Chapter 57

Diabetes Mellitus: An Overview and Current Phytotherapeutic Agents

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ABSTRACT

Diabetes is a long-term health problem that causes high blood sugar levels because the body doesn't make enough insulin or the insulin doesn't work properly. While oral hypoglycemic drugs and insulin therapy work well, they can also cause problems and side effects. It is important to consider other ways to treat the problem. Over time, plants that can help treat diabetes have been important. They provide safer and more natural ways to manage the condition, and they can also save money. These plants have many different healing powers. These can help control diabetes by making more insulin, helping the body use insulin better, stopping the body from absorbing too many carbohydrates, and giving antioxidants and anti-inflammatory benefits. Studies have found that medicinal plants can help control blood sugar and improve overall health. These studies include clinical trials and case studies. It's really important to think about safety and rules because we need to carefully check for any possible bad effects, how the medicine might interact with other medicines, and make sure the medicine is of good quality. It's important to make sure that herbal medicines are safe and effective. This makes sure they are good to use. In the future, scientists should explore new plants for treating diabetes, understanding their effects, and testing them on large populations. Integrating these plants into standard medical care could enhance diabetes management. Patients can improve their condition by combining these plants with conventional treatments and lifestyle changes. Collaboration among healthcare professionals, patients, and researchers is essential to fully benefit from the use of medicinal plants in diabetes care.

KEYWORDS
Diabetes Mellitus; Medicinal Plants; Glycemic Control; Insulin Sensitivity; Alternative Therapies; Antioxidant Properties; Clinical Trials

Received: 07-Jun-2024
Revised: 11-Jul-2024
Accepted: 17-Aug-2024

A Publication of Unique Scientific Publishers

Cite this Article as: Gulnaz R, Altaf S, Iftikhar A and Iqbal T, 2024. Diabetes mellitus: an overview and current phytotherapeutic agents. In: Abbas RZ, Khan AMA, Qamar W, Arshad J and Mehnaz S (eds), Complementary and Alternative Medicine: Botanicals/Homeopathy/Herbal Medicine. Unique Scientific Publishers, Faisalabad, Pakistan, pp: 486-494. https://doi.org/10.47278/book.CAM/2024.465

INTRODUCTION

Diabetes mellitus (DM) is a long-term health problem that causes high blood sugar levels. This occurs when the body cannot produce enough insulin or cannot use it properly. There are two main types of diabetes: type 1, which occurs when the body cannot produce insulin, and type 2, which occurs when the body cannot use insulin well and cannot produce enough insulin. Diabetes is a big problem that many people around the world face and it affects their health (Mughal et al., 2020).

According to the International Diabetes Federation, around 537 million adults between the ages of 20 and 79 had diabetes in 2021. Data shows that there may be 643 million people in 2030 and 783 million people in 2045. Diabetes is becoming increasingly common in poor and middle-income countries. Diabetes can lead to serious health problems, including blindness, kidney failure, heart disease, and loss of a foot or leg. The above problems have a great impact on the lives of patients and also impose a great cost on the healthcare system (Soomro and Jabbar, 2024).

Traditional diabetes treatments, such as insulin injections and oral medications, have been shown to be effective. However, these treatments have disadvantages such as side effects, financial burden, and patients not following instructions. The challenges discussed demonstrate, why we need to use different treatments that are safer, more accessible and less expensive. Some natural treatments, like herbal ones, may help improve diabetes treatment. These treatments offer extra ways to help patients and can make them feel better while reducing side effects and making it easier for patients to follow their treatment plan. People around the world have long used plants as medicine to treat a variety of health problems, such as diabetes. Plants contain substances that can help lower blood sugar, make insulin work better, absorb glucose, and protect

pancreatic cells. A growing body of scientific research shows that using plants as medicine can help people with diabetes. Studies have found these plants to be effective and safe. Using herbal remedies alongside regular treatment for diabetes helps to manage the condition as a whole. This includes controlling blood sugar levels and preventing related problems (Kumar et al., 2021).

