REVIEW ARTICLE JPAR 2024

Journal of Pharmaceutical Advanced Research
(An International Multidisciplinary Peer Review Open Access monthly Journal)
Available online at: www.jparonline.com

A short review on Traditional Herbal drugs used as Anti-diabetic agents

Ashutosh Pathak[1,2], Neetu Soni[2], Bharat Mishra[2], Sanjay Kumar Yadav[2*], Salman Ahmad Khan[2], Desh Deepak Panday[3], Aadya Raj Pandey[4]

[1]Department of Pharmaceutical Sciences, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj-211 007, Uttar Pradesh, India.
[2]Dept. Pharmaceutical Chemistry, Institute of Pharmacy, DSMNRU, Lucknow, Uttar Pradesh, India.
[3]Department of Pharmaceutical Chemistry, City School of Pharmacy Bajha Pratapganj, Faizabad Rd Barabanki, Uttar Pradesh-225001, India.
[4]Department of Pharmaceutical Sciences, Babasaheb Bhimrao Ambedkar University, A Central University, Lucknow, 226025 Uttar Pradesh, India.

Received: 07.02.2023 Revised: 15.02.2024 Accepted: 22.02.2024 Published: 29.02.2024

ABSTRACT: Diabetes Mellitus (DM), often referred to as "honey" due to its metaphorical association with sweetness, encompasses a hyperglycaemic disorder resulting from abnormal metabolism of ingested lipids, fats, and proteins. This metabolic imbalance leads to a myriad of complications across various disciplines, including cardiovascular diseases, neuropathy, retinopathy, and nephropathy. At its core, DM is elevated blood sugar levels and disruptions in insulin metabolism and homeostasis characterize DM, culminating in potentially fatal medical conditions such as blindness, heart disease, kidney damage, and stroke. Despite significant advancements in treatment, the morbidity and mortality rates associated with DM remain stubbornly high, necessitating the exploration of novel therapeutic approaches to mitigate its impact. One promising avenue lies in the utilization of medicinal plants, vitamins, and essential nutrients, offering a cost-effective means of prevention and therapy for individuals affected by diabetes. This review article aims to delve into the realm of DM therapy options centered on medicinal plants. Through a comprehensive analysis of scientific literature, it becomes evident that certain medicinal plants, including *Aloe vera linn, cinnamon, Ivy gourd, ginseng, Catharanthus roseus, Azadirachta indica, Carica papaya, and Mangifera indica,* harbour phytochemicals with notable anti-hyperglycemic properties. By bridging this knowledge gap, the review sheds light on the biological significance of these potent medicinal plants, underscoring their potential as effective agents in the prevention and treatment of DM.

Corresponding author:
Mr. Sanjay Kumar Yadav
Assistant Professor,
Institute of Pharmacy, DSMNRU, Mohaan Road, Lucknow, Uttar Pradesh, India.
Tel: +91-8052805002
E.Mail ID: rrscopashu1986@gmail.com
Keywords: Medicinal plant, Diabetes mellitus, Phytochemicals, anti-hyperglycemic.

INTRODUCTION:

One of the most non-communicable diseases is diabetes mellitus. Diabetes mellitus is a chronic illness that affects the metabolism of proteins, lipids, and carbs. Diabetes mellitus is characterized by a poor or insufficient insulin secretory response, which leads to impaired carbohydrate (glucose) utilization and resultant hyperglycaemia [1]. Diabetes mellitus (DM), the most

common endocrine disease, is typically caused by an insufficient or non-existent supply of insulin or, less frequently, by an impairment of insulin function (insulin resistance) [2]. Diabetes is also referred to as sugar in popular culture. According to the International Diabetes Federation (IDF), India now has 40.9 million diabetics, with that number anticipated to rise to 69.9 million by 2025 [3]. The pancreas produces the hormones insulin and glucagon. Pancreatic islets are required for blood glucose regulation because they emit insulin, glucagon, and somatostatin from the alpha, beta, and delta cells, respectively. Although each kind of islet cell has internal systems for glucose sensing and secretory activity, the observed secretory profiles from intact units cannot be explained by these intrinsic processes [4]. The beta (ß) cells of the islets of Langerhans secrete insulin, while the alpha cells emit glucagon. Insulin decreases blood sugar levels by promoting glycogenesis and transferring glucose to the muscles, liver, and adipose tissue. While alpha cells play an important role in blood glucose management by producing glucagon, which increases blood glucose levels by speeding glycogenolysis, erythrocytes and brain tissue do not require insulin for glucose utilization.

