats, while in rural areas, it's 17%. These habits are starting earlier inlife, 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,aftertheUnitedStates,accordingtoIDFestimates.amongtheSEAarea,italso accountsfor the highestpercentageof incidence casesof type1diabetes amongchildren.[12]PertheWorldHealthOrganization,2%ofalldeathsin Indiaareduetodiabetes.[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 thoseover50was11.8%inthe2019NationalDiabetesandDiabeticRetinopathySurvey.
[14]Theprevalence of diabetes is 6.5% and prediabetes 5.7% among the adults below the age of50 years,accordingtotheDHSsurvey.[15]Theprevalencewassimilarinbothmale(12%) andfemale (11.7%)populations. Itwashigherinurbanareas. [16]Itwasshownthat16.9%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.

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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]

Classifyingdiabetesisimportantforchoosingtherighttreatment,butitcanbe 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 theER-α receptor shields pancreatic islets from damage caused by excess fat and glucose, preventing β-cell dysfunction. [20]

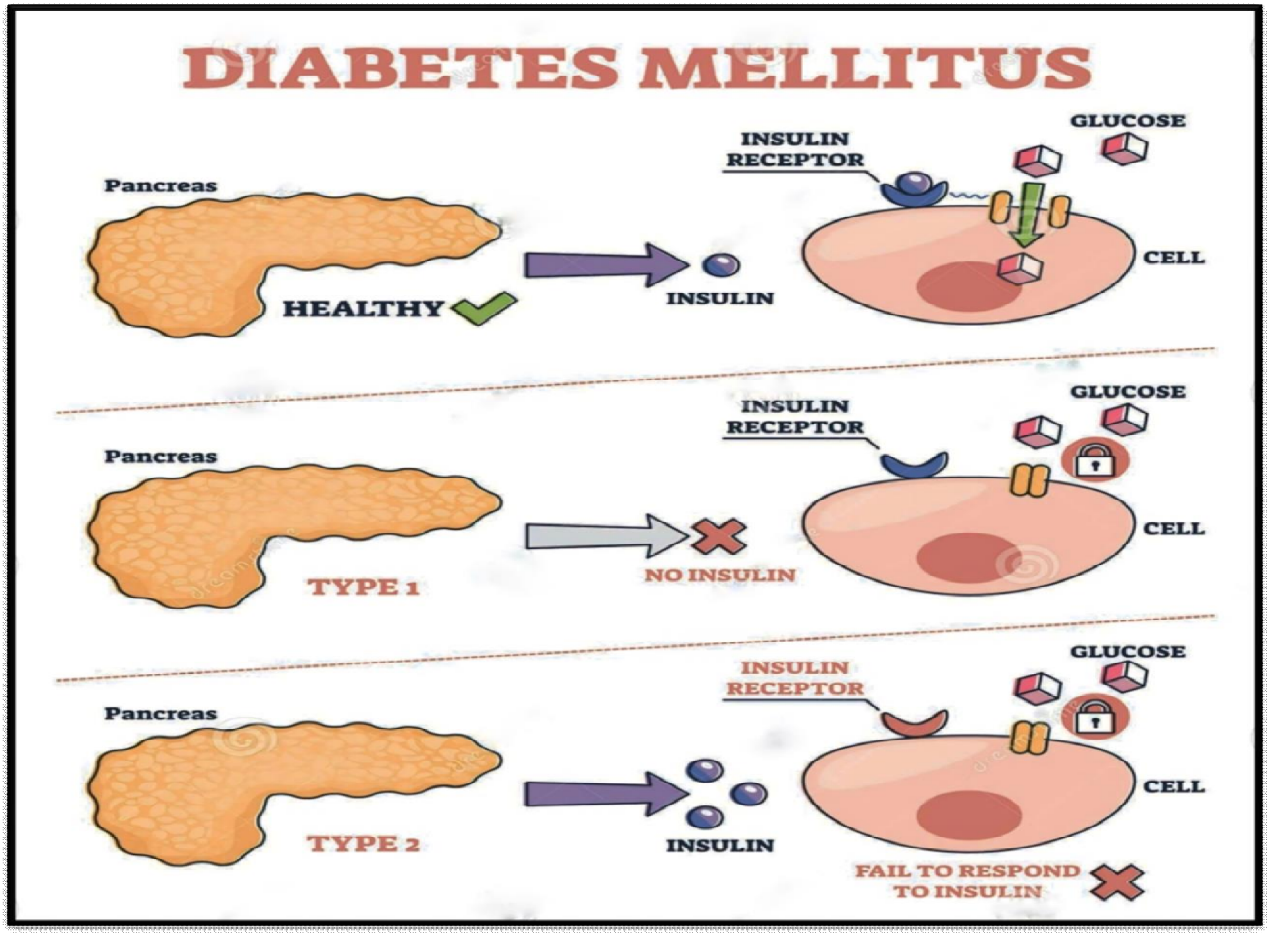


Fig1.DiabetesMellitus

II. NEED OF WORK

1) Cocoamayhelpthepancreasgrownewinsulin-producingcells,increaseinsulinrelease, lower blood sugar, and improve the body's ability to handle sugar.
2) Moringacontainchromogenicacidwhichisanantioxidant,stabilizesbloodsugar level
3) Fenugreek seeds contain soluble fiber which delays intestinal absorption of ingestedsugar
4) LoweredRiskOfSugarCrashesAndCravings
5) GrowingsInterestInFunctionalFoods.

III. HISTORY

1) ARETAEUS OF CAPPADOCIA [2nd century]: Aretaeus, born in Cappadocia, was the greatest physician of Greco-Roman antiquity, surpassing Galen. He studiedmedicine in Alexandria and practiced in Rome during the 2nd century AD. Aretaeus' medical practice was based on the Pneumaticschool, emphasizingthe role ofpneumatic and the theory of the four humors. He accurately described diseases like leprosy,asthma, pneumonia, tetanus, hysteria, epilepsy, and gout.
2) 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.
3) OSKARMINKOWSKI (1858-1931)ANDJOSEPHVONMERING(1849-1908):In1889, 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.
4) 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]

