International Journal of Pharmacy and Herbal Technology

e-ISSN: 2583-8962 Vol. 2, Issue 4 (October – December, 2024) pp: (2549-2568)

A Review on: Role of Herbal Plant and their Mechanism in Management of Diabetes Mellitus

Ujwala Umbarje, * Yogesh B. Raut, Sanjay K. Bais

Fabtech College of Pharmacy, Sangola, Solapur, Maharashtra, India

*Corresponding Author: ujwalaumbarje60@gmail.com

Received Date: November 27, 2024; Published Date: 17 December,2024

Abstract

A serious worldwide health issue today is diabetes mellitus, a long-term metabolic condition characterized by high blood sugar. Insulin and oral hypoglycaemic medications are examples of conventional treatment methods; however, they are frequently linked to long-term problems and adverse consequences. Because of their effectiveness, low cost and lack of negative effects, herbal medicinal plants have drawn interest as alternate or additional medications for the management of diabetes in recent years. This review examines the possible therapeutic benefits, mechanisms of action and active ingredients of several herbal plants in the treatment of diabetes. Through improvements in insulin sensitivity, increased production of insulin and inhibiting glucose absorption, a few plants, including Momordica Charente's (bitter melon), Trigonella frenum-graecum (fenugreek), Cinnamomum verum (cinnamon) and Gymnemate Sylvester, have demonstrated promising anti-diabetic properties. Many phytochemicals located in herbal medicinal plants, especially phenolic, alkaloids, terpenes and flavonoids, have been associated with antidiabetic effects by a variety of mechanisms. These include increased insulin secretion, decreased absorption of glucose and digestion of carbohydrates, increased Radial tissue glucose absorption and antioxidant reactions that reduce one of the main causes of diabetes is oxidative stress. In preclinical as well as clinical research, Trigonella frenum-graecum (fenugreek) and Momordica Charente's (bitter melon) are examples of plants Cinnamomum verum (cinnamon) and Gymnemate Sylvester indicate great potential in promoting insulin sensitivity and lowering blood sugar levels. The pharmacological mechanisms, bioactive components and scientifically proven usefulness of herbal plants the use of therapeutic plants to treat diabetes are examined in this review, which summarises the most recent research in this area. In terms of managing glucose metabolism, improving insulin sensitivity and protecting pancreatic beta cells, medicinal herbs such as Coccinea indica, Salacia oblonga and Berberi's aristae (berberine) have shown efficacy.

Keywords - Diabetes mellitus, Medicinal plants, Hyperglycaemia, Anti diabetic, Antioxidant.

INTRODUCTION

People with diabetes mellitus are afflicted with this frequent and highly prevalent disease in both industrialized and developing nations. This disease is estimated to impact 25% of the world's population. The improper metabolism of carbohydrates, that is connected to low insulin levels in the blood or insulin sensitivity in the target organ, is what causes diabetes mellitus [1] Even though oral hypoglycaemic medications have made significant progress in treating diabetes, there is still a need for additional medications due to the drawbacks of the synthetic ones now on the market.

Despite its admiration with their therapeutic qualities in conventional medical systems, commercially available modern drugs that have an antidiabetic effect have not yet been produced from traditional remedies [2].

Among the more common endocrine conditions worldwide, diabetes mellitus (DM) impacted 422 million individuals in 2014 [3] Type 2 diabetes is related for each relative insulin a lack and increasing resistance to glucose in the peripheral tissues and liver [4]. Reduced synthesis of insulin is the cause of type 1 diabetes. While oral hypoglycaemic drugs have made major advancements in managing diabetes, there remains an opportunity for new drugs due to the limitations of the artificial drugs now on the market. While receiving acknowledgement of their beneficial effects in conventional medical systems, natural remedies that have an anti- diabetic effect are still being developed into current pharmaceuticals for commercial use [5]. Diabetes mellitus (DM) combined with poor glucose tolerance is a potentially fatal condition that can raise the risk of cardiovascular disease up to eight times. In the US, the condition is responsible for 60% of non-invasive amputations [6] and 30.3 million people were believed to have diabetes mellitus, of which 7.2 million were believed to be undiagnosed [7]. In the same Diabetes was directly linked to an estimated 1.6 million deaths each year and an additional 2.2 High blood sugar was linked to million deaths [8]. Furthermore, it was projected that, by the globally, there will be 642 million adult diabetes by the year 2040 [9]. Because higher blood glucose levels raise the possibility of cardiovascular along with other disorders, they have been linked to death. 43 percent of these fatalities happened before the patient turned 70 years old [10] increased oxidative stress brought on by hyperglycaemia results in inflammation and activation of the polyol pathway, as well as harm to the body's organs [11]. Diabetes needs diagnosis, medical treatment, Lifestyle, adjustment, even though as of right now, no effective causative remedy has been found [12]. There are many synthetic medications to treat the symptoms of diabetes mellitus, however none of them can conclusively reduce the cause of the illness [13]. Herbal therapy is utilized in traditional medicine to treat diabetes in developing nations when the general public is impacted by the cost of pharmaceutical medications [14]. Diabetes along with its associated issues remain a serious medical issue even after the development of synthetic and natural hypoglycaemic drugs. It has been displayed that many native Indian medicinal plants are capable of treating diabetes. The reality that plants for medicine are readily available and have minimal adverse effects is one of the many advantages they provide. Traditionally, Plants have been used to a prime source of medications, so several of the medications on the market now coming either through them directly or indirectly. Approximately 800 species are identified within the botanical information as possibly antidiabetic [15]. Many plants and substances produced from them are employed in the treatment of diabetes, therefore the plants offer a potential source of hypoglycaemic medications. Numerous Indian various types of diabetes have been investigated in relation to plants. These studies have been reported in several scholarly journals. Many plants that are utilized like herbal medications for the management of diabetes are mentioned in Ayurveda and other ancient medical systems. Because they are inexpensive and have fewer adverse effects, they are valuable as alternative medicine. It has been observed that the active ingredients in medicinal plants can release insulin, regenerate pancreatic beta cells, and treat insulin resistance. [16]