Types of Diabetes Mellitus

Type 1 Diabetes

Type 1 diabetes happens when the immune system attacks and destroys the β cells in the pancreas that make insulin. This means that the body doesn't make enough insulin, so people need to take insulin for the rest of their lives to stay healthy. The condition usually starts when a person is young, but it can happen at any time in their life (Roep et al., 2021).

Type 2 Diabetes

Type 2 diabetes is the most common kind of diabetes, making up about 90-95% of all cases. This condition happens when the body's cells don't respond well to insulin and the body gradually makes less insulin. Many things can cause certain medical conditions to start, like being overweight, not moving much, eating unhealthy food, getting older, having family members who also have the condition, and your ethnic background. Controlling diabetes often means making changes to how you live and taking pills to lower your blood sugar. As the sickness gets worse, more people need insulin therapy (Kumar et al., 2020).

Gestational Diabetes

Pregnant women can get gestational diabetes when their body has trouble in processing sugar, especially during pregnancy. This condition is usually found during tests done between the 24th and 28th weeks of pregnancy. Women who had diabetes during their pregnancy are more likely to have diabetes after they have their baby. These problems can be really bad for the mother and the baby. They might be born too early, be too big, or cause high blood pressure for the mother (Poblete and Olmos, 2021).

Pathophysiology of Diabetes Mellitus

Diabetes is caused by a mix of genes, environment, and how a person lives. Type 1 diabetes happens when the body's immune system destroys the cells in the pancreas that make insulin, so the body can't produce insulin anymore. Type 2 diabetes happens when your body has trouble using insulin and making enough of it to control your blood sugar levels for a long time. Many people with Type 2 diabetes who are obese have trouble using insulin, especially around their belly fat. This affects how the body processes insulin. Continuously having high blood sugar levels for a long time can harm your organs and tissues, causing diabetes-related problems (Cole and Florez, 2020)

Common Symptoms and Complications

Signs like peeing a lot, feeling very thirsty, losing weight without trying, being hungry, feeling tired, having blurry vision, cuts that heal slowly, getting sick often, and tingling in hands or feet may mean there's a medical issue (Taware, 2023).

Complications

A higher chance of having a heart attack, stroke, and clogged arteries getting worse. Also, there is a greater possibility of nerve damage causing symptoms such as pain, tingling, and less feeling, especially in the arms and legs. Harm to the kidneys can cause long-term kidney disease and complete kidney failure. When the blood vessels in the eye are damaged, it can make it hard to see and might even cause blindness. Poor blood flow and nerve damage can cause foot sores, infections, and sometimes even the need for amputation. Other problems people with diabetes might have include infections, skin changes, and skin conditions. Additionally, individuals with diabetes may be at higher risk of developing mental health problems such as depression and anxiety. To keep diabetes in control, it's important to check blood sugar levels, follow doctor's advice, stay healthy, and watch out for problems (Caplan, 2024)

Conventional Treatments for Diabetes Mellitus

Oral Hypoglycemic Agents

Oral hypoglycemic agents, or OHAs, are pills that you take to lower your blood sugar. These medications help people with Type 2 diabetes by making insulin work better, increasing insulin release, or lowering glucose levels in the body. The most common oral drugs are Metformin, which reduces liver glucose production and improves insulin sensitivity. Glipizide and Glyburide help the pancreas make more insulin. Thiazolidinediones such as Pioglitazone and Rosiglitazone can help the body's peripheral tissues respond better to insulin. Medicines like Sitagliptin and Saxagliptin can help the body make more insulin and lower glucagon levels by stopping the DPP-4 enzyme. SGLT2 inhibitors like Canagliflozin and Empagliflozin help the kidneys get rid of more sugar in the urine. Alpha-glucosidase inhibitors like Acarbose and Miglitol can slow down the digestion and absorption of carbohydrates in the intestines (Chakravarti and Nag, 2021).