Classification of Diabetes Mellitus:

- Insulin Dependent Diabetes Mellitus (Type1 IDDM).
- Non-Insulin Dependent Diabetes Mellitus (Type2 NIDDM).
- Gestational Diabetes Mellitus.

Insulin Dependent Diabetes Mellitus (Type1 IDDM):

Type I diabetes is caused by the loss of beta-cells, which usually leads to total insulin insufficiency. Diabetes, also known as insulin-dependent diabetes, juvenile diabetes, or childhood diabetes, is caused by an autoimmune reaction in which the immune system assaults the beta cells of the pancreas that make insulin [5]. The body's inability to manufacture insulin distinguishes type I diabetes. Patients with this kind of diabetes require daily insulin treatment to return their blood glucose levels to normal. They are in danger of dying if they do not take the insulin. Type 1 diabetes is characterized by antibodies against glutamic acid decarboxylase, islet cells, or insulin, which indicate the autoimmune mechanisms that result in beta-cell death. Type 1 diabetes (caused by the loss of b cells, resulting in a complete lack of insulin) (American Diabetes Association, 2014). Beta cell degeneration occurs at varying rates; in some persons, it occurs quickly, while in others, it takes much longer, as illustrated in Fig 1 [6].

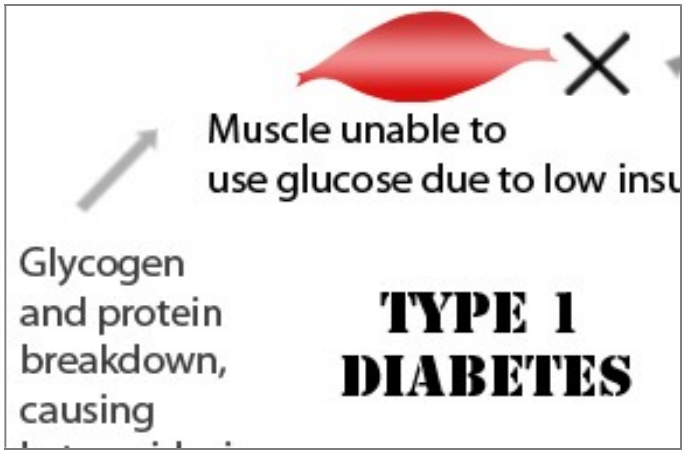


Fig 1. Insulin Dependent Diabetes Mellitus (Type1 IDDM).

Non-Insulin Dependent Diabetes Mellitus (Type 2 NIDDM):

Type 2 diabetes mellitus is also known as adult-onset diabetes. Insulin resistance and insulin secretion dysfunction (American Diabetes Association, 2014) [5]. Insulin activity is usually suppressed in persons with this kind of diabetes [7]. Diabetes-related morbidity and death are mostly caused by long-term issues in the blood vessels, kidneys, eyes, and nerves, which impact all of these organs. The body can still generate insulin in this case, but it is no longer effective due to resistance. When this happens, insulin levels may become insufficient. High blood sugar levels are caused by both insufficient and resistant insulin. Because the symptoms (coincidental to type I diabetes symptoms) are often less visible or non-existent, the condition can go undiagnosed for many years, not until the effects have already ascended.

