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SHORT REVIEW

A Review on Anti-diabetic Activity of Various Herbs

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Abstract

Background: Mother Nature has gifted humanity with an abundance of therapeutic herbs that support a healthier, disease-free life. Among the holistic approaches to health, Ayurveda stands out, particularly through its *Rasayana* group of herbs known for promoting longevity and vitality. These herbs have recently gained significant attention due to their potent anti-diabetic properties and minimal side effects. The increasing reliance on herbal therapies globally, in both developing and industrialised nations, underscores their growing acceptance and clinical potential. **Aim:** This abstract aims to highlight the significance of *Rasayana* herbs in the management of diabetes, emphasising their hypoglycemic and anti-hyperglycemic properties, with a focus on India's contribution to global herbal medicine. **Methods:** An extensive review of literature and ethnopharmacological data was conducted, focusing on the Ayurvedic classification of *Rasayana* herbs. The study explored traditional texts, WHO reports, and recent research articles to identify key herbs with anti-diabetic activity. Additionally, the economic and botanical relevance of Indian medicinal plants was evaluated. **Results:** The World Health Organisation (WHO) has identified around 21,000 medicinal plants used globally, with India contributing over 2,500 species, including 150 of notable economic importance. India is acknowledged as the largest producer of medicinal herbs and is often referred to as a "botanical heaven". Several Indian medicinal plants, such as *Gymnema sylvestre, Momordica charantia,* and *Trigonella foenum-graecum*, have demonstrated significant anti-diabetic effects. These herbs exhibit various mechanisms of action, including insulin mimetic effects, beta-cell regeneration, and improved glucose utilisation. **Conclusion:** *Rasayana* herbs offer a promising, natural avenue for managing diabetes and its complications. With their broad therapeutic potential and low incidence of side effects, they serve as valuable resources in the development of plant-based anti-diabetic therapies, further solidifying India's role in the global herbal medicine landscape.

Major Findings: Among the myriad of Indian plants, certain species have garnered attention for their exceptional benefits and extensive research in relation to diabetes and its complications. Each of these plants exhibits varying degrees of hypoglycemic and anti-hyperglycemic actions, solidifying their importance in the realm of natural remedies. These findings suggest its potential as a natural alternative or adjunct therapy for diabetes management.

Keywords: Indian, *Ayurveda*, Diabetes Mellitus, Plants, Herbal Medicine

1. Introduction

Diabetes stands as a significant metabolic condition characterised by persistently elevated glucose levels, stemming from either (1) insufficient production of adequate insulin or (2) the inability of peripheral tissues to respond effectively to insulin[1]. The International Diabetes Federation reports that currently, there are 451 million individuals worldwide (aged 18-99) with diabetes, and this figure is anticipated to rise to 693 million by 2045. Nearly half of all diabetes cases (49.7 %) are estimated to go undiagnosed. Furthermore, it was projected that 374 million people experienced Impaired Glucose Tolerance (IGT), with around 21.3 million pregnancies affected by various forms of hyperglycemia. In 2017, diabetes contributed to almost 5 million deaths globally among individuals aged 20 to 99[2]. Diabetes mellitus, one of the most prevalent endocrine metabolic disorders, has led to significant morbidity and mortality due to complications impacting both the microvascular (such as retinopathy, neuropathy, and nephropathy) and macrovascular (including coronary artery disease, strokes, and peripheral vascular disorders) systems[3]. The presence

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of diabetes can be divided into four types: type I diabetes, type II diabetes, and gestational diabetes[4].

The World Health Organisation has recognised a global inventory of 21,000 plants utilised for medicinal purposes, of which India boasts 2,500 species[5]. Around 800 plants have gained recognition for their potential anti-diabetic properties[6]. The identification of various bioactive compounds derived from plants has opened avenues for their potential use in the treatment of diabetes. Among the most prevalent and potent anti-diabetic medicinal herbs originating from India are *Brassica juncea, Aloe vera, Swertia chirayita, Parinari excelsa, Coccina grandis, Chaenomeles sinensis, Cinnamon zeylanicum, Hibiscus rosa sinensis, Mangifera indica, Trigonella foenum graecum, Tinospora cordifolia, Azadirachta indica, Allium sativum, Momordica charantia, Withania somnifera,* and *Neolamarckia cadamba*. These plants contain various phytochemicals, and the current study delves into their anti-diabetic properties as integral components of traditional Indian treatments for managing diabetes mellitus.