Insulin Therapy

People with Type 1 diabetes need insulin to manage their condition. Some people with advanced Type 2 diabetes also

need insulin when pills are not enough. Giving insulin usually involves using either shots or insulin pumps. Many types of insulin come in different forms. They work at different speeds, have different peak effects, and last for different amounts of time. This chapter of the book talks about how different insulins work, like how fast they start working, how strong they are, and how long they last. It looks at rapid, short, intermediate, long, and ultra-long-acting insulins. Insulin-like Lispro and Aspart start working quickly in 15 minutes, work best in 1-2 hours, and lasts for 3-4 hours. Regular insulin starts working in 30 minutes, peaks in 2-3 hours, and lasts for 3-6 hours. Intermediate-acting insulin, like NPH insulin, takes 2-4 hours to start working, has its strongest effect in 4-12 hours, and stays in the body for 12-18 hours. Long-acting insulin-like Glargine and Detemir start working in a few hours, don't have a big peak, and keep working for up to 24 hours. Finally, Degludec is a type of insulin that lasts for a very long time and keeps insulin levels steady for more than 24 hours (Syed, 2022).

Lifestyle Modifications

Making changes to how you live is very important in managing diabetes well, no matter what type of diabetes you have. Eating various healthy foods like fruits, vegetables, whole grains, lean meats, and good fats is important for staying healthy. We should watch how many carbs you eat and avoid foods with a lot of added sugar. Exercising for 150 minutes each week can help your body use insulin better. Maintaining a healthy weight is important by eating balanced meals and exercising regularly. It's best not to smoke if you have diabetes to decrease the risks. We should drink less alcohol to keep our blood sugar levels stable and avoid having any problems with our medications. Traditional diabetes treatments work well but have some drawbacks and may cause side effects (American Diabetes Association, 2021). Table 1 shows various plants used for the treatment and management of diabetes.

Table 1: Plants used for the treatment of diabetes and their management

Sr.	Plant Name	Constituents	Diabetes Effect	Management	References
1	Bitter Melon	Charantin, Vicine, Polypeptide-p	Lowers blood glucose levels, improves insulin sensitivity	Consumed as juice, extracts, or in cooked dishes	(Gao et al., 2023)
2	Fenugreek	Soluble fiber, 4-hydroxyisoleucine	Reduces fasting blood sugar, improves glucose tolerance	Seeds soaked in water, powdered form, or supplements	(Cortez et al., 2023)
3	Cinnamon	Cinnamaldehyde, Polyphenols	Enhances insulin sensitivity, lowers blood sugar levels	Used as spice, in tea, or as supplements	Silva et al., 2022)
4	Aloe Vera	Anthraquinones, Glucomannan	Lowers fasting blood glucose, improves HbA1c levels	Consumed as juice or supplements	Haghani et al., 2022)
5	Gymnema Sylvestre	Gymnemic acids	Reduces glucose absorption, stimulates insulin secretion	Consumed as tea, extracts, or supplements	(Dvangan et al., 2021)
6	Berberine	Berberine	Lowers blood glucose, improves insulin sensitivity	Extracts, capsules, or tablets	(Hang et al., 2021)
7	Turmeric	Curcumin	Lowers blood glucose, anti-inflammatory properties	Used as spice, in milk (golden milk), or supplements	(Bozkurt et al., 2022)
8	Ginseng	Ginsenosides	Improves insulin sensitivity, reduces blood glucose levels	Consumed as tea, extracts, or supplements	(Naseri et al., 2022).
9	Neem	Azadirachtin, Nimbin	Lowers blood glucose levels	Leaves, powder, or extracts	(Patil et al., 2022).
10	Holy Basil	Eugenol, Cinnamic acid	Lowers blood glucose levels, enhances insulin secretion	Consumed as tea, extracts, or supplements	(Ganguly, 2021).