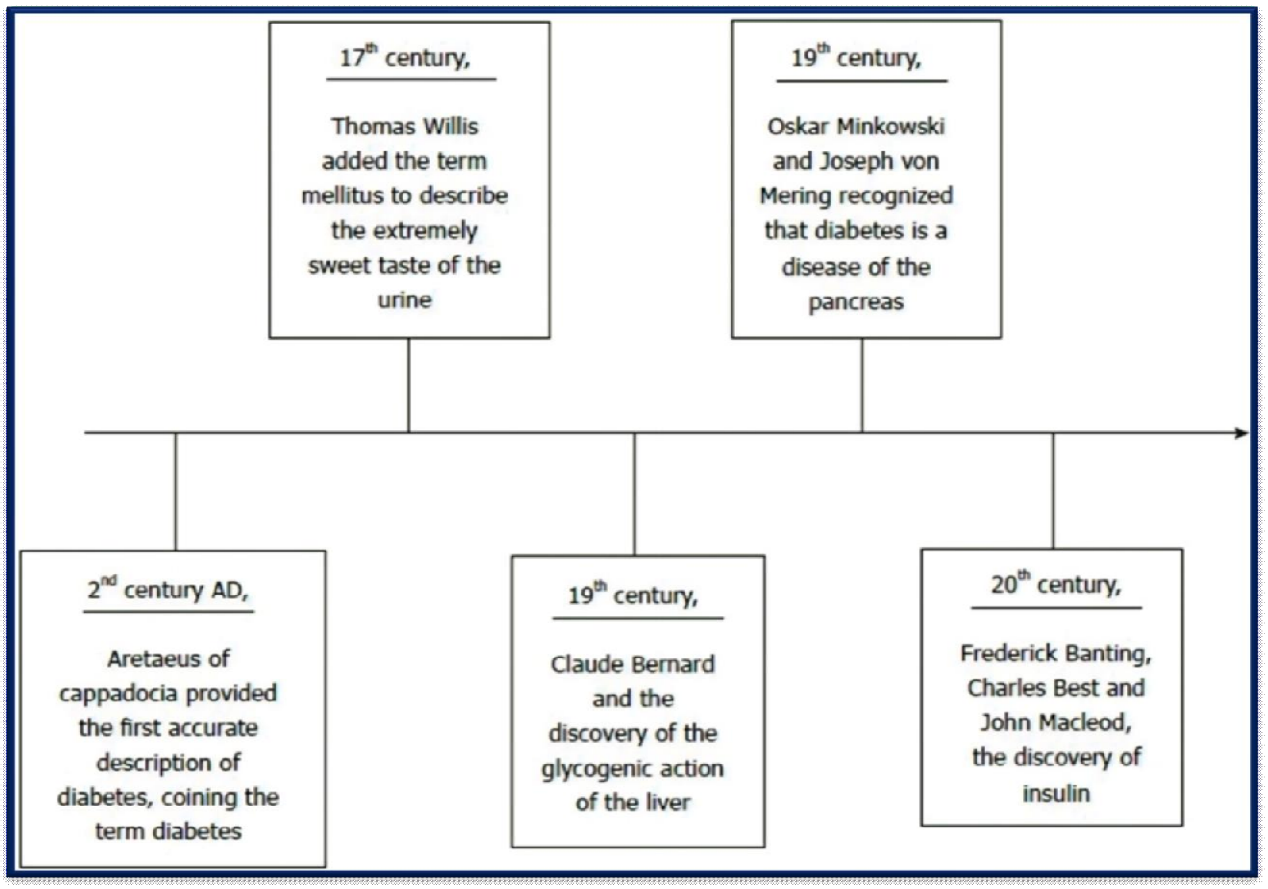


Fig2.Historyof Diabetes

IV. TYPE OF DIABETES MELLITUS

Therearepримarilythreetypesofdiabetes

A. *Type1Diabetes:*

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. In2013, 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 type1 diabetes. In 2009, about 166,984 youngpeopleunder20 yearsold in theU.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]

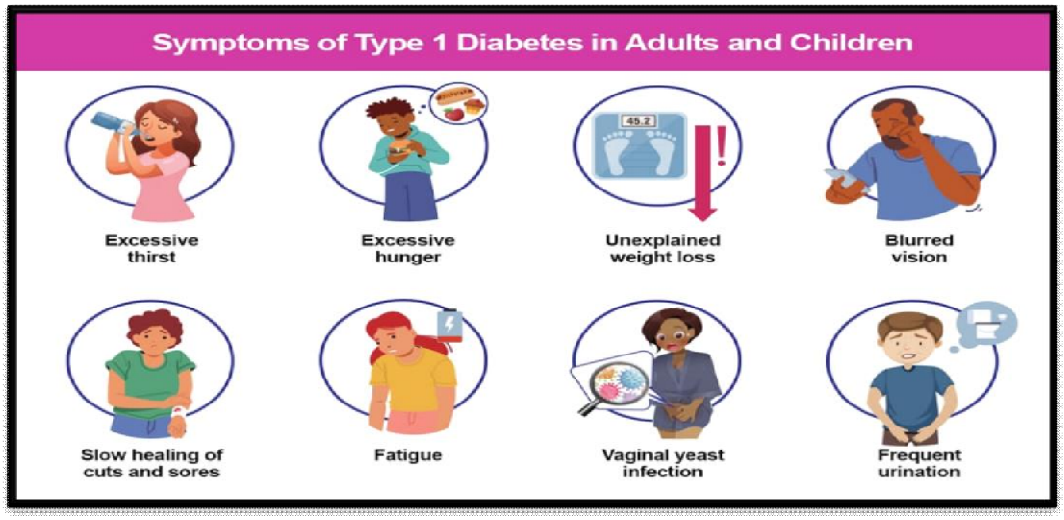


Fig.3SymptomsofType1diabetes

B. *Type2DiabetesMellitus:*

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 Stateswere 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).