The genesis of the emergence of diabetic complications involves hyperglycaemia. Herbs that lower blood sugar levels stimulate insulin secretion, improve muscle or adipose tissue's absorption of glucose, and prevent the liver and intestines from producing glucose [17]. The mainstays of diabetes care remain insulin as well as oral hypoglycaemic drugs like biguanides and sulphonylureas, but efforts are being made to produce more potent anti-diabetic medications.

Herbal medications have grown increasingly useful as a form of hypoglycaemic drugs in recent years. Based on studies by Marles and Farnsworth, more than 1,000 plant species are used as conventional medicine in order to control diabetes [18] The chemical composition of plant-based compounds used as diabetic supplementary therapies has an impact on their biological properties [19]. Plant or herbal items are abundant in components that lower blood glucose levels, such as coumarins, terpenoids, avionics, and phenolic compounds. [20] Several types' antidiabetic effects of herbal medicines have been documented in both scientific and popular literature [21]. Herbal medications are prescribed because of their affordability, perceived effectiveness, and decreased negative consequences in clinical practice price.[22] Diabetes mellitus has long been treated with medicinal and herbal plant items in many different countries. A review paper lists a few therapeutic herbs that have hypoglycaemic effects and describes how they work. These include Combretum micranthum, Elephant opus caber, Bauhinia forficate, Liriope spicata, Parinaric excelsa, Ricinus communis, Sarcopoterium spinosum, Small anthus sonchifolius, Swertia punicea, Vernonia anthelmintic, and Gymnemate Sylvester are some of these approximately 1000 plants reported to have potential to be antidiabetic[23] The goal of this review is to collect all of the knowledge on plants that have hypoglycaemic activity which has been presented in Medline 'PubMed' between 1990 and 2000. [24]

Types of diabetes

Type 1 diabetes

Autoimmune diseases are thought to damage the B cells in the pancreatic islets that produce insulin. Mechanisms, which causes type 1 diabetes. Erroneously, healthy B cells are destroyed by active T cells. The autoimmune component accounts for about 95% of diabetes I cases. Pancreatic cell loss occurs at a very varied rate, with less than 5% of cases being idiopathic and, in some cases, occurring quickly while in others developing slowly. While HPV can happen to anyone at any age, children are more likely to get it, with the infection peaking in the pre-school years [25].

Type 2 diabetes

In terms of clinical traits and aetiology, it has grown more challenging to differentiate between T1D and T2D diabetes. According to a theory, both types of diabetes rapid and slow share the inefficiency of beta cells and would ultimately result in insulin resistance. As diabetes II affects people in later life and this is a hereditary disorder that arises at a younger age that was formerly referred to as adult diabetes or non-insulin-dependent diabetes [26] This particular form of diabetes affects 90–95% of people with the disease. The peptide hormone insulin regulates blood glucose levels by controlling the breakdown of proteins, fats and carbs in the target tissues. Insulin receptors are expressed on many somatic cells [27] Insulin directly affects the liver, adipocytes and skeletal muscle in these tissues. A significant and specific function in metabolic homeostasis that depends on the presence of regulatory pathways. For instance, insulin boosts glucose transport and Synthesis of glycogen in skeletal muscle cells. Improving glucose use in these cells and facilitating the liver's ability to store excess glucose. Also, insulin promotes the production of glycogen in the liver and raises the expression of lipogenic genes [28] Additionally, it affects preventing the breakdown of adipose tissue and promoting the production of lipids and glucose transport. Insulin affects the target tissues indirectly in addition to its direct effects. For instance, insulin lowers the amount of hepatic acetyl-coA by inhibiting the breakdown of the adipose tissue, hence reducing the activity of Pyruvate carboxylase. This process further inhibits the production of hepatic sugar through glycine synthesis and lipolysis. Additionally, obesity raises tissue resistance to insulin's effects, and poor hepatic insulin sensitivity, skeletal muscle and adipose tissue the three major

metabolic organs lower blood sugar levels. Insulin prevents the skeletal muscle cells from absorbing glucose. [29]

Gestational Diabetes Mellitus (GDM)

The term "gestational diabetes" refers to any kind of high insulin levels that develops before or during pregnancy. Two types of gestational diabetes mellitus (GDM) exist: A1GDM, also known as diet-controlled GDM, which is easily controlled without the use of medication and responds well to dietary therapy, and A2GDM. In order to attain proper management of the blood sugar level, drugs regulate the sugar directly. It's evident that a malfunction in the pancreatic beta cells or a delayed reaction of the beta cells to blood sugar levels are the causes of gestational diabetes. Human lactogenic resistance to insulin is the primary hormone linked to elevated insulin resistance in gestational diabetes, however other hormones linked to the development of Prolactin, progesterone, and growth hormone are factors in this condition that help to induce insulin resistance and elevated blood sugar levels in pregnant women.