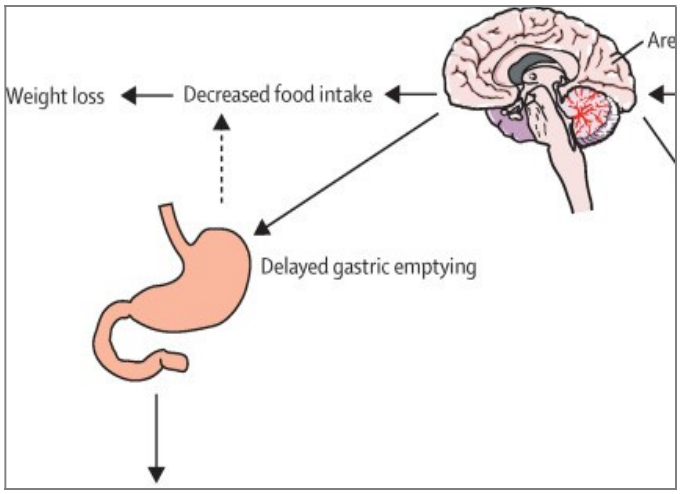


Fig 2. Non-Insulin Dependent Diabetes Mellitus (Type 2 NIDDM).

Type IIDM was previously exclusively seen in adults, but in recent years, as illustrated in Fig 2 [8], it has begun to appear in children as well.

Gestational diabetes mellitus (GDM):

GDM refers to glucose intolerance that appears or is diagnosed for the first-time during pregnancy. Gestational Diabetes Mellitus (GDM) refers to both women who develop Type 1 diabetes mellitus during pregnancy and women who discover they have undiscovered, asymptomatic Type 2 diabetes mellitus during pregnancy [9]. Gestational diabetes mellitus (GDM) refers to pregnancy-related diabetes that is not diabetic. Children born to moms with GDM are more likely to develop obesity and type 2 diabetes later in life, a phenomenon related to the effects of intrauterine hyperglycaemia. As illustrated in Fig 3, gestational diabetes mellitus can develop during pregnancy and vanish after birth [10].

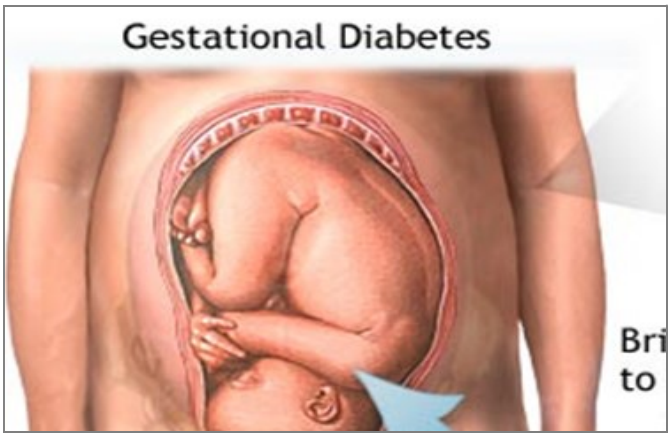


Fig 3. Gestational diabetes mellitus (GDM).

Epidemiology:

The ministries and majority of public health officials are still unaware of the current state of this disease and its implications, making diabetes one of the most serious health crises of the twenty-first century. Table 1 summarises the projected number of diabetes patients in 2015 and 2040. It is believed that 87 to 91 % of people with diabetes who have been diagnosed have type II diabetes, 7 to 12 % have type 1 diabetes, and 1 to 3 % have other types of illness in affluent countries. The prevalence of type I and type II diabetes in developing and poor countries has not been adequately studied. Regardless, type I diabetes appears to be less common than type II diabetes and is on the 3 % rise annually across the globe. According to research, type I diabetes accounts for the majority of cases of juvenile and toddler diabetes mellitus (DM) in developed countries, although type II diabetes is regarded to be a more common disease. Most of the time, the prevalence of type II diabetes has risen in tandem with accelerating societal changes: ageing populations, an increase in urban inhabitants, low levels of physical activity, an increase in sugar consumption, and a low intake of fruits and vegetables [12].

Causes of DM:

- Unhealthy eating habits.
- Predisposition to genetic diseases.
- Genealogy.
- Lack of regular exercise.
- High levels of blood pressure.
- Chronic stress (as discussed in Fig 4).