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 averageage of 62, tested positive for GAD autoantibodies. LADA was more common in people diagnosed with diabetes at a younger age.[21]

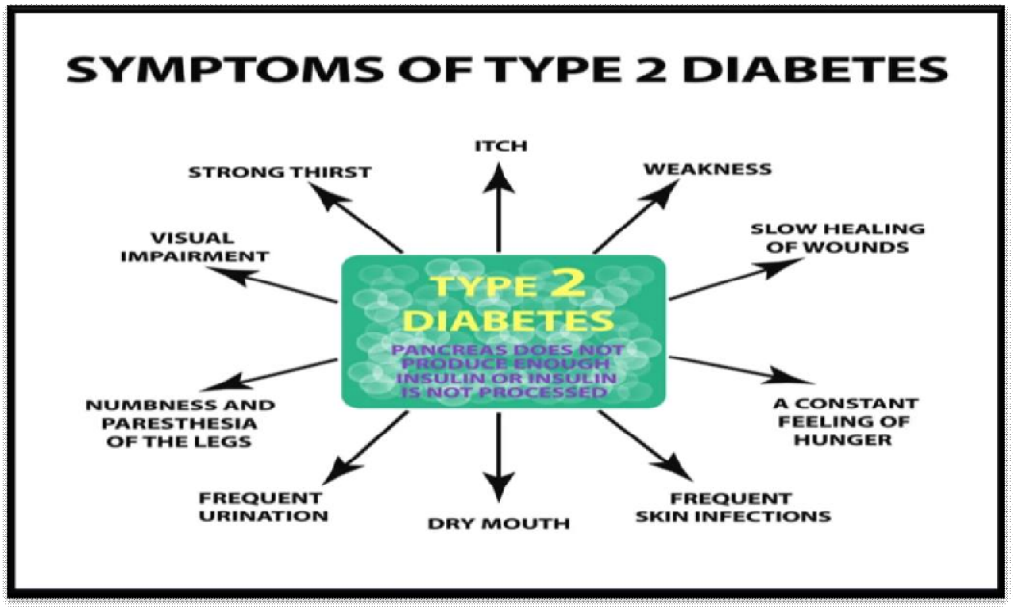


Fig4.SymptomsofType2Diabetes

C. Gestational Diabetes:

Gestationaldiabetesisaconditionwhereapregnantwomanhashigh blood sugar during pregnancy, often caused by factors like obesity, diabetes familyhistory,andmaternalage.Itisthemostcommonpregnancycomplicationandcanbe managed with insulin therapyand lifestyle modifications. Over half a billion people worldwide live with diabetes. [

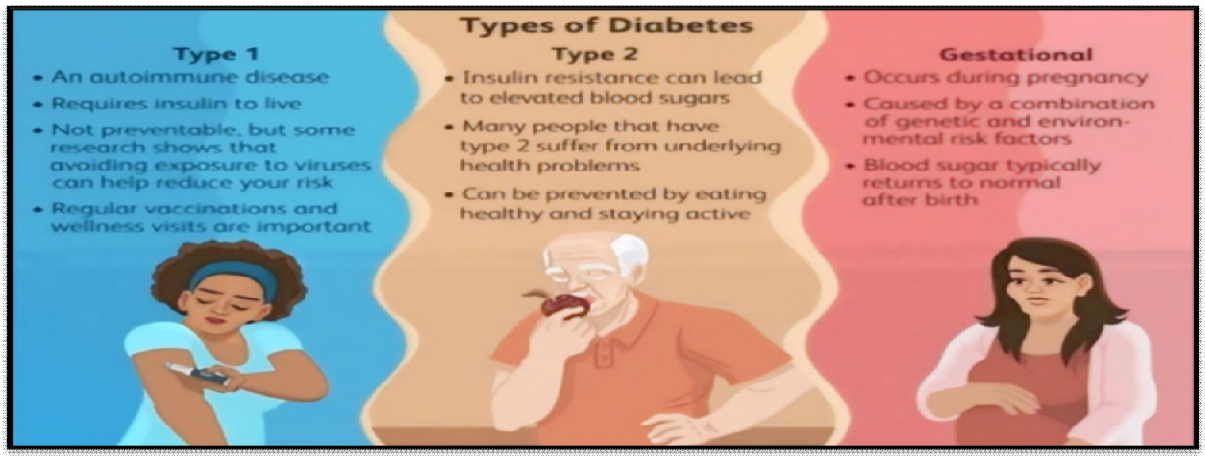


Fig5.TypeofDiabetes

V. PATHOPHYSIOLOGY OF DIABETES

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

A.Type1Diabetes:

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]

B.Type2Diabetes:

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 likepolydipsia,weight loss, andvisionimpairment appearlater. The disease's etiology is influenced by genetic and environmental factors, lifestyle choices, family history, obesity, and pathophysiological conditions. [23]

C. GestationalDiabetesHormonalchanges:

In the second or third trimester of pregnancy and gestation, diabetes orglucose 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]

1) Riskfactors:

- Beingoverweight,
- Afamilyhistoryofdiabetes,
- Lifestylefactors,
- Environmentalfactors.[23]

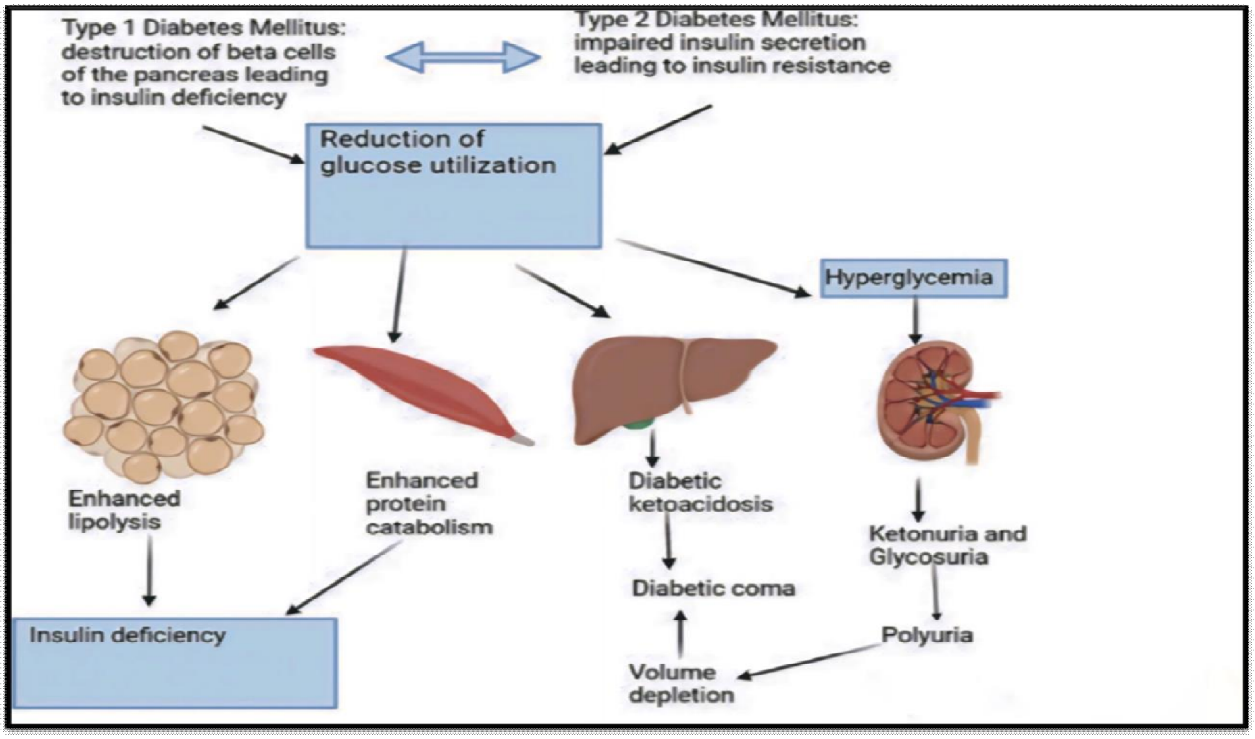


Fig6.Pathophysiologyof Diabetes

2) DietforDiabetes:

Type1Diabetes	Type2Diabetes
Fruits(cherries,kiwi)	Fruits(apples,oranges)
Vegetables(tomatoes,bellpapers)	Vegetables(cauliflower,spinach)
Seeds(flaxseed, fenugreek)	Seeds(pumpkinseeds,chiaseeds)
Healthyfats(fattyfish)	Healthyfats(oliveoil, sesame oil)
Wholegrains(Brownrice,)	Wholegrains(oats,brownrice)
Nuts(peanut)	Nuts(almonds,walnuts)

Table1.DieForDiabetes

3) FoodstoAvoid:

Type1diabetes	Type2diabetes
Addedsugar	Highfatmeat
Refinedgrains	Sweets
Juice drinks	Fullfat dairy
Sugarybreakfast cereals	Potato chips
Processedfoods	Butter,Cheese

Table2.FoodsToAvoid

VI. TREATMENT

1) Tolbutamide: MOA:

ATP-sensitivePotassium(K-ATP)ChannelBinding: Tolbutamidebindstoand blocksATP-sensitivepotassiumchannelsonthebetacellmembrane.

↓

Cell Depolarization: Byblockingthesepotassiumchannels, tolbutamidecausesabuild-upofpotassium insidethecell, leadingto depolarizationofthe cell membrane.

↓

CalciumInflux: Calciumcanenterbetacellswhenvoltage-gatedcalciumchannelsare openedbydepolarization.

↓

InsulinRelease: Theinfluxofcalciumtriggersthereleaseofinsulin-containingvesicles fromthebetacellsintothe bloodstream.

Dose:0.5–3g/day.[25]

2) Metformin: MOA:

Inhibition of Hepatic Gluconeogenesis: Metformin decreases the production of glucose by the liver (hepatic gluconeogenesis). It does this by activating an enzyme calledAMP-activatedproteinkinase(AMPK),whichreducestheexpressionofenzymes involvedinglucose production.

EnhancedInsulinSensitivity: Metforminincreasesinsulinsensitivityinperipheral tissues,especiallymuscleand fat,whichallowscellstotakeinglucosemore effectively.

ReducedIntestinalGlucose Absorption: Metforminalsoslightlydecreasesglucose absorption from the intestines, contributing to lower blood glucose levels.

Dose:0.5–2.5g/day. [25]

3) MedicinalPlantsForDiabetesMellitus:

	Type1diabetes	Type2diabetes
1.	Jamun	Fenugreek
2.	Turmeric	Garlic
3.	Bel	Moringaoleifera
4.	Tulsi	Aloe
5.	BetterMelon	Ginger
6.	Berberine	Cinnamon
7.	Gulvel	Gava

Table3.MedicinalPlantsforDiabetesMellitus

VII.LITERATURE SURVEY

1) Akram T Kharroubi, Hisham M Darwish et.al (2015):

Diabetes mellitus is a global epidemic that continues to rise without early, effective diagnosis. This review highlights types of diabetes, diagnostic methods, and criteria for diabetes and prediabetes. As a complex genetic disease, identifying its genetic basis can enhance diagnosis, individualized therapy, and genetic counseling. Understanding the link between genetics and complications may help delay or prevent them, improving patient quality of life and reducing the growing burden on healthcare systems. Finding these genes can help doctors improve diagnosis, give personalized treatment, and offer better genetic advice.

Understanding how genes affect diabetes complications can also help prevent or delay these problems, which affect the patient's life and increase healthcare costs.

2) Marianna Karamanou et.al (2016):

Doctors have been trying to understand and treat diabetes for over 3,000 years. Major progress happened in the last 200 years due to advances in science. Key milestones include: In 1955, Fred Sanger discovered insulin's structure.In 1967, Donald Steiner found proinsulin and developed a test to measure the body's insulin.That same year, the first pancreas transplant was done.In 1972, U100 insulin was introduced for accurate dosing.In 1982, lab-made (recombinant) human insulin became available.In the 1990s, insulin pens were introduced.Later, fast-acting (1996) and long-acting (2001) insulin types were developed.These discoveries greatly improved diabetes care.

3) Oluwafemi Adeleke Ojo et.al (2023):

The pathophysiology of diabetes involves insulin issues. Type 1 diabetes results from autoimmune destruction of pancreatic β-cells, leading to no insulin production and dependence on insulin therapy. Type 2 diabetes involves insulin resistance and insulin deficiency, linked to genetics, obesity, inflammation, and lifestyle factors. It progresses slowly and may go unnoticed early. Both types lead to high blood glucose. Hypoglycemia, caused by low blood sugar, triggers hormone responses and severe symptoms. Diabetic ketoacidosis can occur in type 1 due to fat breakdown. Treatments include insulin and oral medications to manage glucose levels.

4) Kd Tripathi MD et.al:

Effective diabetes treatment includes tolbutamide stimulating insulin release and metformin improving insulin sensitivity and reducing glucose production.

5) Ayon Bhattacharya et.al (2018):

Moringa oleifera may help manage diabetes in several ways. It can increase insulin release, block enzymes that raise blood sugar, reduce sugar production in the liver, and help muscles and the liver absorb more glucose. It may also prevent glucose from being absorbed in the gut and has antioxidant effects. These benefits may come from its ability to lower inflammation or stress in the body, which can improve how insulin works. However, there isn't much research yet on how its natural compounds directly affect insulin signals.

6) Saleh Ali Alqadoori et.al (2024):

Fenugreek has been known for its anti-diabetic effects for centuries, but recent research has started to explain how it works. Studies show that fenugreek seeds help increase certain proteins that improve how the body uses glucose. This makes insulin work better, helping move glucose into cells and store it as glycogen. Animal studies also show that fenugreek lowers high blood sugar by improving insulin sensitivity and reducing glucose levels. These findings suggest that fenugreek may be a useful natural treatment to help manage diabetes and support healthy blood sugar control.