2. Antidiabetic Properties of Traditional Plants

2.1 *Aloe vera*

The bitter *Aloe vera* principle's hypoglycemic action in rats is achieved via stimulating the Langerhans beta-cells' ability to synthesise or release insulin, as shown in Table 1. The effects of prototinosaponins AIII and pseudoprototinosaponins. All on insulin release and glucose uptake revealed that their hypoglycemic effects are caused by actions on hepatic glycogenolysis or gluconeogenesis, as shown in Table 1. The bitter principle found in *Aloe vera*, when administered either as a single dose or repeatedly, demonstrated a hypoglycemic effect on diabetic mice. This effect was observed through the stimulation of insulin release and production from pancreatic **β**-cells, as shown in Table 1.

2.2 *Allium sativum*

This herb is an annual plant cultivated in various regions of India. The distinct, strong odour it emits is attributed to allicin, a sulfur-rich compound known for its significant effects on blood sugar[10]. These effects are believed to result from improved liver function, increased insulin production by pancreatic β-cells, or a glucose-saving effect. When an aqueous mixture of Garlic (10 mL/kg/day) was orally delivered to sucrose-fed rabbits (10 g/kg/day) over 2 months, it notably elevated the levels of amino acids, fatty acids, and glucose in liver cells. Simultaneously, it decreased the concentrations of lipids and insulin in the bloodstream, as well as the levels of liver sugar, as shown in Table 1.

2.3 *Azadirachta indica*

When this plant's hydroalcoholic extracts increased glucose absorption and the glucose accumulation in separate rats caused phrenic nerve damage, they demonstrated high blood sugar in rats treated with STZ, as shown in Table 1. This plant exhibits hepatoprotective, along with anti-diabetic benefits, it has antimicrobial, malaria treatment, antifertility, and antioxidant properties, as well as referred to in Table 1.

2.4 *Brassica juncea*

In South India, it is a popular spice in a variety of dishes and *Brassica* historic plant and which is belong to the *Cruciferae* family. The Aqueous extract of *Brassica juncea* seeds has demonstrated a hypoglycemic effect in STZ-induced diabetic albino male rats. The extract's impact on rats is evidenced by a reduction in glucose levels, and blood glucose levels were reported at 250,350,450 mg/kg as reported in Table 1.

2.5 *Chaenomeles sinensis*

Chinese quince is the common name of *Chaenomeles sinensis*. It is a kind of fruit which is having a very good diabetes cureing property when ethyl acetate extract fraction is used 50,100 mg/kg b.w dose were reported with anti-diabetic effect, refer to Table 1.

2.6 *Cinnamon zeylanicum*

C. zeylanicum, which is also known as Dalchini. The extract of Cinnamon zeylaniym was studied, and it was found to be very helpful in curing the effects of diabetes, and an *in vitro* study also proved that *C. zeylanicum* is useful in treating diabetes. The insulinotropic action of cinnamaldehyde which caused by an alteration of the transport of glucose (GLUT4) in peripheral cells, resulting in enhanced sugar absorption as shown in Table 1.

2.7 *Coccina grandis*

Lvy Gourd is the common name of *Coccinia grandis* and the alcoholic extract leaves which help in decreasing the glucose level in body and oral injection of alchoholic extract Coccinia *grandis* leaf a dose were reported in the range of 600 mg/kg b.w. Oral administration of alcoholic leaves extract to normally fasting mice caused an extensive hypoglycemic impact on blood sugar levels, as shown in Table 1.

2.8 *Hibiscus rosa-sinensis*

Hibiscus was administered orally at a dosage of 250 mg/kg p.o. Furthermore, there was a notable reduction in blood sugar levels, primarily attributed to the stimulation of insulin release from activated pancreatic β-cells, as shown in Table 1.

2.9 *Mangifera indica*

This plant's leaves are employed in Nigerian traditional medicine as an antidiabetic, and oral extract does not show any changes in the blood sugar level in rats, which are induced diabetics. On the other hand, antidiabetic activity was shown when the rats received the mango extract and glucose at the same time, as well as when the rats received the extract 60 minutes before the glucose. The results show that *Mangifera indica* aqueous extract provides a lower blood sugar level refer Table 1.