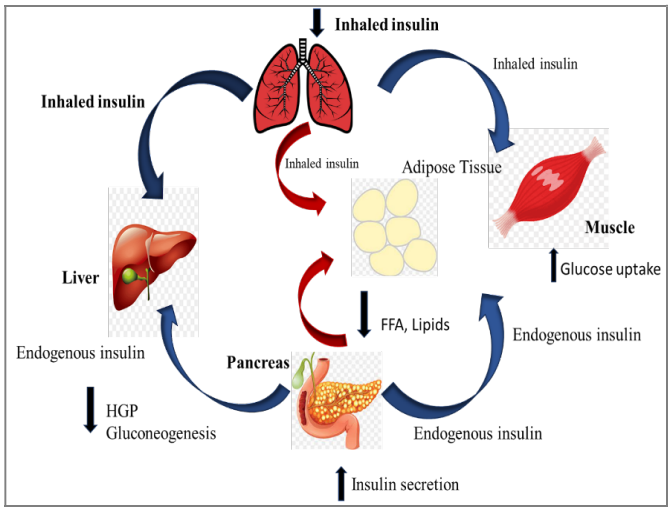


Fig 4. Causes of Diabetes mellitus.

Etiology of DM:

- At the present moment, the juvenile-onset (insulin-dependent) type is assumed to have an auto-immune etiology.
- Additionally, viruses may contribute to the aetiology of polygenic disorders such as coxsackie B.
- Both German measles viruses and epidemic parotitis have been shown to cause morphologic changes in islet-cell structure. The relevance of genetics in the aetiology of polygenic sickness is controversial.
- Perhaps a genetic trait makes an individual's exocrine gland more sensitive to one of the aforementioned viruses [13].
- Mellitus Disturbances or anomalies in ß cell gluco-receptors cause them to respond to an increase in aldohexose concentration or a relative beta-cell deficit.
- In either case, hypoglycemic agent secretion is compromised, which may eventually lead to beta cell failure [14].

Complications of DM:

Even those with tightly controlled blood sugar levels are susceptible to catastrophic diabetic implications. Diabetes patients experience a variety of adverse effects. Diabetes neuropathy, diabetes retinopathy, diabetes nephropathy, and diabetic foot are examples of complications (Fig 5) [15].

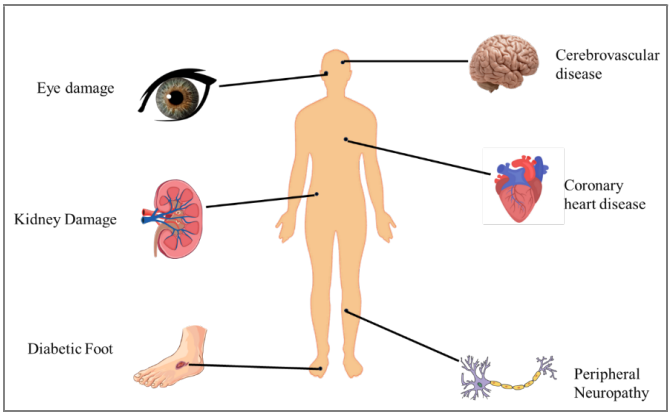


Fig 5. Complications of Diabetes mellitus.

Contributing factors in diabetes mellitus:

Several factors contribute to the growing diabetes epidemic, including the normal-weight physiologically obese phenotype, high intake of refined carbohydrates, excessive alcohol usage, extensive smoking, and frequent reductions in physical activity or exercise [16]. Diabetes may be on the rise because of inadequate nutrition during pregnancy, infancy, and early childhood, mixed with over nutrition later in life. As displayed in Fig 6 and 2 depicts a schematic depiction of the contributing elements that play a vital role in diabetes mellitus.

Treatment of diabetes mellitus by herbal drugs:

The most difficult problem for medical practitioners is to find a strategy to manage diabetes without causing severe side effects. According to the World Ethnobotanical, 800 medicinal plants are used to prevent diabetes mellitus [17]. Only 450 medicinal plants, of which 109 medicinal plants have a comprehensive mode of action, have been clinically confirmed to have anti-diabetic qualities. For thousands of years, both professionals as well as lay people have utilized the active substances and properties of traditional medicinal herbs to treat ailments such as diabetes, cancer, and heart disease [18]. The details of herbal drug used for the treatment of the diabetes is given in Table 1.

CONCLUSION:

Plants serve as potent natural antioxidants and herbal medications due to their anti-diabetic components, which include flavonoids, tannins, phenolic acids, and alkaloids. These substances improve pancreatic tissue function by increasing insulin production or decreasing intestinal glucose absorption. The active components of plants, as well as the molecular interactions of their constituents, must be studied further to establish their medicinal properties.