Additional Diabetes Types

Exogenous pancreatic diseases (such as pancreatitis and cystic fibrosis), monogenetic diabetes syndromes (such as diabetes in young adults and neonates), and diabetes caused on by drugs or chemicals (such as glucocorticoids used in HIV treatment or after organ transplantation) are some of the causes of these types of diabetes.

Syndrome Monogenic Diabetes

This comprises diabetes-onset in youth (MODY), persistent congenital diabetes (PNDM), neonatal transient diabetes mellitus (TNDM), and genetic disorders.[30] It also contains two forms of monogenic genetic abnormalities, namely monogenic B-cell function issues. While polycystic ovarian disease, irritability, and hyper-insulinemia are common symptoms of insulin resistance in the absence of obesity, monogenic defects in insulin function are less common than monogenic B-cell issues [31] A set of clinical symptoms and hyperglycaemia are caused by mutations in the insulin receptors [32].

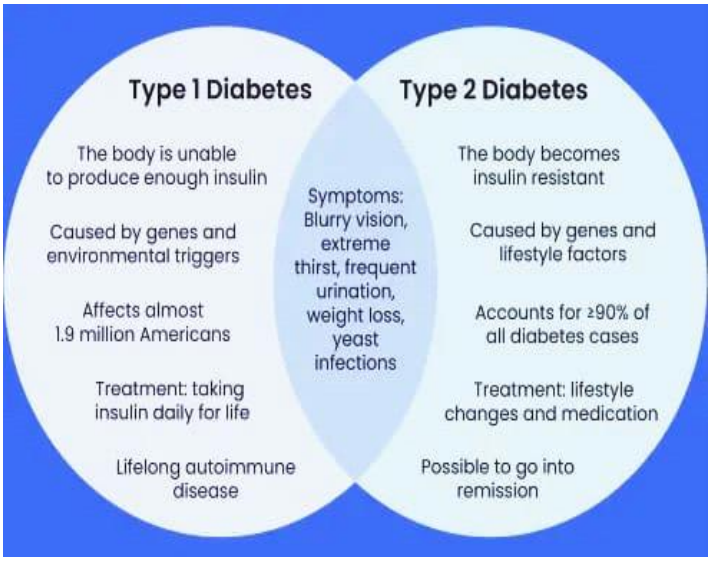

Figure 1*: *Types of Diabetes

Mechanism of Action of Anti-Diabetic Herbal Plants

Insulin Secretion Stimulation

A few medicinal plants work against diabetes by raising insulin levels secreted by pancreatic "β-cells." Bioactive chemicals found in these plants increase the Insulin is released via regulating the

β-cells. So increasing in lowering blood glucose levels. Say for example: There is evidence that the bitter melon, Momordica Charentais, contains polypeptide-p, vicine, and charantin, which can increase the release of insulin. It has been shown that Gymnema Sylvester stimulates insulin secretion and regenerates pancreatic "β-cells." This action has been associated with gymnemic acids [33]

Improving Insulin Sensitivity

After meals, several herbal plants slow down the conversion of carbohydrates into glucose, which helps to avoid sharp rises in blood sugar levels. This mechanism functions similarly to alpha-glycosidase inhibitors seen in medicine. Salacia reticulate: Slows down the breakdown of carbohydrates by inhibiting the alpha-glycosidase enzymes with its salacinol and kotalanol contents. The common bean, Pharsalus vulgaris, has alpha-amylase inhibitory action, which slows down the conversion of starch to glucose [34]

Preventing the Absorption and Digestion of Carbohydrates

Insulin resistance is one of the primary features of type 2 diabetes, which happens when the body's cells do not respond to insulin as they need to. Some herbs improve insulin sensitivity, which enables cells to use glucose more effectively. Plants such as Coptis chinensis and Berberi's aristae contain berberine, which activates AMP-activated protein kinase (AMPK), an essential regulator of energy metabolism. Insulin sensitivity and tissue glucose absorption are enhanced as a result. The saponins and soluble fibre in fenugreek (Trigonella foenum graecum) enhance insulin sensitivity and glucose tolerance. [35]

Antioxidant Activity

Breakdown of pancreatic β-cells and insulin resistance are caused by One of the main factors contributing to the development of diabetes is oxidative stress. Strong antioxidant characteristics found in many herbal plants aid in reducing oxidative stress and preventing cellular damage. Curcuma longa (Turmeric): The active ingredient, curcuma, is a potent antioxidant that enhances insulin sensitivity, lowers oxidative stress, and shields β-cells. Green tea, or Camellia sinensis, is rich in polyphenols, especially epigallocatechin gallate (EGCG), which includes the ability to enhance insulin sensitivity and reduce oxidative damage [36]

Inhibition of a final product of advanced glycation (AGEs) Formation

A metabolism in glucose and insulin resistance are significantly influenced by the gastrointestinal flora. Certain medicinal herbs can enhance glucose regulation by altering the gut flora. Garlic, or Allium sativum, is a probiotic plant that has been demonstrated which promote glucose metabolism and lower insulin resistance by modifying microbiota and improving gut health. Beyond its ability to mimic insulin, cinnamon (Cinnamomum verum) balances the gut microbiota, which enhances glucose homeostasis.