Role of Medicinal Plants in Diabetes Management

Historical Perspective

People have been using plants to treat diabetes for a long time. It's a common practice in many traditional healing methods around the world. Olden cultures like Egypt, India, China, and Greece used herbs and plant parts to help with diabetes symptoms. Traditional Chinese Medicine uses herbs like ginseng, bitter melon, and berberine to lower blood sugar. Ayurveda, the traditional Indian medicine, uses plants like fenugreek, turmeric, and neem to manage "Madhumeha," which is diabetes. Native American Medicine used blueberries and Jerusalem artjson to help with diabetes, and Middle Eastern Medicine used fenugreek and garlic for the same reason. In the past, medicinal plants have been important in helping us learn how they can help treat diabetes. This has paved the way for modern scientific research (Andrade et al., 2020). Table one shown the plants used for the treatment of diabetes and their management.

Advantages of Using Medicinal Plants

Natural and Less Toxic

Many people think that using plants for medicine is a natural option instead of using drugs made in a factory. They believe that plant medicine has fewer and milder side effects. Plants have natural chemicals that work together to make them heal better and reduce the chance of causing problems. Bitter melon has charantin, vicine, and polypeptide-p that help to lower blood sugar with few side effects (Balick and Cox, 2020).

Cost-effective

Many people in poor countries can't afford expensive diabetes treatments. They might find it helpful to use plants for medicine because it's cheaper. Growing medicinal plants is a good and economical way to benefit people's health, especially those who do not have much money. It can help treat diabetes and is easily accessible (Adler et al., 2021).

Multifunctional Therapeutic Effects

Many natural plants contain substances that can help treat diabetes and related problems. Many plants can help the body use insulin better and control blood sugar levels. For example, cinnamon contains cinnamaldehyde, which helps insulin work better, while fenugreek seeds contain 4-hydroxyisoleucine, which causes the body to release more insulin. Berberine, found in different plants, can activate AMP-activated protein kinase (AMPK). This helps reduce blood sugar levels. The curcumin contained in turmeric helps protect pancreatic cells from damage. Green tea and blueberries also contain antioxidants that may reduce stress and inflammation in diabetes (Blahova et al., 2021).

Mechanisms of Action of Medicinal Plants in Diabetes Management

Enhancement of Insulin Secretion

Some plants can help the pancreas produce more insulin. This is important for people with type 1 and type 2 diabetes. This plant contains substances that can help pancreatic cells work better and produce more insulin. The fenugreek plant contains an amino acid called 4-hydroxyisoleucine, which helps the body produce more insulin. Bitter melon, also known as bitter gourd, contains substances such as p-polypeptide and momordica charantia that act similarly to insulin and can help improve insulin production in the body (Blahova et al., 2021)

Improvement of Insulin Sensitivity

To control type 2 diabetes, it is important to get the body to use insulin better. This is because insulin resistance plays an important role in causing this disease. Using plants as medicine can help the body use insulin better and lower blood sugar levels. Cinnamon, a type of plant, contains a substance called cinnamaldehyde that helps the body to respond better to insulin. Cinnamaldehyde makes insulin work better and helps cells use sugar more. This is good for the body. Berberine, found in certain plants, makes a protein in the body work better and helps muscles take in more sugar (Rachdaoui, 2020).

Inhibition of Carbohydrate Absorption

Certain plant-based treatments can stop the body from breaking down and using carbohydrates from food, which helps lower blood sugar levels after eating. Acarbose and Miglitol are natural substances that can slow down quickly your body breaks down carbs. Gymnema Sylvestre is a plant with gymnemic acids that stop sugar from being absorbed in the intestines (Greger, 2020).

Antioxidant Properties

Oxidative stress can affect diabetes and its complications a lot. Plants with health benefits and lots of antioxidants can help protect cells from getting damaged by harmful substances called free radicals. Green tea is made from a plant called *Camellia sinensis* and has a lot of antioxidants that help reduce stress in the body. Turmeric has a compound called curcumin that can protect cells in the pancreas and other tissues from damage caused by stress. Turmeric is another name for the plant called Curcuma longa (Sharifi et al., 2020)

Anti-inflammatory Effects

Long-lasting inflammation is connected to trouble using insulin and the development of problems related to diabetes. Certain plants have special properties that can help reduce swelling in the body and improve the body works. The substance called curcumin, found in turmeric, can lower inflammation by reducing certain chemicals in the body that cause swelling. Ginger is a common plant with a bioactive substance called gingerol. This substance helps reduce swelling and pain by stopping the body's inflammation process (Forrester et al., 2020).