2.10 *Momordica charantia*

Momordica charantia, commonly known as karela, encompasses the fruit, seeds, leaves, and the entire plant. Extensive animal several studies have shown the efficacy of these plant parts in reducing blood glucose levels. In rats, both under normal conditions and those induced with STZ diabetes, ethanolic extracts of *M. charantia* at a dosage of 200 mg/kg have exhibited dual actions, manifesting both anti-hyperglycemic and anti-hypoglycemic effects, as shown in Table 1.

2.11 *Neolamarckia cadamba*

The alcoholic extract from the bark of the stem of *Anthocephalus cadamba*, synonym. *Neolamarckia cadamba* was proved to have a diabetes prevention activity in diabetic rats that were administered alloxan in (120-150 mg/kg), effectively treating the signs and symptoms of diabetes, including fatigue and irritation. Experiments on animals, the dose 400-500 mg/kg extract was proven to be effective in curing diabetes, as shown in Table 1. Alcoholic and aqueous extracts of *A. cadamba* root have been evaluated on hypoglycemic rats and rats produced elevated glucose levels induced by alloxan. It has been found that the dose was reported in the range of 400 mg/kg b.w., refer to Table 1.

2.12 *Parinari excelsa*

In diabetic animal models, the *Parinari excelsa* flavonoid causes a hypoglycemic effect when it secretes insulin, as shown in Table 1.

2.13 *Swertia chirayita*

In normal rats, the hexane fraction of *Swertia chirayita*, administered orally at 250 mg/kg, resulted in a significant decrease in blood sugar levels and elevated insulin levels in the blood. However, there was no observed alteration in the amount of glycogen stored in the liver. Conversely, after a 28-day administration period, there was a notable increase in liver glycogen levels, likely attributed to insulin release as shown in Table 1. Rats given an oral dose of 50 mg/kg of swerchirin experienced a reduction in blood sugar levels, accompanied by a distinct decrease in the amount of immunestained insulin and aldehyde-fuchsin-stained beta-granules in the pancreatic islets. Swerchirin also significantly enhanced insulin release from isolated islets at concentrations of 100, 10, and 1 mg/kg, as shown in Table 1.

2.14 *Tinospora cordifolia*

This expansive deciduous climbing shrub, commonly known as *Guduchi* and belonging to the *Menispermaceae* family, is extensively distributed throughout India, presenting a smooth or hairless appearance. A six-week study involving rats induced with diabetes using alloxan revealed that an extract derived from the roots of *Tinospora cordifolia (T. cordifolia)* effectively diminished both blood and urine glucose levels. Furthermore, it prevented a decline in body weight and significantly lowered serum and tissue lipid levels, as shown in Table 1. In the domain of Indian Ayurvedic medicine, *T. cordifolia* is frequently employed as a remedy for diabetes mellitus, as shown in Table 1.

The oral administration of an aqueous *T. cordifolia* root extract to alloxan-induced diabetic rats resulted in remarkable reductions in blood glucose levels and brain lipids. The 400 mg/kg dose of the aqueous extract exhibited a notable anti-hyperglycemic effect in various animal models, comparable to one unit/kg of insulin, as shown in Table 1. Regular administration of either an alcoholic or aqueous extract of *T. cordifolia* to rats consistently led to a reduction in blood glucose levels and an improvement in glucose tolerance, as shown in Table 1.

2.15 *Trigonella foenum-graecum*

Widely distributed throughout India, fenugreek seeds are a common component of Indian spices. Both in rats and humans, isolated islet cells exhibited heightened insulin release in response to glucose stimulation when introduced to 4-hydroxyleucine, a novel amino acid derived from fenugreek seeds[34]. After the oral administration of a plant extract, both normal and diabetic rats demonstrated a dose-dependent decrease in blood glucose levels when administered 2 and 8 g/kg of the extract, as shown in Table 1. The utilisation of fenugreek seeds also improved glucose metabolism and reinstated regular creatinine kinase activity in the liver, heart, and skeletal muscle of diabetic rats. Moreover, it led to a reduction in the activity of fructose 1,6-bisphosphatase and glucose-6-phosphatase in the liver and kidneys, as shown in Table 1. Additionally, this plant exhibits antioxidant properties, as shown in Table 1.