7) Najmin Ansar Shaikh et.al (2024):

The study showed that guava leaves and Aegle Marmelos (bael) leaves worked better against diabetes than regular antidiabetic chocolate. The best batch (S3) had good taste, safe pH, and stayed stable. These leaves have natural compounds like flavonoids that help control blood sugar. Adding dark chocolate also helped by improving insulin function and blood sugar control. The amount of herbal extracts used was safe with no side effects. Overall, this herbal chocolate could be a safe and helpful way to manage diabetes. More research and clinical testing are needed to fully understand its **benefits over time.**

8) Yogesh s Kolekar et.al (2021):

This study focused on making a herbal chocolate for children with cough-relieving (antitussive) effects. Tulsi leaf extract was prepared and tested for helpful compounds. The chocolate made with this extract was checked for appearance, size, hardness, taste, drug content, and stability. The results showed that the chocolate had a smooth, creamy texture and helped hide the bad taste of medicine. It also worked well as an easy and effective way to deliver medicine by mouth for children.

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9) Nimbalkar Pawan Asaram et.al (2024):

Making good sugar-free chocolate needs careful choice of ingredients to replace sugar without changing its taste, texture, or appearance. In chocolate, sugar adds sweetness but also helps with texture, flavor, and preservation. Replacing sugar with sweeteners like sucralose, stevia, or sugar alcohols, and using bulking agents like polydextrose or inulin, can still make the chocolate tasty and high quality.

VIII. PLANT PROFILE

A. Moringaoleifera:

- Synonyms: Drumsticktree,Saijihantree, Sajnatree,andMulangaytree.
- Biologicalsource:Itcanconsistofdriedlong,slender,triangularseed–podsof Moringa Oleifera.
- Family: *Moringaceae*
- ChemicalConstituents:Alkaloids,Saponins,FattyAcids,Tannins,AminoAcids.
- Biological Activity - Antioxidant, Anticancer, Antihypertensive, Hepatoprotective, and Nutritional effects. [26]



Fig7.Moringaoleifera

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 byeither reducing inflammation or oxidative stress.There is relativelylittle information in the literature about this antidiabetic plant's phytochemicals directly influencinginsulin activation signaling. [27]

Ayurvedic Remedies:

Moringa (*Moringa oleifera),* known as the "drumstick tree"or "miracle tree,"is highly valuedin Ayurvedaforitsnumerousmedicinalproperties,includingantidiabeticeffects. Different parts of the moringa plant, such as leaves, seeds, pods, and bark, have traditionallybeenusedinAyurvedicremediestohelpmanagediabetes.Here'showeach part is used:

1) 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.

AyurvedicRemedy:

- 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.

2) MoringaSeeds:

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

- SeedPowder:Theseeds areoftendriedand groundintoafinepowder.Onecantake 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]

B. Fenugreek:

- Synonyms:Fenugreek,Methi,Bird'sfoot,GreekHay.
- Biological source: Dried seeds of Trigonella foenumFamily:Trigonella foenum graecum
- Chemical Constituent: Alkaloids,Saponins,Fatty Acids, Tannins,Amino Acids phospholipids, glycolipids, oleicacid,linoleicacid,linoleicacid,choline,vitaminsA,B1, B2, C, nicotinic acid, niacin.
- BiologicalActivity-Antidaibetic,Antioxidant,Anticancer,Antihypertensive,Weight management, Antimicrobial. [37]



Fig8. 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 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- hyperglycaemiceffectviaenhancinginsulinsensitivity, reducingtheamountofglucose 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]

AyurvedicRemedies:

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,androots—areused inspecific remediestomanage diabetes and improve glycemic control. Here are the Ayurvedic remedies for diabetes using different parts of fenugreek:

1) 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.

a) SoakedFenugreekSeeds(forBloodSugarControl):

- Remedy:Soak1–2teaspoonsoffenugreekseedsinaglassofwaterovernight.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:Takeiteverymorningforatleast1–2monthsforvisibleresults.

b) FenugreekSeedPowder(forBloodSugarRegulation):

- 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:ThisremedycanbetakenonceortwicedailyasperAyurvedic guidance.

c) FenugreekSeedandCinnamonMix:

- Remedy:Mix1/2teaspoonoffenugreekseedpowderwith1/2teaspoonof cinnamon powder. Take this combination with warm water before meals.
- Benefits:Thiscombinationisknowntohelpbalancebloodsugarlevelsby enhancing insulin sensitivity and reducing glucose levels in the blood.

2) FenugreekLeaves:

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

a) FenugreekLeafJuice(forBloodSugarControl):

- 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:Takethisremedydailyfor2–3monthsforbetterglycemic control.

b) FenugreekLeafPowder(asaSupplement):

- Remedy: Dryfenugreek 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]

C. *FicusRacemosa:*

- Synonyms:clusterfig,Indianfigtree,umbar.
- Biologicalsource:Nativeto India,Australiaand SoutheastAsia
- Family:Moraceae
- ChemicalConstituents:Alkaloid,Saponins,FattyAcids,Tannins,Amino Acids.

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



Fig9.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,decreasedurinesugar,andassistedinbringingitdowntozerowithintwoweeks.
[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 studyby Ahmad and Urooj. [45]

Ayurvedic Remedies:

Ficus Racemosa (cluster fig, Gular)is valued inAyurvedic medicine forits various healing properties.Differentpartsoftheplant—suchasthebark,leaves,fruit,androots—areused inremediestotreatconditionslikediabetes,digestiveissues,skindisorders,and inflammation. Here aresomeAyurvedicremedies usingdifferent partsof *Ficus Racemosa:*

1) Leaves

- ForDiabetesManagement: Crush fresh *Ficus Racemosa* leaves to extract the juice. Take1tables poonofthejuicedailyonanemptystomach.
- Benefits: The leaf juice helps lower blood sugar levels and provides antioxidants to support pancreatic health.

