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Review Article

A Review: Antidiabetic Properties of *Psidium guajava*, *Moringa oleifera*, and *Cucurbita pepo*

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ABSTRACT

Diabetes mellitus is a long-standing metabolic condition that often leads to multiple complications. This study focuses on the role of medicinal plants in controlling diabetes and preventing its complications. Natural antidiabetic agents are known to lower blood glucose and boost insulin release from pancreatic cells. In this study, three medicinal plants—guava (Psidium guajava), pumpkin (Cucurbita pepo), and moringa (Moringa oleifera)—were studied for their effectiveness in managing diabetes. In guava, the phytoconstituents guaijaverin and avicularin are mainly linked to lowering blood sugar concentrations. In pumpkin, compounds such as tocopherols, gallic acid, rutin, and quercetin are associated with blood sugar reduction and antioxidant properties. In moringa, bioactive flavonoids including quercetin and kaempferol are found to show significant antidiabetic benefits by lowering blood glucose and improving insulin sensitivity. The study emphasizes the value of plant-based compounds as potential alternatives or supportive therapies to conventional therapy for the treatment and management of diabetes mellitus.

INTRODUCTION

Diabetes is a chronic disease caused by metabolic disorders, characterized by a rapid increase in blood glucose levels (hyperglycemia).[1],[2]

A collection of common endocrine disorders, diabetes, commonly known as diabetes mellitus, is typified by persistently elevated blood sugar levels. There are three primary forms of diabetes, which are caused by either the pancreas not making enough of the hormone insulin or the body's cells losing their sensitivity to the effects of insulin: Type 1 diabetes; Type 2 diabetes; gestational diabetes[3], [4]

Type 1 Diabetes: Also known as insulin-dependent diabetes mellitus (IDDM), Type I diabetes is a severe metabolic disease with an autoimmune foundation that is typified by the

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death of beta cells in the pancreas. Given the role of genetic and environmental factors, it is not surprising that HLA-DR3 and HLA-DR4 increase the risk of developing Type 1 diabetes mellitus[5]

Type 2 diabetes was once known as adult-onset diabetes, non-insulin-dependent diabetes mellitus, or NIDDM for short. A number of dysfunctions that are typified by hyperglycemia and are brought on by a combination of excessive or incorrect glucagon secretion, insufficient insulin secretion, and resistance to insulin action make up type 2 diabetes mellitus[6]

Gestational Diabetes: Gestational diabetes mellitus (GDM) impacts approximately 7% of all pregnancies and is characterized by carbohydrate intolerance during gestation.[7]

Prediabetes: Blood glucose levels that are higher than normal but note high enough to be classified as type 2 diabetes are known as prediabetes. You are more likely to get type 2 diabetes later in life if you now have prediabetes. Compared to those with normal glucose levels, you are also at a higher risk of heart disease.[8]

Other Particular Types: Other less prevalent types of diabetes include pancreatic disorders, drug-induced diabetes, diabetes linked to certain medical conditions, and genetic abnormalities that alter insulin production or activity.