2.16 *Withania somnifera*

Withania somnifera, a highly esteemed medicinal plant, holds a rich history in traditional medicine for addressing a diverse range of health concerns. Researchers have identified the presence of flavonoids in both the root (WSREt) and leaf (WSLEt) extracts of *W. somnifera*. The total flavonoid content was measured at 520 mg/100 g dry weight for WSLEt and 530 mg/100 g dry weight for WSREt. Moreover, an investigation on rats induced with diabetes through alloxan delved into the potential hypoglycemic and hypolipidemic effects of WSR Et and WSLEt, as shown in Table 1.

Table 1. Antidiabetic properties of traditional plants

S. No.	Plant	Family	Part used	Type of extract	Test model	References
1	*Adansonia digitata* L.	*Bombacaceae*	Bark	Methanolic	Wistar Rats	42
2	*Aloe vera*	*Liliaceae*	Leaf	Aqueous	Male Albino Rats	43
3	*Albizia odoratissima*	-	Bark	Methanolic	Mice	44
4	*Bryophyllum pinnatum*	*Crassulaceae*	Leaf	Alcoholic	STZ rat	45
5	*Commiphora africana (A. rich.)* Engl.	*Burseraceae*	Stem bark	Aqueous and Ethanolic	Wistar Rats	46
6	*Coscinium fenestratum*	*Menispermaceae*	Stem bark	Alcoholic	STZ rat	47
7	*Hemionitis arifolia* (Burm.) Moore.	*Polypodiaceae*	Whole plant	Aqueous	Swiss Albino Mice	48
8	*Musa paradisiaca* L.	*Musaceae*	Fruit	Methanol	STZ rat	49
9	*Neolamarckia cadamba* (Roxb.) Bosser	*Rubiaceae*	Leaf	Ethanolic	Male Swiss Albino Mice	50
10	*Rosa canina* L.	*Rosaceae*	Fruit	Ethanol	Male Albino Wistar Rats	51
11	*Salvadora oleoides* Decne	*Salvadoraceae*	Aerial part extract	Ethanol	Albino Rats	52
12	*Solanum torvum*	*Solanaceae*	Friut	Aq.& hydroalcoholic	Sprague Dawley Rats	53
13	*Spinacia oleracea* L.	*Chenopodiaceae*	Leaf	Ethanolic	Male Wistar Rats	54
14	*Strychnos henningsii* Gilg.	*Loganiaceae*	Seed	Aqueous	Male Wistar Rats	55
15	*Talinum portulacifolium* Forssk.	*Portulacaceae*	-	Methanol	Wistar Albino Rats	56

Table 1. Continued...

16	*Trianthema portulacastrum* L.	*Aizoaceae*	-	Methanol	Male Albino Wistar Rats	[57]
17	*Turnera diffusa*	*Turneraceae*	Leaf	-	-	[58]
18	*Triumfetta pilosa* Roth	*Tiliaceae*	-	Ethanolic	Male Albino Wistar Rats	[59]
19	*Urtica dioica* L.	*Urticaceae*	Leaf	Aqueous	Male Long Evans Rats	[60]
20	*Withania somnifera* (L.) Duna	*Solanaceae*	Leaf	Methanol	Male Albino Wistar Rats	[61]

3. Conclusion

In this research, we focused on the utilisation of Traditional plants used for treating diabetic mellitus. Given the abundance of medicinal plants in rural areas, many folk medicinal herbs are commonly employed in these regions. The accessibility of plant-derived chemicals, easily obtained without the need for time-consuming pharmaceutical production, makes plant-based therapy for diabetes mellitus an attractive option. In this study, pharmacologists, scientists, and academics with a keen interest in pharmacology and therapeutics aimed to explore medicinal plants with antidiabetic properties, envisioning their potential contribution to the development of antidiabetic medications.

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5. Author Contribution

Riya Rai–Extensive literature review on the various herbs providing antidiabetic effects and findings of the subject area. Dr. Avani Khristi - review and technical guidance for drafting a review article. All authors have read and agreed to the published version of the manuscript.