2) Root

- ForDiabetesManagement: Boilasmallpieceof*FicusRacemosa*rootinwatertoprepareadecoction. Take one dose of the decoction every day.
- Benefits:Therootcontainscompoundsthatmayhelplowerbloodsugarand improve metabolic health. [46]

D. TheobromaCacao:

- Synonyms:ChocolateTree,Cacao,ErythroxylomCacao.
- Biologicalsource:TheobromacacaotreeoriginatedintheupperAmazonbasinregion (Brazil, Colombia, and Peru).
- Family:Sterculiaceae
- ChemicalConstituent:Alkaloids,Polyphenol,Lipids,flavonoid,AminoAcids.
- Biological Activity - Antidaibetic, Antioxidant, Anti-Obesity Effects, Anticancer, Antihypertensive, Weight management, Antimicrobial. [47]



Fig10.TheobromaCacao

Another name for cacao powder is "cocoa solids," which is an unsweetened product made by removing the cocoa butter from cacao beans. Theresulting 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 cocoabeans 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]

Preparationofcacao powder:

Harvesting: Whenthecacaopodsareready,theyaretakenfromthecacaotree (Theobroma cacao). In order to prevent tree damage, pods are typically removed fromthe tree using blades or other instruments

↓

PodOpening:Thecacaobeans,whichareencasedinasticky,deliciouspulp,are extracted bydelicatelyopeningthe harvestedpods.

↓

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 convertedtoacidsover the fivetosevendaysof fermentation.Thistechnique makesthe cacaotastebetter.

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

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 arecracked open to remove the outer shells. This process separates the cacao nibs (the edible part) from the husk.

Grinding: Thecacaonibsare groundintoapastecalledcocoamassorchocolateliquor. This paste contains both cocoa solids and cocoa butter.

Pressing: Toextractthecocoabutterfromthecocoasolids,themassofcocoais compressed.Cacao powder is madefrom thewastesolids.

GrindingintoPowder: Thecocoasolidsarefurthergroundintoafinepowder, resultingincacaopowder.Thispowdercanbenaturaloralkalized(Dutch-processed)to reduce aciditvand alter theflavour

Packaging: Thefinalcacaopowderispackagedandstoredinairtightcontainersto preserveitsquality.[49]

AyurvedicRemedies:

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.

1) CacaoPowder(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.

2) 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 inAyurveda 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 andreducing blood sugar fluctuation. [50]



Fig11:HealthBenefitsof Darkchocolate

IX. AIM

Formulation and Evaluation of Herbal Hypoglycemic chocolate

X. OBJECTIVE

1) To make a special chocolate that people of all ages with diabetes can enjoy safely.
2) To help control blood sugar levels and lower the risk of diabetes in the long run.
3) To offer a natural option that may reduce the need for diabetes medicines.
4) To check how the chocolate tastes, smells, looks, and feels to make sure people will like it.
5) To improve the recipe so it tastes good, is healthy, and stays fresh, making it a good choice for people with diabetes.
6) To give people a natural way to manage diabetes instead of only using medicines.
7) To overcome intake of medicated drugs to get antidiabetic activity.[53]

XI. MATERIALS

1) Materials: Moringa Oleifera leaves powder, fenugreek leaves powder, Ficus Racemosa leaves powder, Cocca butter, Dark chocolate, coffee, stevia sugar, Distilled water.
2) Equipment's: Measuring cylinder, Beaker, Mortar pestle, Conical flask, Funnel, Chocolate mould, Petri dish
3) Instruments: Refrigerator, water bath, sieves, grinder.[51]

A.Methods Of Extraction

Fresh leaves of Ficus racemosa, fenugreek, and Moringa oleifera were gathered from a home garden and cleaned with water to get rid of dust. With the aid of distilled water and a grinding machine, more leaves were crushed and turned into a paste. Paste made using the decoction method, which involves boiling the leaves in distilled water for 30 to 45 minutes. To prevent overheating, greater caution should be used in this situation. To obtain crude extract, the extract was then filtered and the entire water was evaporated using an electric water bath. Additional phytochemical analysis of the extract was conducted using an identification test.[52]

B.Preparation of Chocolate:

1) Collect Moringa oleifera, fenugreek, and Ficus racemosa leaves and wash them well to remove any dirt.
2) Let the leaves dry naturally for 4–5 days.
3) Once dry, grind the leaves into a fine powder using a grinder.
4) Sift the powder using a sieve to make it smooth.
5) Melt dark chocolate and cocoa butter using a water bath. Then add the leaf powders and other ingredients. Mix everything well.
6) Pour the mixture into chocolate molds and keep it in the freezer for 8 to 10 hours.[51]

C. Formula:

Sr.no	Ingredients	Quantity Taken			Category
		F1	F2	F3	
..	Moringa oleifera powder	1.60	1.20	1.20	Antidiabetic agent
2.	Fenugreek powder	1.0	1.0	1.0	Antidiabetic agent
3.	Ficus Racemosa powder	1.0	1.0	1.0	Antidiabetic agent
4.	Dark chocolate	12	15	20	Main chocolate base
5.	Cocoa butter	03	02	02	Smoothness
6.	Coffee	1.0	1.20	1.50	Flavoring agent
7.	Stevia	0.20	05	10	Natural sweetener
8.	Sodium Benzoate	0.20	0.20	0.20	Preservative

Table4.FormulaTable



Fig12: Weigh Ingredients.



Fig13: melt base





Fig14:MouldFig15: Final Chocolate

D. Evaluation Test

1) Colour: Observe colour by visualisation.

2) Texture: Evaluate the texture of the chocolate Checking its soft ness and brittle ness of chocolate

3) Mouth feel: Place chocolate in mouth and feel it.

4) Taste of chocolate: Taste the chocolate.

a) Hardness:

- Prepare the Sample:Ensure the chocolate sample is fully set and at room temperature (around 20–25°C).
- Place on Flat Surface: Put the chocolate on a flat, stable surface.
- Apply Load:Gently place a small known weight (e.g., 100g) on top of the chocolate piece.
- Observe Deformation:

➢ If the chocolate holds the weight without bending, it is considered hard.

➢ If it bends, cracks, or breaks easily, it has low hardness.

➢ You can gradually increase the weight to test its resistance.

- Record Observations: Note at what weight the chocolate begins to deform or break. Thisgives a comparative measure of hardness.
- Instrumental Method – Texture Analyzer:

➢ Use a texture analyzer fitted with a cylindrical probe.

➢ Set the machine to compress the chocolate at a fixed speed and depth.