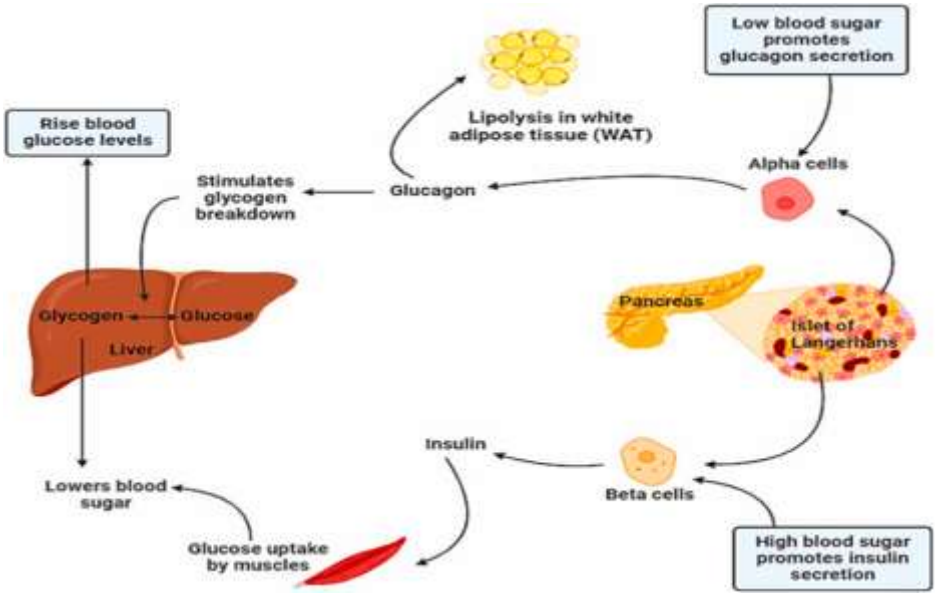


Fig. 1. Regulation of glucose in blood in human body.

Causes of diabetes:-

Age: After the age of 45, the risk of Type 2 diabetes rises.

Genetics: Although the precise genes causing Type 1 diabetes are still being studied, a family history of the condition raises the risk.

Autoimmune response: When the body's immune system unintentionally targets and kills the pancreatic cells that produce insulin, there is insufficient insulin.

Insulin resistance: When the body's cells lose their sensitivity to insulin, they are less able to react to it, which causes blood glucose levels to rise.

Lifestyle factors: A poor diet, physical inactivity, and being overweight or obese can all lead to insulin resistance and Type 2 diabetes.

Hormonal changes: The placenta's hormones during pregnancy can lead to insulin resistance, which makes it more difficult for the body to control blood sugar levels.

Lifestyle factors: Not leading a healthy lifestyle and being overweight or obese prior to becoming pregnant can further raise the risk.

Environmental factors: Although their exact involvement is unknown, several illnesses or environmental stimuli may contribute to the autoimmune reaction in people who are genetically predisposed.

Additional factors: The risk of Type 2 diabetes can also be raised by prediabetes, high blood pressure, and high cholesterol.

The following are typical symptoms of diabetes:

- Fatigue
- Blurred vision
- Increased thirst and urine
- Unintentional loss of weight
- Prolonged healing of wounds Hands and feet that tingle or go numb recurring infections, especially those affecting the skin, gums, or urinary tract[9], [10], [11]

If diabetic complications are not treated or are not adequately managed, they can have a major negative impact on the body's organs and systems. Among the issues are: -

Cardiovascular diseases: Diabetes raises the risk of peripheral artery disease, heart disease, and stroke. High blood sugar levels can cause neuropathy, or damage to the nerves, which can result in discomfort, weakness, and numbness, especially in the hands and feet.

Nephropathy, or kidney damage: Diabetes is a major contributor to kidney failure, necessitating dialysis or a kidney transplant.

Eye damage (retinopathy): If left untreated, diabetes can harm the blood vessels in the retina, resulting in blindness or visual loss.

Foot complications: Poor circulation and nerve damage can raise the risk of infections, ulcers, and ultimately amputation. [12]