6. References

1. Geberemeskel GA, Debebe YG, Nguse NA. Antidiabetic effect of fenugreek seed powder solution (*Trigonella foenum-graecum* L.) on hyperlipidemia in diabetic patients. J Diabetes Res. 2019; 2019:8507453.
2. Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, Malanda B. IDF Diabetes Atlas: global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes Res Clin Pract. 2018; 138:271-81. https://doi.org/10.1016/j.diabres.2018.02.023
3. Patel DK, Kumar R, Prasad SK, Sairam K, Hemalatha S. Antidiabetic and *in vitro* antioxidant potential of *Hybanthus enneaspermus* (Linn) F. Muell in streptozotocin-induced diabetic rats. Asian Pac J Trop Biomed. 2011; 1(4):316-22. https://doi.org/10.1016/S2221-1691(11)60051-8
4. American Diabetes Association. 2. Classification and diagnosis of diabetes. Diabetes Care. 2017; 40:S11-24. https://doi.org/10.2337/dc17-S005
5. Modak M, Dixit P, Londhe J, Ghaskadbi S, Devasagayam TPA. Indian herbs and herbal drugs used for the treatment of diabetes. J Clin Biochem Nutr. 2007; 40(3):163-73. https://doi.org/10.3164/jcbn.40.163
6. Patil R, Patil R, Ahirwar B, Ahirwar D. Current status of Indian medicinal plants with antidiabetic potential: A review. Asian Pac J Trop Biomed. 2011; 1(2):S291-8. https://doi.org/10.1016/S2221-1691(11)60175-5
7. Patel L, Shah D, Chandpa H, Khristi A, Bhavsar P. Inhalation therapy with *Clerodendrum serratum* Linn. extract: an experimental study on ovalbumin-induced asthma in rats. J Nat Remedies. 2024 Jan;24(1). doi:10.18311/jnr/2024/34453.
8. Bnouham M, Ziyyat A, Mekhfi H, Tahri A, Legssyer A. Medicinal plants with potential antidiabetic activity - a review of ten years of herbal medicine research (1990-2000). Dubai Diabetes Endocrinol J. 2006; 14(1):1-25. https://doi.org/10.1159/000497588
9. Nkafamiya II, Osemeahon SA, Dahiru D, Umaru HA. Studies on the chemical composition and physico-chemical properties of the seeds of Baobab (*Adansonia digitata*). Afr J Biotechnol. 2007; 6:756–759.
10. Gwarzo MY, Bako HY. Hypoglycemic activity of methanolic fruit pulp extract of *Adansonia digitata* on blood glucose levels of Alloxan induced diabetic rats. Int J Anim Vet Adv. 2013; 5:108–113. https://doi.org/10.19026/ijava.5.5585
11. Rajesham VV, Ravindernath A, Bikshapathi DVRN. A review on medicinal plant and herbal drug formulations used in diabetes mellitus. Indo Am J Pharm Res. 2012; 2(10):1200-12.