➢ Measure the force (in Newtons) needed to penetrate or break the chocolate.4. Record the peak force — this indicates the hardness.

b) Blooming test:

- Fat Bloom :When a thin layer of fat forms on the surface of chocolate, it makes the chocolate lose its shiny look and appear with a soft white coating. This white layer makes the chocolate look less tasty. It happens because the fat in the chocolate changes form or because fat from the filling moves to the surface. Keeping the chocolate in a place with a steady temperature can help slow down or prevent this from happening
- Sugar Bloom :When chocolate is taken out of the fridge, water from the air settles on it. This water melts the sugar in the chocolate. Later, when the water dries up, the sugar forms rough, bumpy crystals on top. This makes the chocolate look bad.

c) Physical stability:

To check the physical stability, sample of chocolate was kept in closed container for 1 month at 28°C After 1 month interval, Test sample of chocolatewas observed for physical appearance and drug degradation.

d) Melting Point:

- A chocolate sample was placed in a closed container.
- It was stored at 28°C for 1 month.
- After 1 month, the sample was checked.
- Observations were made for: changes in physical appearance

Any signs of drug (active ingredient) degradation

e) ChemicalTest:

- TestforCarbohydrate(Fehling'sTest):
  - A solution was prepared by mixing equal amounts of Fehling's Solution A and Fehling's Solution B.
  - This mixture was added to the test sample.
  - The solution was then heated.
  - A brick-red precipitate formed.
  - This indicates the presence of carbohydrates in the sample.
- TestforProtein(BiuretTest/GeneralTest):
  - Chocolate formulation was mixed with 4% sodium hydroxide (NaOH).
  - A few drops of 1% copper sulfate solution were added to the mixture.
  - A violet color appeared.
  - This violet color indicates the presence of protein in the sample.
- Test for amino acids(Ninhydrin test):
  - 3ml of the test solution was taken and heated.
  - 3drops of 5% Ninhydrin solution were added.
  - The mixture was placed in boiling water and boiled for 10 minutes.
  - A purple or bluish color appeared.
  - This color change indicates the presence of amino acids.
- Test for Saponins(Foam Formation):
  - 2ml of chocolate formulation was added to water.
  - The mixture was poured into a test tube.
  - The test tube was shaken well.
  - A stable foam was formed.
  - The formation of stable foam indicates the presence of saponins.

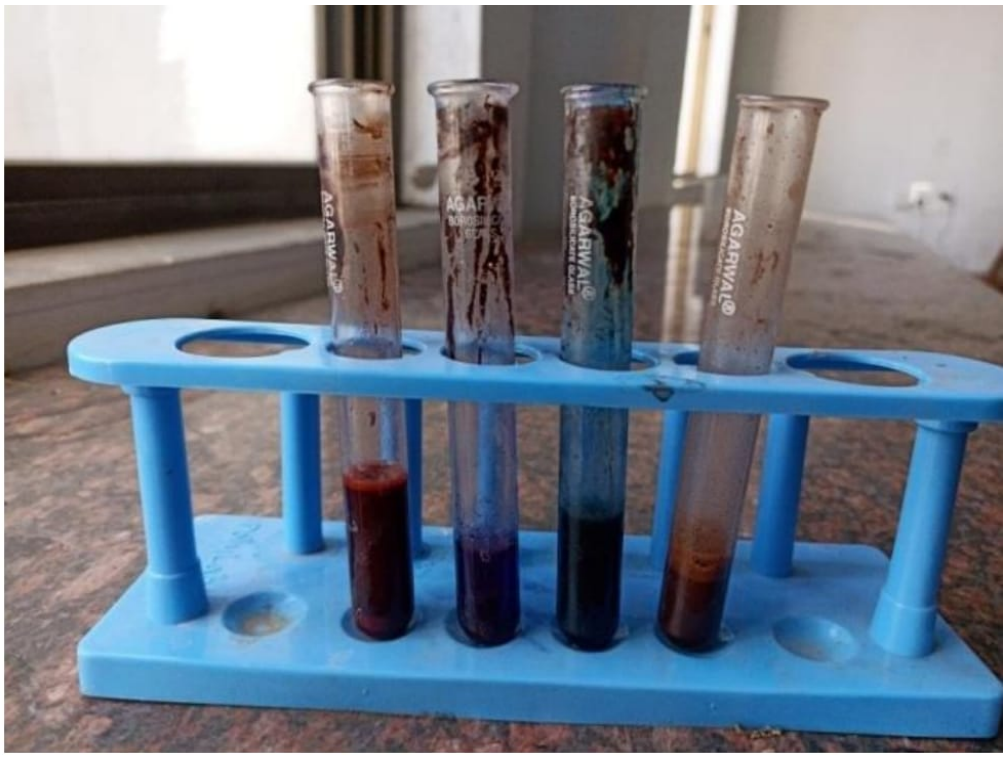


Fig16: Chemical Test

f) pH:

2gm of prepared chocolate was dissolved in 100ml of phosphate buffer solution and of the resulted solution was studied by digital pH meter with glass electrode.

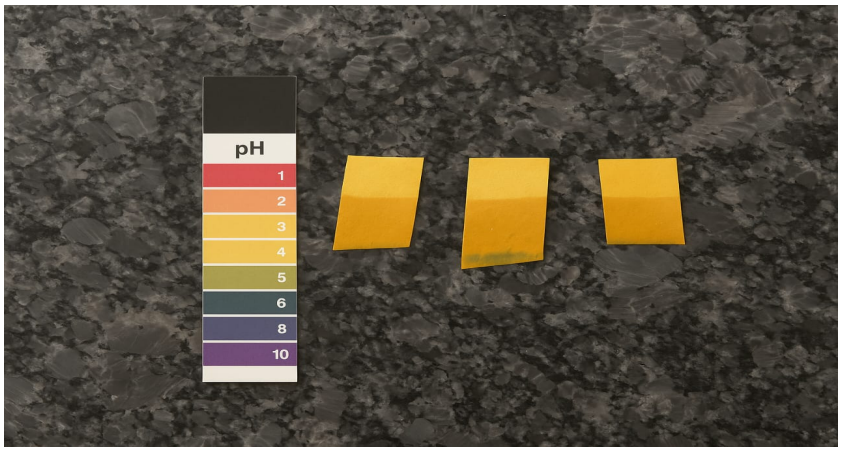


Fig17: pH Determination

g) Weight Variation:

- Four chocolate samples were weighed individually and together.
- The total weight was used to calculate the average weight.
- Each individual weight was compared with the average weight.
- The percentage deviation was calculated using the formula:
- % Deviation = (Individual Weight – Average Weight) / Average Weight × 100