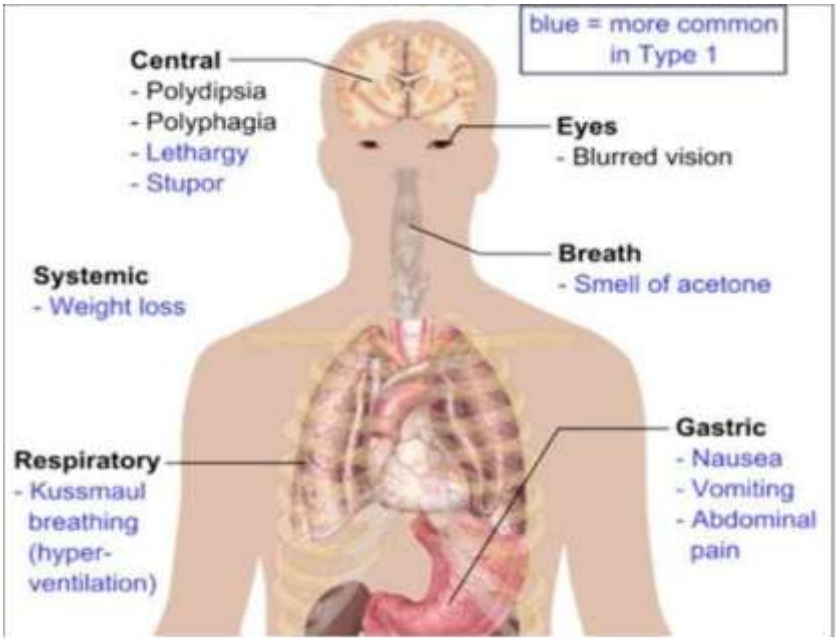


Fig. 2.Sympotoms of Diabetes

Plants profile:-

1. **Guava Leaves**



Fig . 3 . Guava leaves

Botanical classification of guava leaves:-[13]

Biological name	*Psidium guajava*
Family	*Myrtaceae*
Kingdom	Plantae
Order	Myrtales
Genus	Psidium
Species	*Psidium*

Antidiabetic Activity of Guava (*Psidium guajava*)

Psidium guajava (guava) is a tropical fruit with potent medicinal properties. The leaves and fruits of guava are rich in flavonoids such as quercetin, which are known for their strong antioxidant and glucose-lowering activity.[14] Guava leaf extract has been shown to inhibit α-glucosidase and α-amylase enzymes, thereby reducing postprandial hyperglycemia. Additionally, animal and clinical studies indicate that guava leaf tea improves glycemic control and enhances lipid metabolism in diabetic patients.[15], [16], [17].

Antidiabetic action:

Through a number of trials, several researchers have investigated P. guajava's ability to treat diabetes. In particular, studies have shown that extracts from guava leaves and bark efficiently increase muscle cells' absorption of glucose and reduce α-amylase activity. Furthermore, it has been demonstrated that guava leaf extract lowers fasting insulin and glucose plasma levels, as well as insulin resistance in diabetic KK and fatal yellow (Ay) mice that have a heterozygous agouti gene mutation (KK-Ay strain). [17]Furthermore, in streptozotocin-induced diabetic mice, P. guajava leaf extracts have been shown to reduce fasting blood glucose levels, control lipid profiles, and alter glucose metabolism (STZ).[18]

Physiochemical Composition of guava leaves:-

Guava Leaves' composition and properties (GLP) Without decreasing sugar, GLP had a total sugar content of 62.58% and a uronic acid concentration of 7.59%. It indicated the dominance of neutral polysaccharides. [21] GLP's reaction to the Coomassie brilliant blue reaction was negative. It showed that GLP had no protein. Using the HPLC-RI system, four fractions were identified in GLP; their retention times were 8.587, 10.57, 11.92, and 17.94 minutes, respectively . Four fractions made up around 23.28%, 7.57%, 3.04 percent, and 66.10% of the total. They had respective molecular weights of 957.09 kDa, 288.40 kDa, 127.40 kDa, and 3.34 kDa.It demonstrated that low molecular weight polysaccharides made up the majority of GLPs, with high molecular weight polysaccharides coming in second. Polysaccharides isolated from mulberry leaves (MLP) contained multiple fractions made up of low molecular weight polysaccharides (3.64 kDa) and high molecular weight polysaccharides (≥80.99 kDa), according to Yuan et al[22], [23].

***Psidium guajava's* Mechanism of Action in Diabetes**

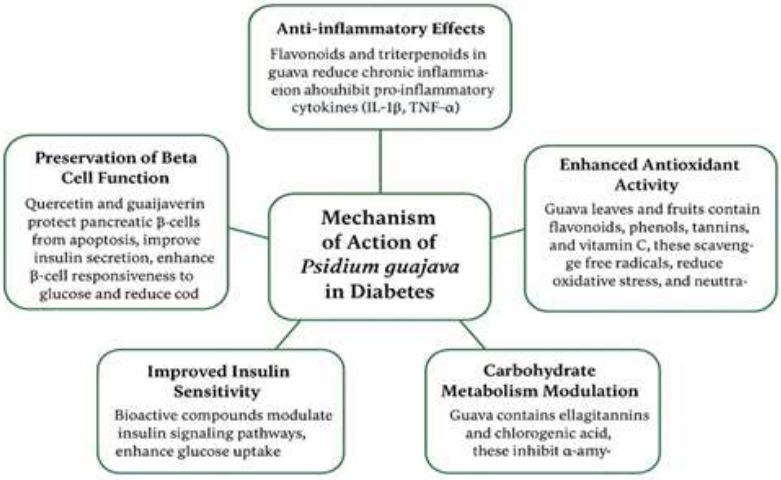
1. Anti-inflammatory Properties: Chronic inflammation is lessened by guava's flavonoids and triterpenoids. They block pro-inflammatory cytokines associated with insulin resistance, such as TNF-α and IL-1β.[24]