12. Dhole R, Khristi A. A comprehensive overview of herbal bioenhancers. Tuijin Jishu/J Propul Technol. 2023; 44(6).
13. Shankar R, Dhiman KS. Diabetes mellitus and its traditional cure in India. 2016.
14. Biswas K, Chattopadhyay I, Banerjee RK, Bandyopadhyay U. Biological activities and medicinal properties of neem (*Azadirachta indica*). Curr Sci. 2002; 82(11):1336-45.
15. Thirumalai T, Therasa SV, Elumalai EK, David E. Hypoglycemic effect of *Brassica juncea* (seeds) on streptozotocin induced diabetic male albino rat. Asian Pac J Trop Biomed. 2011; 1(4):323-5. https://doi.org/10.1016/S2221-1691(11)60052-X
16. Sancheti S, Sancheti S, Seo SY. Antidiabetic and antiacetylcholinesterase effects of ethyl acetate fraction of *Chaenomeles sinensis* (Thouin) Koehne fruits in streptozotocin-induced diabetic rats. Exp Toxicol Pathol. 2013; 65(1-2):55-60. https://doi.org/10.1016/j.etp.2011.05.010
17. Anand P, Murali KY, Tandon V, Murthy PS, Chandra R. Insulinotropic effect of cinnamaldehyde on transcriptional regulation of pyruvate kinase, phosphoenolpyruvate carboxykinase, and GLUT4 translocation in experimental diabetic rats. Chem Biol Interact. 2010; 186(1):72-81. https://doi.org/10.1016/j.cbi.2010.03.044
18. Ajay SS. Hypoglycemic activity of *Coccinia indica* (Cucurbitaceae) leaves. Int J Pharm Tech Res. 2009; 1(3):892-3.
19. Grover JK, Yadav S, Vats V. Medicinal plants of India with anti-diabetic potential. J Ethnopharmacol. 2002;81(1):81-100. https://doi.org/10.1016/S0378-8741(02)00059-4
20. Bräunlich M, Slimestad R, Wangensteen H, Brede C, Malterud KE, Barsett H. Extracts, anthocyanins and procyanidins from *Aronia melanocarpa* as radical scavengers and enzyme inhibitors. Nutrients. 2013; 5:663–678. https://doi.org/10.3390/nu5030663
21. Vosloo MC. Some factors affecting the digestion of glycaemic carbohydrates and the blood glucose response. J Fam Ecol Consum Sci. 2005; 33:1–9. https://doi.org/10.4314/jfecs.v33i1.52877
22. Kaboré D, Swadogo-Lingani H, Diawara B, Compaoré C, Dicko MH, Jakobsen M. A review of Baobab (*Adansonia digitata*) products: Effect of processing techniques, medicinal properties and uses. Afr J Food Sci. 2011; 5:833–844. https://doi.org/10.5897/AJFSX11.004
23. Shelke DP, Vishwas SM. Medicinal plants for diabetes mellitus: a review. Asian J Pharm Clin Res. 2021; 14(4):45-48. https://doi.org/10.22159/ajpcr.2021.v14i4.40825
24. Wani TA, Pandith SA, Rana S, Bhat WW, Dhar N, Razdan S, *et al*. Promiscuous breeding behaviour in relation to reproductive success in *Grewia asiatica* L. (*Malvaceae*). Flora. 2015; 211:62-71. https://doi.org/10.1016/j.flora.2014.11.002
25. Yoshino K, Miyauchi Y, Kanetaka T, Takagi Y, Koga K. Anti-diabetic activity of a leaf extract prepared from *Salacia reticulata* in mice. Biosci Biotechnol Biochem. 2009; 73(5):1096-104. https://doi.org/10.1271/bbb.80854
26. Wolever TM, Mehling C. Long-term effect of varying the source or amount of dietary carbohydrate on postprandial plasma glucose, insulin, triacylglycerol, and free fatty acid concentrations in subjects with impaired glucose tolerance. Am J Clin Nutr. 2003; 77:612–621. https://doi.org/10.1093/ajcn/77.3.612
27. Singh LW. Traditional medicinal plants of Manipur as anti-diabetics. J Med Plant Res. 2011; 5(5):677-87.
28. Gupta D, Raju J, Baquer NZ. Modulation of some gluconeogenic enzyme activities in diabetic rat liver and kidney: effect of antidiabetic compounds. 1999.
29. Ravikumar P, Anuradha CV. Effect of fenugreek seeds on blood lipid peroxidation and antioxidants in diabetic rats. Phytother Res. 1999; 13(3):197-201. https://doi.org/10.1002/(SICI)1099-1573(199905)13:3<197::AID-PTR413>3.0.CO;2-L
30. Dixit P, Ghaskadbi S, Mohan H, Devasagayam TP. Antioxidant properties of germinated fenugreek seeds. Phytother Res. 2005; 19(11):977-83. https://doi.org/10.1002/ptr.1769
31. Stanely Mainzen Prince P, Menon VP. Hypoglycaemic and hypolipidaemic action of alcohol extract of *Tinospora cordifolia* roots in chemically induced diabetes in rats. Phytother Res. 2003; 17(4):410-3. https://doi.org/10.1002/ptr.1130
32. Stanely Mainzen Prince P, Menon VP. Antioxidant action of *Tinospora cordifolia* root extract in alloxan diabetic rats. Phytother Res. 2001; 15(3):213-8. https://doi.org/10.1002/ptr.707
33. Khristi A, Navale A, Yadav R, Jha L, Dharamsi A. Therapeutic efficacy of an herbal dry powder inhaler in alleviating ovalbumin-induced lung inflammation and restoring hemostatic balance in a rat asthma model. J Nat Remedies. 2025; 25(5):1-8. https://doi.org/10.18311/jnr/2025/45275
34. Almeida RN, Filho JM, Naik SR. Chemistry and pharmacology of an ethanol extract of *Bumelia sartorum*. J Ethnopharmacol. 1985; 14:173–85. https://doi.org/10.1016/0378-8741(85)90085-6
35. Joshi H, Khristi A. RP-HPLC method development and validation for the simultaneous estimation of teneligliptine hydrobromide hydrate (TEN) and metformin hydrochloride (MET) in tablet dosage form. Indian Drugs. 2019; 56(8):49-56. https://doi.org/10.53879/id.56.08.11253
36. Aderibigbe AO, Emudianughe TS, Lawal BAS. Antihyperglycaemic effect of *Mangifera indica* in rat. Phytother Res. 1999; 13(6):504-7. https://doi.org/10.1002/(SICI)1099-1573(199909)13:6<504::AID-PTR533>3.0.CO;2-9
37. Sauvaire Y, Petit P, Broca C, Manteghetti M, Baissac Y, Fernandez-Alvarez J, *et al*. 4-Hydroxyisoleucine: a novel amino acid potentiator of insulin secretion. Diabetes. 1998; 47(2):206-10. https://doi.org/10.2337/diabetes.47.2.206