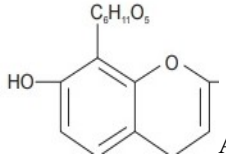
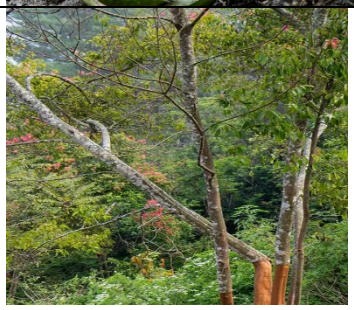
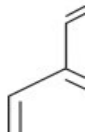
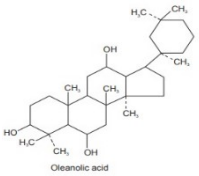
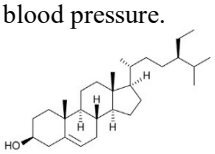
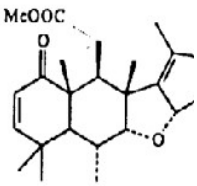
ACKNOWLEDGEMENT:

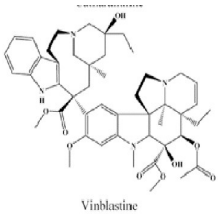
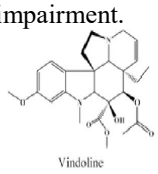
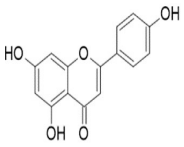
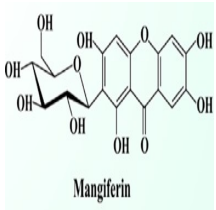
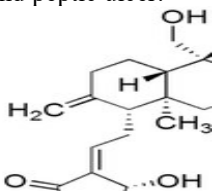
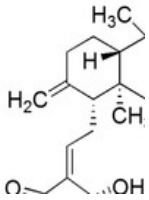
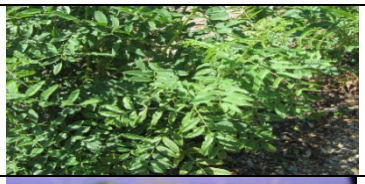
We would like to express our deepest appreciation to Dr. Gaurav Kaith for their invaluable guidance, expertise, and insightful feedback throughout the development of this manuscript. We are also thankful to BBAU (Babasaheb Bhimrao Ambedkar University, A Central University), Lucknow for providing the necessary resources and support for this research endeavour.

REFERENCES:

1. Dilworth L, Facey A, Omoruyi F. Diabetes mellitus and its metabolic complications: the role of adipose tissues. Int J Mol Sci, 2021; 22(14): 7644.
2. Ross and Wilson. Anatomy and Pathophysiology in Health and Illness. 11th ed. Churchill Livingstone: Elsevier; 2010. pp. 227-229
3. Bacchetta R, Passerini L, Gambineri E, Dai M, Allan SE. Defective regulatory and effector T cell functions in patients with FOXP3 mutations, J Clin Invest, 2006; 116: 1713-1722,
4. Ng XW, Chung YH, Piston DW. Intercellular communication in the islet of langerhans in health and disease. Compr Physiol, 2021; 11(3): 2191.
5. Hollstein T, Schulte DM, Schulz J, Glück A, Ziegler AG, Bonifacio E, *et al*. Autoantibody-negative insulin-dependent diabetes mellitus after SARS-CoV-2 infection: a case report. Nat Metab, 2020; 2(10): 1021-1024.
6. Wassmuth R, Lernmark A. The genetics of susceptibility to diabetes. Clin Immunol Immunopathol, 1989; 53: 358-399.
7. Leonardo JS. Pharmacology. 3rd ed. Hong Kong, London: The national medical series from Williams and Wilkins Bartiarco; 1987. pp. 221-225.
8. Blood A, Hayes TM, Gamble DR. Register of newly diagnosed diabetic children. BMJ, 1975; 3: 580-583.
9. Olokoba LB. Type 2 Diabetes Mellitus: A Review of Current Trends. Oman Med J, 2012; 27(4): 269-273.
10. Harris MI. Undiagnosed NIDDM, clinical and public health issues. Diabetes Care, 1993; 16: 642-652.