2. Increased Activity of Antioxidants: Vitamin C, phenols, tannins, and flavonoids are all present in guava leaves and fruits. These substances neutralize reactive oxygen species (ROS), lessen oxidative stress, and scavenge free radicals.[25]

3. Maintenance of Beta Cell Activity: Guaijaverin and quercetin prevent apoptosis in pancreatic β-cells. They lower harmful nitric oxide levels, increase β-cell responsiveness to glucose, and improve insulin secretion.[26]

4. Enhanced Sensitivity to Insulin; Insulin signaling pathways are modulated by bioactive substances. They decrease inflammation, inhibit enzymes that break down carbohydrates, and improve the uptake of glucose.[27]

5. Modulation of Carbohydrate Metabolism: Chlogenic acid and ellagitannins are found in guava. These slow down the digestion of carbohydrates and control the absorption of glucose by inhibiting the enzymes α-amylase and α-glucosidase.



2. Morninga Leaves



Fig. 4.Moringa leaves

Botanical classification of moringa leaves:-[28]

Biological source	*Moringa oleifera*
Family	*Moringaceae*
Kingdom	Plantae
Class	Angiosperms
Order	Brassicales
Genus	Moringa
Species	*Moringa oleifera*

Antidiabetic Activity of Moringa (*Moringa oleifera*)

Moringa oleifera, commonly known as the drumstick tree, is rich in bioactive compounds such as flavonoids, phenolic acids, glucosinolates,

and isothiocyanates. Several studies have demonstrated its hypoglycemic and antihyperglycemic effects. Moringa leaf extracts improve glucose uptake, increase insulin secretion, and exhibit antioxidant effects that protect pancreatic β-cells. Its polyphenolic content also helps reduce oxidative stress, a key factor in diabetes progression.

It has been demonstrated that moringa can treat both Type 1 and Type 2 diabetes. Patients with type 1 diabetes are unable to produce insulin, a hormone that keeps blood glucose levels within the necessary normal range. Insulin resistance is linked to type 2 diabetes. Another possible cause of type 2 diabetes is beta cell malfunction, which lowers insulin signaling and results in elevated blood glucose levels by failing to perceive glucose levels.[29]

Physiochemical composition of moringa leaves:-

Higher concentrations of proteins, calcium, potassium, and amino acids like histidine and arginine are found in the leaves [170]. Cinnamic acid, sinapic acid, syringic acid, gentisic acid, gallic acid, ferulic acid, protocatechuic acid, vanillin, caffeic acid, o-coumaric acid, p-coumaric acid, and epicatechin are among the phenolic acids and flavonoids that are more abundant in M. oleifera leaves. On the other hand, myricetin, kaempferol, quercetin, and catechin are flavonoids with exceptional medicinal properties.

Dried moringa leaf powder is highly nutritious and contains a wide range of essential minerals, vitamins, and macronutrients. It is particularly rich in calcium (440 mg/100 g), potassium (337–461 mg/100 g), magnesium (176 mg/100 g), phosphorus (60–70 mg/100 g), copper (0.49 mg/100 g), zinc (17 mg/100 g), and iron (53 mg/100 g). It also provides nitrogen (2–3%) and sulfur (268–310 mg/100 g), while the sodium content remains low at 9 mg/100 g. In terms of vitamins, moringa leaves are a valuable source of β-carotene (vitamin A) ranging from 187–278 mg, thiamine (vitamin B1) 2.02–2.64 mg, riboflavin (vitamin B2) 0.66 mg, niacin (vitamin B3) 0.82 mg, ascorbic acid (vitamin C) 220 mg, and tocopherol acetate (vitamin E) 113 mg per 100 g. Alongside these micronutrients, the powder also contains significant amounts of protein (27.1–29.4 g), dietary fiber (6–9.6 g), carbohydrates (13.4 g), and a small proportion of fat (1.7 g). This rich nutritional profile makes moringa leaf powder an excellent dietary supplement with strong potential for therapeutic and health-promoting applications.[30]