Common Medicinal Plants Used in Diabetes Management

Aloe Vera

A study found that people with Type 2 diabetes who added aloe vera gel to their diet had lower blood sugar levels compared to those who didn't. Many people have said that aloe vera gel can lower blood sugar and help people with diabetes. Additionally, using aloe vera gel may cause less side effects than regular medical treatments. Also, there is evidence showing that the good results come from the active ingredients in aloe vera gel. Aloe vera contains many helpful ingredients that work together to treat diabetes. These things help with diabetes in different ways and have many good effects on health. These things help the body use insulin better, make more insulin, and protect cells in the pancreas. This can help lower blood sugar levels. Improving insulin sensitivity helps the body use glucose better. Also, the substance can help protect cells from damage by fighting against oxidative stress and inflammation as an antioxidant. Also, the enzymes that help process glucose affect the amount of sugar in the blood, making it lower. So, this stuff helps lower blood sugar levels, improve cholesterol levels, and reduce a measure of long-term glucose control (Deora and Venkatraman, 2022).

Bitter Melon

A research study found that bitter melon extract helped lower blood sugar in people with Type 2 diabetes. It worked just as well as metformin. Many research studies have shown that adding bitter melon to the diet can help people with Type 2 diabetes. These studies found that patients were able to better control their blood sugar levels and relied less on artificial medications. Bitter melon has good effects because it contains charantin, vicine, polypeptide-p, momordicin, and momordin. The bitter melon plant has a lot of helpful compounds that can lower blood sugar levels. These chemicals act like insulin, help release insulin, and improve how cells take in glucose. Polypeptide-p works like insulin to bring down blood sugar levels. Furthermore, charantin and vicine help the pancreas produce more insulin and also help the body absorb glucose better. These things are good for you because they help lower your blood sugar levels and make our body more sensitive to insulin. They also protect our cells from damage (Hsu et al., 2020).

Fenugreek (*Trigonella foenum-graecum*)

Adding fenugreek seed powder helped people with diabetes to lower their blood sugar levels when they haven't eaten and also improved their overall blood sugar control. The research found that fenugreek can help people with diabetes control their blood sugar and lipid levels. Some people with diabetes have seen better control of their blood sugar and insulin levels when they add fenugreek seeds to their diet or treatment, as reported in informal studies and clinical cases. Active compounds are tiny parts in something that cause a certain reaction in living things or chemicals. These things can interact with cells in the body and cause reactions. Many scientists study these natural substances to see if they can be used to make new drugs. Some of these substances, like 4-Hydroxyisoleucine, Trigonelline, Galactomannan, and Diosgenin, may have good effects on health. A lot of studies have been done on these compounds because they affect how the human body works. Fenugreek seeds contain compounds that help with insulin release, the body's response to insulin, and the breakdown of carbohydrates. These compounds have positive effects. These things contain 4-Hydroxyisoleucine, which helps release insulin from the pancreas, and galactomannan, a type of fiber that slows down digestion and the absorption of carbs. In addition, trigonelline helps the body use insulin better and take in glucose (Yako, 2020).

Gymnema Sylvestre

Gymnema supplements help reduce blood sugar levels and improve insulin levels in patients. Studies have found that actively working parties have the greatest impact on this system. Gurmar contains gymnemic acids, gymnemycins, saponins and flavonoids. The Gymnema plant contains a substance called gymnemic acids that can help treat diabetes. Studies have found that these substances can block the absorption of sugar, help the body produce more insulin, and help regenerate pancreatic cells. Gymnemic acids prevent the body from absorbing sugar by blocking sugar receptors in the intestines. Additionally, these substances help the body release insulin and help repair the beta cells of the pancreas. Additionally, gymnemycins help reduce sugar cravings by making sweet foods taste less sweet. This combination of effects has good benefits, such as reducing blood sugar levels before and after meals, improving insulin production and the working capacity of beta cells (Girgis et al., 2022).