Modulation of Gut Microbiota

Long-term diabetes problems such neuropathy, retinopathy, and nephropathy are associated with the development of AGEs, or advanced glycation end products. Certain plant extracts can stop or lessen the production of AGEs. Triphala is a traditional Ayurvedic preparation including three fruits: Terminalia bellirica, Terminalia chebula, and Emblica officinalis. It has been shown to prevent the production of AGEs. Ginkgo biloba Flavonoids and terpenoids with anti-glycation properties are present in this herb, reducing the production of AGEs and subsequent tissue damage. [37]

Herbal medicinal plants which used as anti-diabetic

Gymnema Sylvester (Gurmar)

Family: Asclepiadaceae,

Mechanism of action

Gymnemic acids, which are found in Gymnema Sylvester leaves, have been demonstrated to inhibit the taste of sweetness and prevent the intestines from absorbing sugar. By increasing the release of insulin and promotes the regeneration of pancreatic beta cells. It also increases peripheral tissues' sensitivity to insulin.

Scientific Evidence

Gymnema Sylvester extract administration significantly lower blood glucose levels in those who have Type 2 diabetes, as per clinical research by Baskaran et al. (1990). [38]

Figure 2*: *Gymnema Sylvester.

Momordica charantia (Bitter melon)

Family: Cucurbitaceae

Mechanism of action:

Compounds with insulin-like characteristics found in bitter melon include vicine, charantin, and polypeptide-p. These substances enhance the cells' ability to absorb glucose, increase insulin secretion, and reduce the liver's production of glucose.

Scientific Evidence

Dan's et al. (2007) reported that individuals treated with bitter melon extract saw an important reduction in fasting blood glucose when compared to placebo in a randomised, controlled experiment [39]

Figure 3*: *Momordica Charantia

Trigonella Frenum-graecum (Fenugreek)

Family: Fabaceae

Mechanism of action

Soluble fibre, which is present in fenugreek seeds, makes it more difficult for carbohydrates to be absorbed and digested. The seeds also contain the amino acid 4-hydroxyisoleucine, which promotes the release of insulin. It has been shown that fenugreek lowers blood sugar and improves insulin sensitivity after eating rises.

Scientific Evidence

Fenugreek seed administration, It has been demonstrated to decrease fasting blood sugar levels and raise glucose tolerance Among people who have Type 2 diabetes, per a 1990 study by Sharma and Raghuram [40]

Figure 4*: *Trigonella Frenum-Gracecum

Cinnamomum verum (Cinnamon)

Family: Lauraceae

Mechanism of action

Bioactive substances found in cinnamon that improve insulin sensitivity include cinnamon aldehyde and cinnamomic acid. It functions by enhancing glucose absorption, decreasing insulin resistance, and imitating insulin. Cinnamon also reduces cholesterol and blood sugar levels during fasting.

Scientific Evidence

In individuals Have diabetes type 2 research by Khan et al., 2003 showed which after 40 days of dietary supplements, cinnamon dramatically lowered fasting blood glucose levels [41]

Figure 5: *Cinnamomum Verum*

Aloe Vera (Aloe barbadensis)
Family: Liliaceae
Mechanism of action
The phytosterols and polysaccharides included in aloe vera is demonstrated to increase the secretion and sensitivity of insulin, hence lowering blood glucose levels. Moreover, it contains antioxidant and anti-inflammatory qualities to protect against problems from diabetes. Also it assist in relieving dry skin.
Scientific Evidence
After consuming aloe vera juice, diabetic patients' fasting blood glucose levels and the haemoglobin A significantly decreased, according to a clinical investigation by Yongchaiyudha et al. (1996).[42]

Figure 6*: *Aloe Vera.

Tulsi (Holly basil)
Family: Lamiaceae
Mechanism of action
Because of their capacity to increase insulin production and decrease oxidative stress, holy basil leaves which demonstrated to decrease in blood sugar. In a gut, the leaves also prevent glucose absorption.
Scientific Evidence
Holy basil extracts significantly decreased blood glucose levels during both fasting periods in individuals with Type 2 diabetes and after periods, according to a study by Agrawal et al. (1996).[43]

Figure 7*: *Ocimum Sanctum

Syzygium cumini (Jamun)

Family: Myrtaceae

Mechanism of action

Ellagic acid and jamboline, found in Syzygium cumini seeds, work in order to lower blood sugar levels by improving the insulin sensitivity and preventing the absorption of glucose. Additionally, they have antioxidant qualities that guard against oxidative damage to pancreatic beta cells.

Scientific Evidence

Ayyanar and Subash-Babu's (2012) study, which presented an important drop in diabetic rats' blood glucose levels, supported the anti-diabetic properties of jamun seeds. [44]

Figure 8*: *Syzygium Cumini

Allium sativum (Garlic)

Family: Amaryllidaceae

Mechanism of action

There is evidence that garlic reduces blood glucose and enhances insulin sensitivity. Garlic contains sulphur-containing chemicals called allicin, which increase insulin secretion and lower oxidative stress.

Scientific Evidence

In a study published in 2006, Eidi et al. found that garlic substance effectively lowered the diabetic rats' blood glucose levels. [45]

Figure 9*: *Allium Sativum

Curcuma longa (Turmeric)

Family: Zingiberaceae

Mechanism of action

Curcumin, the main ingredient in turmeric, has been demonstrated to reduce blood sugar by improving insulin sensitivity and lowering inflammatory responses. Additionally, pancreatic beta cells are shielded from oxidative damage by curcumin.

Scientific Evidence

Curcumin helped diabetic rats better regulate their blood sugar and lessened oxidative stress, according to a 2005 study by Nishiyama et a [46]

Figure 10*: *Curcuma Longa

Berberis aristata (Indian barberry)

Family: Berberidaceae

Mechanism of action

The main ingredient, has been established to reduce blood sugar levels by activating AMP-activated protein kinase (AMPK), which causes the liver to produce less glucose and enhance glucose absorption. It increases the sensitivity to insulin as well.