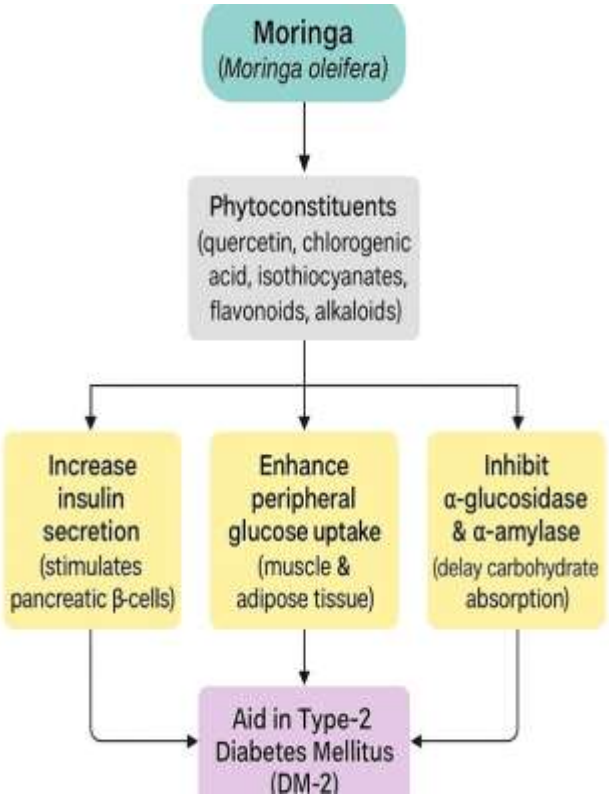


Fig. 5 Possible MOA Of Moringa

3. Cucurbita Seed



Fig. 6 cucurbita seed

Botanical classification of *cucurbita pepo*:

Biological name	*Cucurbita pepo*
Family	*Cucurbitaceae*
Kingdom	Plantae
Class	Angiosperms
Order	Cucubitales
Genus	Cucurbita
Species	*Cucurbita pepo*

Antidiabetic Activity of pumpkin *(cucurbita pepo)*

Cucurbita species, commonly referred to as pumpkin, are widely consumed as both food and traditional medicine. Pumpkin pulp and seeds are rich in polysaccharides, carotenoids, and peptides with antidiabetic potential. Pumpkin polysaccharides have been reported to improve glucose tolerance, enhance insulin sensitivity, and reduce blood glucose levels in diabetic models. Furthermore, pumpkin seed protein fractions may promote pancreatic β-cell regeneration and improve insulin secretion. The antidiabetic qualities of plants belonging to the Cucurbitaceae family have been the subject of numerous investigations . In diabetic-induced in-vivo models, discovered that polysaccharide in combination with the extracted protein from C. pepo had antidiabetic benefits by raising insulin levels, reducing blood glucose levels, and enhancing glucose tolerance. Additionally, a different study looked into the antidiabetic effects of C. pepo peel ethanolic extracts. In rats with diabetes produced by alloxan, the study verified improvements in serum lipid and blood glucose levels . Pumpkin seeds also contain compounds that have hypoglycemic effects. One of these molecules is tocopherols. Examined the effect of tocopherols derived from pumpkin seeds in diabetic rats in an in vivo paradigm.[31], [32], [33].