Cinnamon

Using cinnamon as a supplement may help lower blood sugar and improve cholesterol levels in people with type 2 diabetes. Research from multiple clinical trials has shown that cinnamon can lower blood sugar, A1C, and cholesterol levels in people with type 2 diabetes. This means that cinnamon may contain substances that can help control a person's diabetes symptoms. In this research, substances such as cinnamaldehyde, cinnamic acid and cinnamate were mainly used, but also polyphenols. Cinnamon has many benefits for the body, such as helping insulin work better, controlling blood sugar levels and acting as an antioxidant. Cinnamon contains cinnamaldehyde and polyphenols, which help insulin work better, improve the way glucose is used in the body, and have antioxidant effects. Cinnamaldehyde helps insulin work better and improves the way the body uses glucose. Polyphenols can also reduce stress and inflammation in the body. These effects keep the body healthier by lowering blood sugar levels, improving long-term blood sugar control, and preventing damage caused by diabetes. This can help reduce the problems that come with diabetes (Jamali et al., 2020).

Berberine

Research shows that berberine works as well as metformin in lowering blood sugar levels and improving insulin sensitivity in people with type 2 diabetes. Research shows that berberine may help lower blood sugar and improve the body's response to insulin. These findings suggest that berberine may have the same benefits as traditional medications in lowering blood sugar levels.

The properties of berberine, berbamine and palmatine make these compounds very interesting. Berberine, a chemical found in different plants in the Berberidaceae family, has been studied extensively to see if it can help treat diabetes. AMP-activated protein kinase (AMPK) is important in controlling how our body uses sugar and fat. Activating AMPK helps the body better absorb glucose and improves the body's response to insulin. Additionally, AMPK prevents the liver from making glucose by blocking a process called hepatic gluconeogenesis. Additionally, AMPK activation is important for improving fat levels by controlling how the body handles fat. Activating AMPK has benefits such as reducing fasting and post-meal blood sugar levels, reducing glycated hemoglobin (HbA1c), and improving blood sugar control. Additionally, it has been found to improve blood fat levels, which can reduce the chances of heart disease (Xie et al., 2022)

Scientific Evidence Supporting the Use of Medicinal Plants

Clinical Studies and Trials

Research and trials have shown that the use of medicinal plants can help control diabetes. The research usually involves people and tries to test if different plant extracts and compounds are safe, how much to use, and how well they work. Case studies and anecdotal evidence are commonly used in academic research. Using stories and case studies helps show how well medicinal plants can help treat diabetes. While not as strict as clinical trials, these reports give important insights into how things are used and their potential benefits in real life (Salleh et al., 2021).

Safety and Regulatory Considerations

Potential Side Effects and Toxicity

Using medicinal plants to manage diabetes can be helpful, but we need to be careful about possible side effects and toxic effects if we use them the wrong way or too much. Aloe vera is a type of plant that can be used for medicine. This stuff has good effects on health and is used in many industries like medicine, beauty, and wellness products. This plant has special substances that scientists are interested in because they can help with skin health, healing wounds, and reducing inflammation. More people are interested in using it as a natural treatment so researchers are studying how well it works and if it's safe to use on the skin or in the mouth (Msanda and Cherifi, 2020).

Potential negative effects: Consuming too much may lead to stomach pain and loose stools. Using this substance too much or for a long time can mess up the balance of important minerals in your body and hurt your kidneys. Bitter melon is a type of tropical plant that grows on a vine. It is part of the gourd family (Drewes et al., 2020).

Side effects may include low blood sugar, stomach pain, and headaches. Too much eating or drinking can hurt your liver and make it hard to have babies. Fenugreek is also known as Trigonella foenum-graecum. Some people may have stomach problems like bloating, gas, or diarrhea, as well as allergic reactions after taking it (Buse et al., 2020).