Table. 1 Herbal drugs used in the treatment of Diabetes Mellitus.

Herbs used	Image	Advantages	Limitations	Author
Aloe [21,30]: Biological name -*Aloe vera Linn* Family- *Liliaceae* Chemical constituents- ➢ Resins ➢ Tannins ➢ Steroids ➢ Alkaloids		The hypoglycaemic agent's activity reduced starch and provided effective postprandial glycaemic control.  Alo esin	The majority of people may be sensitive to aloe vera gel, which can result in skin allergies, eye redness, skin rashes, irritation, and burning sensations.	Amira Mourad, *et al.* (2020)
Cinnamon [22,31]: Biological name- Cinnamomum zeylanicum Family- lauraceae Chemical constituents - ➢ Cinnamaldehyde ➢ Caryophyllene ➢ Copaene Cadinenes		In diabetics, cinnamon may lower blood glucose levels. 	Use of cinnamon could raise the risk of developing cancer.	Farzaneh Hasanzade, *et al.* (2013)
Ginseng [23,32]: Biological name - *Panax ginseng* Family- *Araliaceae* Chemical constituents - ➢ Oleanalic acid ➢ Panaxadiol ➢ Ginsenoside ➢ Volatile oil		Ginseng included compounds that could help to bring blood glucose levels back to normal. 	Although it was safe to eat, some persons had headaches, diarrhoea, and an accelerated heartbeat.	Morris Karmazyn *et al.* (1999)
Ivy gourd [24,33]: Biological name - *Coccinia grandis* Family - *Cucurbitaceae* Chemical constituents- ➢ β-amyrin ➢ carbonic acid ➢ coccineside ➢ taraxerol lupeol ➢ β-sitosterol		These herbs could aid with diabetes and could lower stress and high blood pressure.  β-sitosterol	There were some minor adverse effects, such as headaches, nausea, and dizziness.	Anura V Kurpad *et al.* (2010)
Neem [26,35]: Biological name - *Azadiracta indica* family- *Meliaceae* Chemical constituents- 1. Nimbin 2. Azodirachtin 3. Phytol 4. Elemene		The leaves either had decreased glucose tolerance or had fewer and less active insulin signalling molecules. 	Serious adverse effects included loss of consciousness, seizures, blood problems, vomiting, diarrhoea, and sleepiness.	Muhammad Fazal Hussain Qureshi, *et al* (2021)

Vinca [27]: Biological name - *Catharanthus roseus* Family- *Apocynaceae* Chemical constituents - ➢ Vindoline ➢ Catharanthine ➢ Vinblastine ➢ Vincristin		These herbs reduced blood sugar levels and had brought TC, LDL, VLDL, and TG down to levels that were nearly normal.  Vinblastine	It could result in negative side effects include nausea, vomiting, bleeding, hearing loss, hair loss, and hearing impairment.  Vindoline	Leena Muralidharan (2014)
Papain [25]: Biological name - *Carica papaya* Family- *Caricaceae* Chemical constituents - ➢ Papayaproteinase ➢ Chymopapain ➢ Arachidic acids ➢ Myristoleic		The strict blood glucose control provided by these medicines lessens microvascular consequences.	The negative effects were nausea, vomiting, and immobility. 	Peter Giovannini, *et al.* (2016)
Mango [29]: Biological name - *Mangifera indica* family- *Anacardiaceae* Chemical constituents - ➢ Mangiferin ➢ α-carotene ➢ β-carotene ➢ gallic acid		The plant's stem and bark were used to make a variety of dietary supplements because of their antioxidant, anti-inflammatory, and immune-modulating properties.	A high intake could make you feel hotter inside.  Mangiferin	Subhasis Samanta, *et al.* (2015)
Green chiretta [36]: Biological name – *Andrographis paniculata* Family – *Acanthaceae* Chemical constituents – Neoandrographolide, Deoxy andrographolide, Dihydro andrographolide, Andrographolide		The leaves and stem are used to decrease blood glucose levels, dysentery, snakebites, and peptic ulcer. 	The negative effects were loss of appetite, diarrhoea, and vomiting. 	Maoyuan Jiang, *et al.* (2021)
Mulethi [28]: Biological name - *Glycyrrhiza glabra* Family – *Fabaceae*		Non-alcoholic liver disease, liver damage, Jaundice, hepatitis	Hypokalaemia, hypertension, cardiac arrhythmia, and myopathy.	Ahirwar RK, *et al.* (2023)
Zygophyllum caccineum [38]:		Symptomatic relief of diabetes, hypertension, Wound healing, burns, infections, and rheumatoid arthritis pain.	Severe diarrhea, Polyuria, and Photosensitization.	Amin E, *et al.* (2011)