This helped to check the consistency in weight of the chocolate samples.[53]

h) Physical Stability

To check physical stability, samples of chocolate were kept in closed containers for 1 month at 28°C. After 1 month, test samples ofchocolate were observed for physical appearance and drug degradation.[54]

Chemical test result:

Table No05: Chemical test result

Sr.no	Test Name	Observation	Result
	Carbohydrates	Brick red ppt	2+
	Protein	Violet colour	3+
	Amino acid	Purple colour	1+
	Saponin	Foam formation	+

Observation Table:

Table No 06:Observation Table

Sr.no	Test	F1	F2	F3
	Color	Dark Brown color	Dark Brown color	Dark Brown color
	Texture	Smooth	Smooth	Smooth
	Mouth feel	Creamy	Creamy	Creamy
	Odour	Chocolaty	Chocolaty	Chocolaty
	Blooming test	No	No	No
	pH	6.8	6.4	6.5
	Test of Chocolate	Bitter	Sweet	Sweet
	Hardness	5.3	5.7	6.4
	Melting Point	32.2 C	32.5 C	33 C
	Stability	Stable	Stable	Stable
	Environmental impact assessment	Biodegradable	Biodegradable	Biodegradable

XII.RESULT

Antidiabetic Chocolate was Formulated and Evaluated by Using of Moringa Oleifera , fenugreek and Ficus Racemosa showed good results.As per Ayurveda, there exists a huge collection of plants with antidiabetic potential. Only few of them have been scientifically proven and a lot more have yet to be explored and proved. Out of all samples, Batch S3 was the best. It tasted good, had a proper pH level, and stayed stable over time. The herbal ingredients helped lower blood sugar levels because they contain natural compounds that are good for managing diabetes. Adding dark chocolate also helped improve insulin function. The chocolate is safe to eat and may help people control their diabetes in a natural way.

XIII. DISCUSSION

The discussion on antidiabetic chocolate focuses on creating a sweet treat suitable for diabetic patients. It involves replacing sugar with safe alternatives like stevia and using ingredients that help control blood sugar, such as dark chocolate and fiber. The evaluation checks taste, texture, and how it affects glucose levels. This helps ensure the chocolate is both enjoyable and beneficial for diabetic health.

XIV. CONCLUSION

Diabetes is achronic medical conditionwherethe bodyeitherdoesnotproduce 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 managementthroughahealthydiet,regularexercise,medicationandregularmonitoringcan 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.

XV. SUMMARY

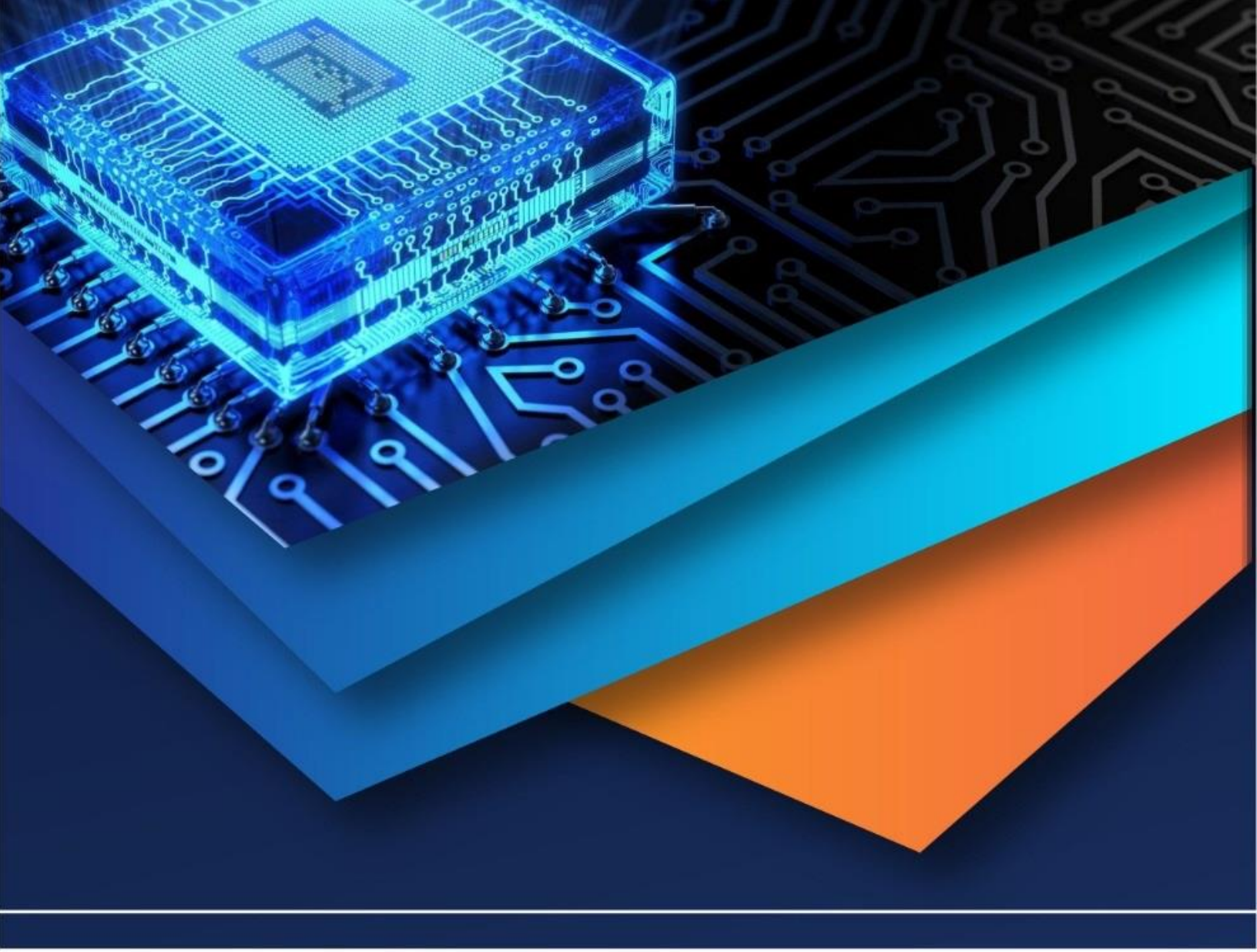
This study made and tested a special chocolate using Moringa Oleifera, fenugreek and Ficus Racemosa to help control diabetes. The natural ingredients worked better than regular antidiabetic chocolate. The new herbal chocolate is cheaper, has fewer side effects, and helps reduce diabetes. It doesn't cure it fully but supports better health in a safe and affordable way.

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