Overdosing can make your blood sugar go down and affect how your blood clots. Gymnema Sylvestre is a plant that has been used in traditional medicine for a long time and is known for its good healing abilities. It can make you healthier by preventing diabetes, helping you stay at a healthy weight, and lowering cholesterol. Many studies have shown that it can help treat diabetes and obesity. We need to study it more to understand how it works and what harm it could cause. Possible bad effects: belly ache and low sugar in your blood (Mason et al., 2022).

Limited research has been done on the possible long-term effects of this substance, but it is thought to be safe when used as directed. Cinnamomum verum, also known as cinnamon, is a spice made from the inner bark of trees in the Cinnamomum genus. Potential negative effects of eating cinnamon can include allergic reactions and sores in the mouth. Eating a lot of a type of cinnamon called Cinnamomum cassia with coumarin can damage the liver. Eating too much coumarin can damage your liver. Berberine is a substance found in different plants like Berberis, Hydrastis canadensis, and Coptis chinensis. Chemical compound from plants. A lot of studies have been done on it because it could have medical benefits and be used as a treatment. Potential side effects: This medicine might make your stomach feel bad, like making it hard to poop, giving you diarrhea, or making your belly hurt. If you use it for a long time or take a lot of it, it might make your blood pressure go down and could cause problems with our heart (Pathak and Sharma, 2021).

Interactions with Conventional Medications

Using natural plants with diabetes medication can make it harder to control diabetes. Plants like Aloe Vera, Bitter Melon, Fenugreek, Gymnema Sylvestre, Cinnamon, and Berberine can make some medications work stronger, which can be risky for low blood sugar. Also, some of these plants could react with blood thinning and clot prevention drugs, increasing the chance of bleeding, or changing the levels and effects of medications that are processed by the liver. It's important to keep a close eye on your blood sugar levels and think carefully about how these herbs might interact with our other medications (Ansari et al., 2022).

Quality Control and Standardization

It's really important to make sure that herbal medicines are safe and work well. This means checking that they are good quality, pure, and strong. Following good manufacturing practices (GMP) helps to make sure that herbal products are always made and controlled in the right way to meet high standards of quality. Testing for contaminants such as heavy metals, pesticides, and microorganisms is critical to product safety. It is also important to ensure that each batch of a product contains the same amount of active ingredients. Taking the right amount of medication at the right time is essential to staying safe and regaining your health (Gil et al., 2021).

Different rules and guidelines control how medicines are made and used. These rules may be different in each country and even in different regions within the same country. This can affect the ease of obtaining a medication, its effectiveness, and its safety for the person using it. The DSHEA makes sure that herbal medicines are safe and labeled correctly, but it doesn't require them to be approved before being sold. The European Union's Herbal Directive lets medicinal plants be registered as traditional herbal medicines if there is proof that they have been used traditionally and are safe, even if there is no evidence from clinical trials that they are effective. In India, Ayurvedic, Siddha, and Unani Drugs are controlled by the Drugs and Cosmetics Act. This law requires that these drugs meet traditional medicine standards and undergo safety checks. China's government watches over Traditional Chinese Medicine to make sure it's safe, works well, and is high quality

(Brinckmann et al., 2020).

Practical Considerations for Using Medicinal Plants

Dosage Forms (Extracts, Teas, Capsules, etc.)

Many kinds of plants can be used to help with diabetes. Each one has its benefits and things to consider when using it. Liquid extracts are strong forms that can be mixed with water or taken straight. Quickly taken into the body and easy to consume in precise amounts, standardized extracts ensure that the levels of active ingredients are always the same, leading to dependable health benefits. Herbal teas are made by soaking parts of plants that can help with medicine in hot water. They are easy to make and eat, but their strength can change depending on how they are made. Infusions are a strong tea that is brewed longer to make it more powerful. Capsules and tablets have crushed plants that can heal you. They make it easy to measure and take the right amount. Tablets and capsules give you the right amount of medicine easily, but tablets might have extra ingredients. Ground medicinal plant material can be mixed with food or drinks as loose powders. Tinctures are strong extracts kept in alcohol. They can be easier to measure for the right amount, but they may not be as handy as capsules or tablets because they last longer and work faster. Not suitable for people who don't drink alcohol. Creams and ointments are good for treating specific problems like diabetic nerve pain or skin issues (Blahova et al., 2021).