38. Khosla P, Gupta DD, Nagpal RK. Effect of *Trigonella foenum graecum* (fenugreek) on blood glucose in normal and diabetic rats. Indian J Physiol Pharmacol. 1995; 39:173-3.
39. Udayakumar R, Kasthurirengan S, Mariashibu TS, Rajesh M, Anbazhagan VR, Kim SC, *et al*. Hypoglycaemic and hypolipidaemic effects of *Withania somnifera* root and leaf extracts on alloxan-induced diabetic rats. Int J Mol Sci. 2009; 10(5):2367-82. https://doi.org/10.3390/ijms10052367
40. Rohini Sharma RS, Vikrant Arya VA. A review on fruits having anti-diabetic potential. 2011.
41. Bisht J, Khristi A. Development and validation of novel high-performance liquid chromatography method for simultaneous estimation of p-cymene and aloe-emodin. J Nat Remedies. 2023; 23(1):185–190. https://doi.org/10.18311/jnr/2023/31612
42. Tanko Y, Yerima M, Mahdi MA, Yaro AH, Musa KY, Mohammed A. Hypoglycemic activity of methanolic stem bark of *Adansonnia digitata* extract on blood glucose levels of streptozocin-induced diabetic Wistar rats. Int J Appl Res Nat Prod. 2008; 1(2):32-6.
43. Rehman SU, Jafri SA, Hassan S, Ishtiaq N, Muhammad N. Study on antidiabetic effect of *Aloe vera* extract on alloxan induced diabetic rats. Libyan Agric Res Cent J Int. 2011; 2(1):29-32.
44. Dinesh Kumar DK, Sunil Kumar SK, Sonia Kohli SK, Renu Arya RA, Jyoti Gupta JG. Antidiabetic activity of methanolic bark extract of *Albizia odoratissima* Benth. In alloxan induced diabetic albino mice. Asian Pac J Trop Med. 2011; 4(11):900-3. https://doi.org/10.1016/S1995-7645(11)60215-0
45. Ojewole JA. Antinociceptive, anti-inflammatory and antidiabetic effects of *Bryophyllum pinnatum* (*Crassulaceae*) leaf aqueous extract. J Ethnopharmacol. 2005; 99(1):13-9. https://doi.org/10.1016/j.jep.2005.01.025
46. Goji ADT, Dikko AAU, Bakari AG, Mohammed A, Ezekiel I, Tanko Y. Effect of aqueous-ethanolic stem bark extract of *Commiphora africana* on blood glucose levels on normoglycemic Wistar rats. Int J Anim Vet Adv. 2009; 1(1):22-4.
47. Shirwaikar A, Rajendran K, Punitha ISR. Antidiabetic activity of alcoholic stem extract of *Coscinium fenestratum* in streptozotocin-nicotinamide induced type 2 diabetic rats. J Ethnopharmacol. 2005; 97(2):369-74. https://doi.org/10.1016/j.jep.2004.11.034
48. Nair SA, Shylesh BS, Gopakumar B, Subramoniam A. Anti-diabetes and hypoglycaemic properties of *Hemionitis arifolia* (Burm.) Moore in rats. J Ethnopharmacol. 2006; 106(2):192-7. https://doi.org/10.1016/j.jep.2005.12.020
49. Abdel Aziz SM, Ahmed OM, Abd EL-Twab SM, Al-Muzafar HM, Amin KA, Abdel-Gabbar M. Antihyperglycemic effects and mode of actions of *Musa paradisiaca* leaf and fruit peel hydroethanolic extracts in nicotinamide/streptozotocin-induced diabetic rats. Evid Based Complement Alternat Med. 2020; 2020:9276343. https://doi.org/10.1155/2020/9276343