Curcuma longa [40]**:**		Disorder of the skin, Upper respiratory track, joint, and digestive system.	Nausea, diarrhea, skin rash, headache, and yellow stool.	Kartik Verma, *et al.* (2023)
Acacia nilotica**:** Wild ex. Del. belongs to family *Fabaceae* (subfamily: Mimosoideae) [39]		Anti-inflammatory, antioxidant, antibacterial, anti-uveal melanoma, anticancer, antifungal, antidiabetic, antiplatelet aggregatory, AChE inhibitory activities.	Minor decrease in body weight.	Luqman Jameel, *et al.* (2015)
***Zingiber officinale* roscoe** [37]**:**		antioxidant, antinausea, antiobesity, anticancer, anti-inflammatory	Burning feeling in mouth/throat, abdominal pain, diarrhea, or heartburn [36]	Qian-Qian Mao, *et al.* (2019)

11. Verge CF, Gianani R, Kawasaki E, Yu L, Pietropaolo M, Jackson RA, *et al*., Predicting type I diabetes in first– degree relatives using a combination of insulin, GAD, and ICA512bdc/IA-2autoantibodies. Diabetes, 1996; 45: 926-933.
12. Link CL, McKinlay JB. Disparities in the Prevalence of Diabetes: Is It Race/ethnicity or Socioeconomic Status? Results from the Boston Area Community Health (BACH) Survey. Ethn Dis, 2009; 19(3): 288-292.
13. Heidemann DL, Joseph NA, Kuchipudi A, Perkins DW, Drake S. Racial and Economic Disparities in Diabetes in a Large Primary Care Patient Population. Ethn Dis, 2016; 26(1): 85-90.
14. Whitticar NB, Nunemaker CS. Reducing glucokinase activity to enhance insulin secretion: a counterintuitive theory to preserve cellular function and glucose homeostasis. Front Endocrinol, 2020; 11: 378.
15. Wild S, Roglic G, Green A, Sicree R, King. Global prevalence of diabetes: Estimates for the year 2000and projections for 2030. Diabetes Care, 2004; 27: 1047-1053.
16. Nathan DM. Long-term complications of diabetes mellitus. N Engl J Med, 1993; 328(23): 1676-1685.
17. Choudhury AA, Rajeswari VD. Gestational diabetes mellitus-A metabolic and reproductive disorder. Biomed Pharmacother, 2021; 143: 112183.
18. Rendell M. Diabetes: New Drug Options and Old Choices. Consultant, 2013; 53: 217-227.
19. Ranade M, Mudgalkar N. A simple dietary addition of fenugreek seed leads to the reduction in blood glucose levels: A parallel-group, randomized single-blind trial. Ayu, 2017; 38: 24.
20. Madar Z, Abel R, Samish S, Arad J. Glucose-lowering effect of fenugreek in non-insulin dependent diabetics. Eur J Clin Nutr, 1988; 42: 51-54.
21. Abo-Youssef AMH, Messiha BAS. Beneficial effects of *Aloe vera* in treatment of diabetes comparative *in vivo* and *in vitro* studies. Bull Fac Pharm Cairo Univ, 2013: 51(1): 7-11.
22. Hasanzade F, Toliat M, Emami SA, Emamimoghaadam Z. The effect of cinnamon on glucose of type II diabetes patients, J Trad Complementary Med, 2013; 3(3): 171-174.
23. Karmazyn M, Gan XT. Ginseng for the treatment of diabetes and diabetes related cardiovascular complications a discussion of the evidence. Canad J Physiol Pharmacol, 2018; 97(4): 265-276.
24. Kurpad AV, Raj R. The effect of ivy gourd (*Coccinia cordifolia*) extract on diabetic patients. Bull Nutri Foundation India, 2008: 29(1): 1-5.
25. Sivakumar T, Deepa B. A critical review on Antidiabetic Potential of Herbal plants and its their bioactive components. J Univer Shanghai Sci Tech, 2023; 25(1): 303-314.
26. Sadiq S, Qureshi MFH. Antidiabetic property of *Azadirachta indica* a molecular approach. Pak Armed Forces Med J**,** 2018: 68(6):1791-1791.