Dosage and Administration

The right way to use medicinal plants depends on the specific plant, its form, and the person using it. Here are some tips for using common medicinal plants, take 1-3 tablespoons of Aloe Vera gel every day, either on its own or mixed with water or juice. We can have Bitter Melon by drinking 50-100 ml of fresh juice every day or taking 1-2 capsules with 500 mg of dried extract twice a day. It works best if you take it on an empty stomach. You can eat fenugreek by taking 5-10 grams of seeds every day, or 500-1000 mg of standardized extract two times a day. the seeds in water overnight or add the powder to your food or drinks. Gymnema Sylvestre is a plant extract that you can take as a pill. Take 200-400 mg twice a day before meals to help lower your blood sugar after eating (Pengelly, 2020)

Sourcing and Authenticity

We need to ensure that the medicinal plants are of good quality and authentic so that they work well and are safe and harmless. When purchasing medicinal plants, it is best to buy them from trusted sellers who follow strict regulations and have them tested by third-party companies. This ensures that the plants are pure and strong. It's a good idea to check the label to see if it indicates that the product is organic, non-GMO, and contains standardized extracts. Make sure the label has detailed information about the product's ingredients and the dosage to take. Also, choose products that have been checked for harmful metals, chemicals, and bacteria to avoid impurities. Choose products that don't have anything extra or unnecessary added. When purchasing plants, choose plants that have been harvested in a way that is good for the environment and treats humans fairly (Dasilva et al., 2022).

Integrating Medicinal Plants into Diabetes Management Plans

Using herbs as part of a whole-body approach to treating diabetes requires collaboration with your doctor and other health professionals. Always check with your doctor before using any plants as medicine to make sure they won't cause any problems with your other treatments and that you are taking them in the correct amounts. Personalized care is important for good diabetes control. Tailor your use of herbs to your body's needs, your preferences, and how your body responds to the treatment. Monitor your blood sugar levels carefully and adjust your medications as necessary. Be aware of any side effects or problems when using conventional medications and complementary treatments at the same time. It's good to make changes to our daily habits, such as eating healthy, staying active, and managing stress, to help manage diabetes. It can also be useful to add natural plants that can help treat diabetes. Be sure to tell patients how to use medicinal plants correctly, what benefits they have, and any problems they may have. Encourage your child to make smart decisions and stick to a treatment plan (Yako, 2020).

Future Directions and Research Needs

Emerging Medicinal Plants with Potential Anti-diabetic Properties

Scientists have been discovering new plants that can help treat diabetes. These new plants could further help control diabetes. Moringa contains several nutrients that can help lower blood sugar levels and make insulin work better. Nigella sativa, also known as black seed, contains a substance called thymoquinone, which in studies has been found to help lower blood sugar levels in animals and make insulin work better. Ayurvedic medicine uses Salacia reticulata to help treat diabetes. Studies show that it can make it harder for the body to absorb carbohydrates and help control blood sugar levels. Viola macrophylla contains corosolic acid, which may help lower blood sugar levels by making insulin work better. Ginseng contains ginsenosides, which can help the body produce more insulin and respond better to it. This can be helpful for people with diabetes (Tran et al., 2020).

Integration with Conventional Medicine

This means making rules for using plants as medicine for diabetes, getting doctors and herbalists to work together, teaching patients about the good and bad parts of using plants, making sure plant products are safe and good quality, and

making it easier for people to get insurance to cover plant treatments for diabetes (Allen et al., 2023).

Conclusion

Diabetes is a chronic condition in which high blood sugar results from insufficient insulin. Globally, it's rising and impacting health and finances. While treatments include medication and lifestyle changes, medicinal plants offer a cost-effective option with benefits like increasing insulin levels and protecting against damage. However, it's crucial to be aware of potential side effects and quality concerns. Regulating and ensuring the safety of herbal products can enhance their effectiveness in managing diabetes.

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