50. Ahmed F, Rahman S, Ahmed N, Hossain M, Biswas A, Sarkar S, *et al*. Evaluation of *Neolamarckia cadamba* (Roxb.) Bosser leaf extract on glucose tolerance in glucose-induced hyperglycemic mice. Afr J Tradit Complement Altern Med. 2011; 8(1). https://doi.org/10.4314/ajtcam.v8i1.60549
51. Orhan N, Aslan M, Hosbas S, Deliorman OD. Antidiabetic effect and antioxidant potential of Rosa canina fruits. Pharmacogn Mag. 2009; 5(20). https://doi.org/10.1055/s-0029-1234731
52. Yadav JP, Saini S, Kalia AN, Dangi AS. Hypoglycemic and hypolipidemic activity of ethanolic extract of *Salvadora oleoides* in normal and alloxan-induced diabetic rats. Indian J Pharmacol. 2008; 40(1):23. https://doi.org/10.4103/0253-7613.40485
53. Gandhi GR, Ignacimuthu S, Paulraj MG, Sasikumar P. Antihyperglycemic activity and antidiabetic effect of methyl caffeate isolated from *Solanum torvum* Swartz. fruit in streptozotocin induced diabetic rats. Eur J Pharmacol. 2011; 670:623-31. https://doi.org/10.1016/j.ejphar.2011.09.159
54. Kumar NJ, Loganathan P. Hypoglycemic effect of *Spinacia oleracea* in alloxan induced diabetic rat. Glob J Biotechnol Biochem. 2010; 5:87-91.
55. Oyedemi S, Bradley G, Afolayan A. Antidiabetic activities of aqueous stem bark extract of *Strychnos henningsii* Gilg in streptozotocin-nicotinamide type 2 diabetic rats. Iran J Pharm Res. 2012; 11(1):221.
56. Rao TN, Kumarappan CT, Lakshmi SM, Mandal SC. Antidiabetic activity of leaves of *Talinum portulacifolium* (Forssk) in alloxan-induced diabetic rats. Pharmacologyonline. 2007; 2:407-17.
57. Sunder AS, Rajyalakshmi G, Bharath A, Rajeshwar Y. Antihyperglycemic activity of *Trianthema portulacastrum* plant in streptozotocin-induced diabetic rats. Pharmacologyonline. 2009; 1:1006-11.
58. Makheswari MU, Sudarsanam D. Database on antidiabetic indigenous plants of Tamil Nadu, India. Int J Pharma Sci Res. 2012; 3(2):287-93.
59. Ramakrishna D, Vidyasagar G, Kumar KP, Reddy IM, Atyam VS. Evaluation of antidiabetic activity of *Triumfetta pilosa* Roth in streptozotocin induced diabetic rats. Int J Pharma Sci Res. 2011; 2(3):98-103.
60. Das M, Sarma BP, Rokeya B, Parial R, Nahar N, Mosihuzzaman M, *et al*. Antihyperglycemic and antihyperlipidemic activity of *Urtica dioica* on type 2 diabetic model rats. J Diabetol. 2011; 2(2):2. https://doi.org/10.4103/2078-7685.197792
61. Rathod N, Rathod N, Khristi A. Various herbs having antifungal activity against skin fungal infection: a review. Int J Biol Pharm Allied Sci. 2024; 13(2):707-17. https://doi.org/10.31032/IJBPAS/2024/13.2.7770