27. Muralidharan L. *Catharanthus roseus* leaves as an anti-diabetic and hypolipidemic agents in alloxan induced diabetic rats. Am J Phytomed Clin Ther, 2014; 2(12): 1393-1396.
28. Giovannini P, Howes MJR, Edwards SE. Medicinal plants used in the traditional management of diabetes and its sequelae in central america a review. J Ethnopharmacol, 2016: 184: 58-716.
29. Samanta S, Chanda R, Ganguli S, Reddy AG, Banerjee J. Antidiabetic activity of mango (*Mangifera indica*) a review. MOJ BB, 2019: 6(2): 23-26.
30. Yagi SM, Yagi AI. Traditional medicinal plants used for the treatment of diabetes in the Sudan: A review. Afr J Pharmacy Pharmacol, 2018; 12(3): 27-40.
31. Farzaei F, Morovati MR, Farjadmand F, Farzaei MH. A mechanistic review on medicinal plants used for diabetes mellitus in traditional. J Evid Based Complementary Altern Med, 2017; 22(4): 944-955.
32. Zanzabil KZ, Hossain MS, Hasan MK. Diabetes Mellitus Management: An Extensive Review of 37 Medicinal Plants. Diabetol, 2023; 4(2): 186-234.
33. Sivakumar T, Deepa B. A critical review on Antidiabetic Potential of Herbal plants and its their bioactive components. J Univer Shanghai Sci Tech, 2023; 25(1): 303-314.
34. Nanda J, Verma N, Mani M. A Mechanistic Review on Phytomedicine and Natural Products in the Treatment of Diabetes. Curr Diabetes Rev, 2023; 19(7): 44-54.
35. Alam S, Sarker MM, Sultana TN, Chowdhury MN, Rashid MA, Chaity NI, *et al*. Antidiabetic phytochemicals from medicinal plants: prospective candidates for new drug discovery and development. Front Endocrinol, 2022; 13: 800714.
36. Jiang M, Sheng F, Zhang Z, Ma X, Gao T, Fu C, *et al*. *Andrographis paniculata* (Burm. f.) Nees and its major constituent andrographolide as potential antiviral agents. J Ethnopharmacol, 2021; 272: 113954.
37. Mao QQ, Xu XY, Cao SY, Gan RY, Corke H, Beta T, *et al*. Bioactive compounds and bioactivities of ginger (*Zingiber officinale* Roscoe). Foods, 2019; 8(6): 185.
38. Amin E, El-Hawary SS, Fathy MM, Mohammed R, Ali Z, Tabanca N, *et al*. Triterpenoidal saponins: bioactive secondary metabolites from *Zygophyllum coccineum*. Planta Medica, 2011; 77(5): 488-491.
39. Ansari P, Akther S, Hannan JM, Seidel V, Nujat NJ, Abdel-Wahab YH. Pharmacologically active phytomolecules isolated from traditional antidiabetic plants and their therapeutic role for the management of diabetes mellitus. Molecules, 2022; 27(13): 4278.
40. Tran N, Pham B, Le L. Bioactive compounds in anti-diabetic plants: From herbal medicine to modern drug discovery. Biol, 2020; 9(9): 252.

Conflict of Interest: None
Source of Funding: Nil
Paper Citation: Pathak A, Soni N, Mishra B, Yadav SK*, Khan SA, Panday DD, Pandey AR. A short review on Traditional Herbal drugs used as Anti-diabetic agents. J Pharm Adv Res, 2024; 7(2): 2098-2105.