Scientific Evidence

Zhang et al. (2010) shown through a meta-analysis that berberine was just as successful as metformin in reducing the blood sugar levels of individuals with Type 2 diabetes. [47]

Figure 11*: *Berberis Aristata

Panax ginseng (Ginseng)

Family: Araliaceae

Mechanism of action

Ginseng includes ginsenosides, which have been found to decrease hepatic glucose production, raise insulin secretion, and enhance insulin sensitivity. Furthermore, it has antioxidant and anti-inflammatory qualities to protect against issues from diabetes.

Scientific Evidence

Vuksan et al. (2000) found that Levels of blood glucose after meals in individuals with Type 2 diabetes were significantly reduced using North American ginseng. [48]

***Figure 12*:** *Panax Ginseng*

Pterocarpus marsupium (Indian Kino)

Family: Leguminosae - Papilionoidea

Mechanism of action

Pterostilbene, which has been shown to promote pancreatic beta cell repair and insulin secretion is found in the heartwood of Pterocarpus marsupium. In addition, it stops the intestines from absorbing glucose.

Scientific Evidence

According to Grover et al. (2002), Pterocarpus marsupium extracts substantially lowered the diabetic rats' fasting blood glucose levels. [49]

***Figure 13*:** *Pterocarpus Mar5supium*

Salacia reticulate

Family: Celastraceae

Mechanism of action

Salacia reticulate involves chemicals called salacinol and kotalanol, which inhibit the enzyme alpha-glycosidase. This inhibits the breakdown and absorption of carbs, hence preventing blood sugar rises that occur after a meal.

Scientific Evidence

Salacia reticulate extract was discovered by Yoshikawa et al. (2002) to significantly decrease postprandial hyperglycaemia in humans and animal models [50]

Figure 14*: *Salacia Reticulate

King of bitters (Andrographis paniculata)

Family: Acanthaceae

Mechanism of action

It has been shown that the active ingredient, the substance, reduces blood sugar levels via improving insulin sensitivity, lowering oxidative stress, and modifying inflammatory pathways.

Scientific Evidence

A study by Zhang et al. (2019) shown that the insect Andrographis paniculata lowered fasting improved glucose tolerance and blood glucose levels in diabetic mice. [51]

Figure 15*: *Andrographis Panaculata.

Ficus Bengalese's (Banyan tree)

Family: Moraceae

Mechanism of action

It has been discovered that the aerial roots of Ficus Bengalese's have anti-diabetic effects by increasing glucose absorption and insulin sensitivity. In addition, it has antioxidant properties that reduce the oxidative stress caused on by diabetes.

Scientific Evidence:

The fibre Bengalese's aqueous extract substantially reduced the blood sugar levels of diabetic rats, as reported by a study by Augusti et al. (1994).[52]

Figure 16*: *Ficus Bengalese

Coccinea indica (Ivy gourd)

Family: Cucurbitaceae

Mechanism of action:

Diabetes has long been managed by using coccinea indica. The active ingredients, which include beta-sitosterol and flavonoids, decrease the liver's production of glucose and raise insulin sensitivity

Scientific Evidence:

In diabetic rats, Coccinea indica extract significantly reduced blood glucose levels during fasting and enhanced ability to tolerate glucose, based on a 2009 study by Kirana et al [53]

Figure 17: *Coccinea Indica*

Moringa oleifera (Drumstick tree)

Family: Moringaceae

Mechanism of action

By enhancing insulin sensitivity, lowering oxidative stress, and blocking glucose absorption, the compounds quercetin and chlorogenic acid found in moringa oleifera leaves help lower blood glucose levels.

Scientific Evidence

Rats with diabetes had significantly less blood glucose levels when given doses of Moringa oleifera leaf powder, according to a 2012 study by Mbikay. [54]

Figure 18*: *Moringa Oleifera

Silybum marianum (Milk thistle)

Family: Daisy

Mechanism of action

The main ingredient in milk thistle, silymarin, been demonstrated to decrease hepatic glucose synthesis or increase insulin sensitivity. In addition, its strong antioxidant qualities protect against oxidative damage to the pancreas and liver

Scientific Evidence

Silymarin significantly improved the control of glucose in people who have Type 2 diabetes, as per research by Huseini et al. (2006) [55]

Figure 19*: *Silybum Marianum

Nigella sativa (Black seed)

Family: Ranunculaceae

Mechanism of action

Thymoquinone, which is found in Nigella sativa, has been established to reduce inflammation, increase insulin sensitivity, and shield pancreatic beta cells from oxidative stress.

Scientific Evidence

Nigella sativa oil administration resulted in significant reductions in the haemoglobin A and blood glucose levels during fasting in individuals with Type 2 diabetes, according to a study carried out by Bamosa et al. (2010).[56]

Figure 20*: *Nigella Sativa

Psidium guajava (Guava)

Family: Myrtaceae

Mechanism of action

Quercetin and flavonoids found in guava leaves inhibit alpha-glycosidase and decrease the absorption of carbohydrates, decreasing postoperative blood sugar levels. It also possesses antioxidant and anti-inflammatory properties.

Scientific Evidence

In diabetic rats, guava leaf extract significantly decreased blood glucose levels, according to a 2005 study by Ojewole. [57]

Figure 21*: *Guava

Neem

Family: Meliaceae

Biological Source: Azadirachta indica, a plant in the Meliaceae family, is the substance's natural source.