Physiochemical composition of pumpkin seeds:-

The most widely used pumpkin species that is the subject of research worldwide is Cucurbita pepo L. According to recent research, Cucurbita pepo species is abundant in phytoestrogens, phytosterols like daidzein, genistein, and secoisolariciresinol, trace components, and polyunsaturated fatty acids like palmitic acid, stearic acid, oleic acid, and linoleic acid. Unsaturated fatty acids appeared to be the largest component, accounting for up to 80% of the overall percentage of constituents in pumpkin seeds. [34]

Compared to the stated values for peanut and soybean seed oils, this value is comparatively greater. Pumpkin seeds are also known as “pepitas,” a Mexican Spanish term. Pumpkin seeds also include trace levels of potassium, riboflavin, and folate, as well as certain antioxidants and the nutrients mentioned above.

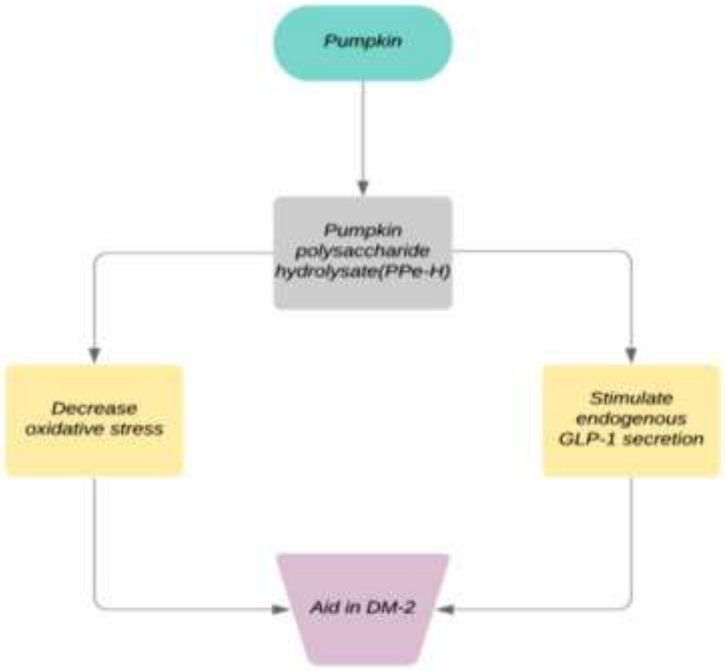


Fig.7. Mechanism of pumpkin polysaccharide hydrolysate in the treatment of DM

CONCLUSION:-

Moringa oleifera, Psidium guajava, and *Cucurbita* species show strong potential in managing diabetes through multiple mechanisms, such as improving insulin sensitivity, inhibiting key metabolic enzymes, and reducing oxidative stress. These plants may serve as effective complementary therapies for diabetes management. However, more well-designed clinical trials are necessary to confirm their safety and effectiveness in humans.

Herbal therapy for diabetes has been practiced worldwide and has shown benefits in managing both Type I and Type II diabetes, along with their complications. In many cases, conventional treatments based on allopathic medicine can be costly, less accessible, or associated with adverse effects, particularly in developing countries. This makes herbal alternatives a promising option. Early studies have already highlighted the hypoglycemic potential of several Indian plants, and many of them have been scientifically validated for their ability to lower blood sugar levels. Consequently, a wide variety of medicinal plants have been used, either individually or in combination, to help manage diabetes.

Future Direction:-

1. **Development of Standardized Extracts as a Prospective Path**

- Invest in the phytochemical profile and quantification of active components (e.g., quercetin in guava).
- Preserving bioactivity by the use of advanced extraction techniques (cold extraction, supercritical fluid).

2. **Clinical trials and efficacy studies**

- Perform meticulously designed human clinical trials to confirm glucose control, safety, and patient compliance. Examine the long-term benefits for people who have prediabetes and diabetes.

3. **Product Form Diversification**

- Provide sugar-free chocolate drinks, spreads, or supplements instead of just bars.

- Tailor formulae to certain populations (e.g., high-fiber for obese diabetics, high-antioxidant for the elderly).

4. **Regulatory Harmonization:**

- Work with food and drug authorities to provide clear regulations for functional foods, including herbs.
- Verify that the components, dosage, and claims are all properly labeled.

5. **Consumer Education and Awareness Campaigns**

- To emphasize the health benefits, use evidence-based marketing, nutritional lectures, and product demonstrations.
- Use social media, medical recommendations, and influencers to build trust.

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