Use: mainly used to control diabetes, [58]

Figure 22*: *Neem

Dietary Guidelines for Management of Diabetes According to Ayurveda

Numerous herbal medicines have had encouraging results in preclinical and clinical investigations, including bitter melon or Momordica charantia, Gymnema Sylvester, and Fenugreek, or Trigonella foenum-graecum. Though many people are aware of the traditional uses of these herbs, more standardised, large-scale clinical research are still required to verify their safety, determine the best dosages, and verify their efficacy. Furthermore, it is important to thoroughly investigate how herbal remedies might be combined with traditional medical therapy, with a focus on individualised diabetic care strategies. The knowledge of every person is genuinely unique and has a unique constitution known as Prakriti is at the basis of Ayurvedic nutrition. When it comes to diabetes management, Ayurveda creates a specific diet plan that not only cures symptoms but also intends to bring the balance of the body and harmony back. The developing possibility of individualised nutrition is highlighted as this article investigated the specifics of Ayurvedic dietary advice for diabetes.

Vata Prakriti

Airy and ethereal characteristics define people with a Vata constitution. They have an ability for abnormalities yet are often imaginative, approachable, and flexible.

Pitta Prakriti

People who are Pitta dominant represent the elements of fire and water. They frequently have determination, bright minds, and an affinity for overheating.

Kapha Prakriti

The elements of earth and water have an impact on kapha people. With an ability towards heaviness, they are usually solid, steady, and soothing. In. [59]

Future Prospects of Herbal Plants

Both established and emerging countries will see continued rapid growth in the market for herbal medicines and other herbal healthcare products. Growing understanding of holistic health, which considers a person's mental, emotional, and spiritual well-being in addition to their physical health. Finally, due of the abundance of information available online, people may now find and learn about herbal medications more readily. Several investigations are presently underway to ascertain the potential benefits of herbal medicine in the treatment of various illnesses. Certain herbs, for

example, have been demonstrated in some studies to improve immune function, lower blood pressure, and reduce inflammation. Moreover, more and more studies suggest that some herbal remedies could be helpful in treating mental health conditions. Also, controlling serious illnesses like diabetes and cardiovascular disease is beneficial. All things considered, as more people look for natural remedies for their medical problems, herbal medicine seems to have a bright future. However, it's important to keep in mind that taking herbal remedies should be done very carefully because they might not be appropriate for everyone and could conflict with prescription medications. Before taking any herbal medication, it is best to consult a qualified healthcare provider. [60]

CONCLUSION

In addition to synthetic drugs, the use of therapeutic herbs to treat diabetes provides a natural treatment. Significant antioxidant properties have been established by the plants discussed in this article, mostly through mechanisms that increase insulin production, improve insulin sensitivity, and decrease glucose absorption. For these plants to be widely used, more extensive for their safety and effectiveness to be completely proven, clinical trials are required. Numerous herbal medicines have had encouraging results in preclinical and clinical investigations, including Momordica charantia, Gymnema Sylvester, and Fenugreek, or Trigonella foenum-graecum. Though many people are aware of the traditional uses of these herbs, more standardised, large-scale clinical research are still required to verify their safety, determine the best dosages, and verify their efficacy. Furthermore, it is important to thoroughly investigate how herbal remedies might be combined with traditional medical therapy, with a focus on individualised diabetic care strategies.

REFERENCE

1. Maiti R., Jana D., Das U.K., Ghosh D., Antidiabetic Effect of Aqueous Extract of Seed of Tamarindus Indica in Streptozotocin-Induced Diabetic Rats, Journal of Ethnopharmacology,2004:92(1): 85–91.
2. Wadkar K.A., Magdum C.S., Patil S.S., Naikwade N.S., Antidiabetic Potential and Indian Medicinal Plants, Journal of Herbal Medicine and Toxicology,2008:45(2):45–50.
3. Yeh G.Y., Eisenberg D.M., Kaptchuk T.J., Phillips R.S, Systematic Review of Herbs and Dietary Supplements for Glycemic Control in Diabetes Care, National Journal of Herbal Medicine,2003:26(4):1277–1294.
4. Mahmoudian-Sani M.R., Luther T., Asadi-Samani M., A New Approach for Treatment of Type 1 Diabetes Phytotherapy and Phytopharmacology of Regulatory T cells, Journal of Renal Injury Prevention,2017:6(3):158–163.
5. Deshpande K., Chitre D., Yoga for the Diabetic Patient, International Journal of Yoga, 2010:3(1):2–5.
6. Norhammar A., Tenerz A., Nilsson G., Glucose Metabolism in Patients with Acute Myocardial Infarction and No Previous Diagnosis of Diabetes Mellitus, Journal of Pharmacology and Toxicology,2002:359(9324):2140–2144.
7. Patwardhan B., Gautam M., Botanical Immunodrugs Scope and Opportunities, Journal of Ethnopharmacology,2005:10(7):495–502.

8. Grover J.K., Yadav S., Vats V., Medicinal Plants of India with Anti-diabetic Potential, Journal of Ethnopharmacology,2002:81(1):81–100.
9. Herman W.H., The Global Burden of Diabetes an Overview, In Dagogo-Jack editor, Diabetes Mellitus in Developing Countries and Underserved Communities, Journal of Pharmacology and Toxicology,2017:978(3)415-574.
10. Tripathi Y.B., Yadav D., Diabetes Treatment with Aloe Vera and Honey, International Journal of Green Pharmacy,2009:3(3):236–238.
11. Amiri M., Oxidative Stress and Free Radicals in liver and kidney Diseases an Updated Short Review, Journal of Nephropathy,2018:7(3):127–13.
12. Rahimpour S., Hasanpour Dehkordi, An Antioxidant Defence System Versus 8-Hydroxy-2' Deoxyguanosine A short look at recent findings, Journal of Renal Injury Prevention,2018:7(3):121–123.
13. Li W.L., Zheng H.C., Bukuru J., Natural Medicines Used in Traditional Chinese Medical System for Therapy of Diabetic Mellitus, Journal of Ethnopharmacology,2004:92(7):1–21.
14. Saravanan G., Pari L., Hypoglycaemic and Antihyperglycemic Effect of Syzygium Cumini Bark in Streptozotocin-Induced Diabetic Rats, Journal of Pharmacology and Toxicology,2008:3:(4)1–10.
15. Alarcon-Aguilara F.J., Roman-Ramos R., Perez-Gutierrez S., Aguilar-Contreras A, Contreras-Weber C.C., Flores-Saenz J.L., Study of the Anti-Hyperglycaemic Effect of Plants Used as Anti-Diabetics, Journal of Ethnopharmacology,1998:61(2):101–110.
16. Dhakal M., Sharma. P., Ghosh S., Paul B., Bhutia S. Pal, Preparation and Evaluation of Herbal Lipsticks Using Natural Pigment Lycopene (Solanum lycopersicum), Universal Journal of Pharmaceutical Science and Research,2016:2(2):23–29.
17. Hui H., Tang G., Go V.L.W., Hypoglycaemic Herbs and Their Action Mechanisms, Journal of Chinese Medicine,2009:4(5):11–14.
18. Marles R.J., Farnsworth N.R., Antidiabetic Plants and Their Active Constituents, Journal of Phytomedicine,1995:2(2):137–189.
19. He C.N., Wang C.L., Guo S.X., Study on Chemical Constituents in Herbs of Anoectochilus Roxburghii II, Chinese Journal of Chinese Materia Medica,2005:30(9):761–776.
20. Jung M., Park M., Lee H-C., Kang Y., Kang E.S., Kim S.K., Antidiabetic Agents from Medicinal Plants, Journal of Current Medicinal Chemistry,2006:13(3):1203–1218.
21. Ji H.F., Li X.J., Zhang H.Y., Natural Products and Drug Discovery, Arabian Journal of Chemistry,2009:10(3):194–200.
22. Chopra A., Doiphode V.V., Ayurvedic Medicine Core Concepts, Therapeutic Principles, and Current relevance, Journal of Medical Clinics of North America,2002:86(1):75–89.
23. Verspohl E.J., Recommended testing in diabetes research, Diabetes Treatment with Aloe Vera and Honey, International Journal of Green Pharmacy,2002:68(1):581–590.
24. Ivorra M.D., Paya M., Villar A., A Review of Natural Products and Plants as Potential Antidiabetic Drugs, Journal of Ethnopharmacology,1989:27(1):248–275.
25. Galicia-Garcia U., Benito-Vicente A., Jebari S., Larrea-Sebal A., Siddiqi H., Uribe K.B., Martín C., Pathophysiology of Type 2 Diabetes Mellitus, International Journal of Molecular Sciences,2020:21(17):6275.
26. Sulaiman M.K., Diabetic nephropathy, Recent Advances in Pathophysiology and Challenges in Dietary Management, Journal of Diabetology and Metabolic Syndrome,2019:11(1):1–5.
27. Chen T.K., Knicely D.H., Grams M.E., Chronic kidney Disease Diagnosis and Management Journal of Medicine America,2019:322(13):1294–1304.

28. Taderegew M.M., Woldeamanuel G.G., Emeria M.S., Tilahun M., Yitbarek G.Y., Zegeye B., Platelet Indices and its Association with Microvascular Complications Among Type 2 Diabetes Mellitus Patients in Northeast Ethiopia, A Cross-sectional Study of Diabetes, Metabolic Syndrome or Obesity, Journal of Targets and Therapy,2021:14(9):865.
29. Rawal G., Yadav S., Kumar R., Singh A., Glycosylated haemoglobin, A Brief Overview for Clinicians, Indian Journal of Immunology and Respiratory Medicine,2016:1(2):33–36.
30. Nurman D.G., Karim A.K., Akhnazarov S.K., Mukashev S.T., Demissenov O.M., Current Issues of Molecular Diagnostics of Bladder Cancer, International Journal of Health Sciences, 2021:5(3):286–301.
31. Shimizu M., Furuichi K., Kitajima S., Toyama T., Oshima M., Ogura H., Natural Products and Drug Discovery, Journal of Nephrology,2021:22(1):1–12.
32. Vega M.P.L., Ortega M.A.Q., Gutierrez D.F., Cedeno M.D., Comparative Analysis of The Lipid Profile Before and After Application of the Nursing Strategy, International Journal of Health Sciences,2022:6(1):509–518.
33. Li W.L., Zheng H.C., Bukuru J., De Kimpe N., Natural Medicines Used in the Traditional Chinese Medical System for Therapy of Diabetes Mellitus, Journal of Ethnopharmacology, 2004:92(1):1–21.
34. Kumar D., Rani R., Aggarwal A., Herbal Plants Used in Treatment of Diabetes, International Journal of Ayurvedic and Herbal Medicine,2013:3(2):383–393.
35. Jayasri M. A., Radha A., Mathew T. L., Aqueous Extract of Costos Pictus Don Induces Antidiabetic and Antioxidant Effects in Alloxan-induced Hyperglycaemic Rats, Journal of Phytomedicine,2016(11):900-907.
36. M. Maghrani, M. Lemhadri, A. Ouahidi, M. L. Jouad, Ethno Pharmacological Survey of Medicinal Plants Used for the Treatment of Diabetes Mellitus, Hypertension, and Cardiac Diseases in the Southeast Region of Morocco, Journal of Ethnopharmacology,2014:82(2-3):97-103.
37. Sharma S., Nasir A., Therapeutic Effects of Medicinal Plants and Their Bioactive Constituents on Diabetes Mellitus, Journal of Traditional and Complementary Medicine, 2020:10(2):321–336.
38. Tick H.A., Turkmen F.U., Atlas F.C., Akan F.U., Bakirhan P., Demir C., Sekeroglu, Anti-diabetic Effect of a Leaf Extract from Gymnema Sylvester in Non-Insulin-Dependent Diabetes Mellitus Patients, Journal of Ethnopharmacology,1990: 30(3):295–305.
39. Dan's A.M., Bitter Melon and Blood Glucose Levels in Diabetes Mellitus Patients Randomized Controlled Trial, Journal of Clinical Epidemiology,2007: 60(5):554–559.
40. Sharma R.D., Raghuram T.C., Hypoglycaemic Effect of Fenugreek Seeds in Non-insulin Dependent Diabetic Patients, Journal of Nutrition Research,1990:10(7):731–739.
41. Khan A., Cinnamon Improves Glucose and Lipids of People with Type 2 Diabetes, Journal of Diabetes Care,2003:26(12):3215–3218.
42. Raut Y. B., Bais S. K., Chavan S., Review Moisturizing Activity of Herbal Cold Cream for Skin Dryness, International Journal of Pharmacy and Herbal Technology,2024: 2(1):407–417.
43. Raut Y. B., Bais S. K., Shinde A. B., Danole V. M., Waghmode A. V., Current Scenario of Herbal Medicines and Future Prospectus, International Journal of Pharmacy and Herbal Technology, 2024:2(5):1622–1633.

44. Ayyanar M., Subash-Babu P., Syzygium cumini Skeels Review of its Phytochemical Constituents and Traditional Uses, Asian Pacific Journal of Tropical Biomedicine,2012: 2(3):240–246.
45. Eidi A., Anti-diabetic Effect of Garlic in Normal and Streptozotocin-induced Diabetic Rats, Journal of Phytomedicine,2006:13(9-10):624–629.
46. Nishiyama T., Curcumin Prevents and Improves Diet-induced Obesity and Insulin Resistance in Mice, Journal for Biochemical or Biophysical Research Communications, 2005:337(1):236–242.
47. Zhang H., Berberine Lowers Blood Glucose in Type 2 Diabetes Mellitus Patients through Increasing Insulin Receptor Expression, Journal of Ethno pharmacology, 2010:59(2):285–292.
48. Vuksan V., American Ginseng Improves Glycaemia in Individuals with Normal Glucose Tolerance Effect of Dose and Time Escalation, Journal of the American College of Nutrition,2000:19(6):738–744.
49. Grover J.K., Medicinal Plants of India with Anti-diabetic Potential, Journal of Ethno pharmacology,2002:81(1):81–100.
50. Zhang H., Berberine Lowers Blood Glucose in Type 2 Diabetes Mellitus Patients through Increasing Insulin Receptor Expression, International Journal of Pharmacy and Herbal Technology,2010:59(2):285–292.
51. Vuksan V., American Ginseng Improves Glycaemia in Individuals with Normal Glucose Tolerance Effect of Dose and Time Escalation, Journal of the American College of Nutrition,2000:19(6):738–744.
52. Grover J.K., Medicinal Plants of India with Anti-diabetic Potential, Journal of Ethnopharmacology,2002:81(1):81–100.
53. Augusti K. T., Studies on the Hypoglycaemic Effects of Ficus Bengalese's Linn, In Diabetic Rats, Journal of Ethnopharmacology,40(1):39-49.
54. Mbikay M., Therapeutic Potential of Moringa Oleifera Leaves in Chronic Hyperglycaemia and Dyslipidaemia, Journal of Frontiers in Pharmacology,2012:3(2):24.
55. Huseini H.F., The Clinical Investigation of the Effects of Silymarin on Glycaemic Control in Type 2 Diabetes Mellitus, Journal of Phytotherapy Research,2006:20(12):1036–1039.
56. Bamosa A.O., Effects of Nigella Sativa Seeds on the Glycaemic Control of Patients with Type 2 Diabetes Mellitus, Indian Journal of Physiology and Pharmacology,2010: 54(4):344–354.
57. Ojewole J. A., Hypoglycaemic and Hypotensive Effects of Psidium Guajava Linn, Leaf Aqueous Extract, Journal of Methods and Findings in Experimental and Clinical Pharmacology,2005:27(8):689–695.
58. Raut Y. B., Bais S. K., Yelpale P., Review on Significance of Some Herb Formulation and Evaluation of Herbal Mouthwash, International Journal of Pharmacy and Herbal Technology, 2024:2(1):1446–1457.
59. Raut Y. B., Bais S. K., Landage N., Review Role of Ayurveda in Diabetes, International Journal of Pharmacy and Herbal Technology,2024:2(1):791–810.
60. Raut Y. B., Bais S. K., Wale S., More R., Tavate P., Unlocking Nature's Pharmacy the Power of Herbal Medicine in Modern Healthcare, International Journal of Pharmacy and Herbal Technology,2024:2(3):1622–1633.