REVIEW ARTICLE

# Review on hundred plants used in the diabetes and its complications emphasizing on diabetic nephropathy

**Galanki Vasantha[1]*, Bathina Vara Lakshmi[1], Y.Srinivasa Rao[2]**

*[1]Department of Pharmacology, Vignan Institute of Pharmaceutical Technology Vishakapatnam, Andhra Pradesh, India, [2]Department of Pharmaceutics, Vignan Institute of Pharmaceutical Technology, Vishakapatnam, Andhra Pradesh, India*

## Abstract

Diabetic nephropathy, commonly known as diabetic kidney disease, is a group of metabolic disorders characterized by a high blood sugar level over a prolonged period of time. Symptoms often include frequent urination, increased thirst, and increased appetite. If left untreated, diabetes can cause many health complications. Acute complication can include diabetic ketoacidosis, hyperosmolar hyperglycemic state, or death. Serious long-term complications include cardiovascular disease, stroke, chronic kidney disease, foot ulcers, damage to the nerves, damage to the eyes, and cognitive impairment, diabetes is due to either the pancreas not producing enough insulin, or the cells of the body not responding properly to the insulin produced. Insulin is a hormone which is responsible for helping glucose from food get into cells to be used for energy. Type-1 diabetes (absolute insulin deficit and autoimmune-cell death) and other types of diabetes, such as type-2 diabetes (relative insulin insufficiency and resistance), are conceivable (for example, pancreatic illness). The prevalence of diabetes is increasing in the current population in the world. The epidemic of disease is increasing in the population of all countries including India. Several herbal plants are in usage in the management of diabetes till now. The lesser side effects and high therapeutic potential features of these drugs gained importance than the standard antidiabetic drugs.

**Key words:** Diabetes, diabetic nephropathy, plants

## INTRODUCTION

Diabetic nephropathy (DN) or diabetic kidney disease is a syndrome characterized by the incidence of diabetic glomerular lesions, pathological quantities of urine albumin excretion, and loss of glomerular filtration rate (GFR) in diabetics.[1] Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. Insulin is a hormone that regulates blood sugar. Hyperglycemia, or raised blood sugar, is a common effect of uncontrolled diabetes and over time leads to serious damage to many of the body's systems, especially the nerves and blood vessels.[2,3] A healthy diet, regular physical activity, maintaining a normal body weight, and avoiding tobacco use are ways to prevent or delay the onset of type-2 diabetes. Diabetes can be treated and its consequences avoided or delayed with diet, physical activity, medication, and regular screening and treatment for complications.[4] The principal clinical options of polygenic disorder are its contribution to complications of chronic tissues. A brief rise in blood glucose does not result in major clinical consequences.[5] The severity of hyperglycemia and its continuance is one in every of the main anorexigenic factors in instigating organ injury. Nephromegaly and a modified Doppler are early morphological markers of nephritic damage, although GFR and albuminuria are the greatest indicators of severity.[6] During the first 10–20 years following diabetes beginning, the average incidence of DN is substantial (3% each year).[7] The tiny blood veins in kidney, nerve, and ocular organs, on the other hand, often take 15 years to become affected. It is predicted that 20–40% of diabetics may acquire chronic renal disease.[8,9] DN is the leading cause of end-stage

**Address for correspondence:**
Dr. Galanki Vasantha, Vignan Institute of Pharmaceutical Technology, Vishakapatnam, Andhra Pradesh, India.
E-mail: vasanthagrace10@gmail.com

**Received:** 01-06-2022
**Revised:** 29-07-2022
**Accepted:** 10-08-2022

**Table 1:** Herbal drugs for the treatment of diabetic nephropathy

| S. No. | Medicinal plant | Plant part | Species | Route of administration | Reference |
|---|---|---|---|---|---|
| 1 | *Abroma augusta* L. | Leaves | Male albino Wistar rats | Orally | [17] |
| 2 | *Acacia ataxacantha* | Roots | Albino rats | Orally | [18] |
| 3 | *Acacia Arabica* | Bark | Female albino rats | Orally | [19] |
| 4 | *Acacia catechu* | Leaves | Male Wistar albino rats | Orally | [20] |
| 5 | *Acacia gerrardii* | Leaves | Male albino rats | Orally | [21] |
| 6 | Acacia melanoxylon Linn. | Seeds | Wister rats | Orally | [22] |
| 7 | *Acacia pennata* | Aerial parts | Male rats | Orally | [23] |
| 8 | Acacia tortilis (Forsk.) | Gum | Male Albino Wistar rats | Orally | [24] |
| 9 | *Acacia nilotica* | Leaves | Male Sprague Dawley albino rats | Orally | [25] |
| 10 | *Achillea biebersteinii Afan.* | Flower aerial parts | Male and female Wistar rats | orally | [26] |
| 11 | *Achyranthes aspera* Linn. | Leaves | Sprague Dawley male [SD] rats | Orally | [27] |
| 12 | *Acrocomia aculeata kernel oil* | Fruits | Male albino rats | Orally | [28] |
| 13 | *Aegle marmelos* | Leaves | Albino Wistar rats | Orally | [29] |
| 14 | *Aegle marmelos* | Fruits | Albino Wistar rats | Orally | [30] |
| 15 | *African mistletoe* (*Viscum album*) | Whole plant | Male Wistar rats | Orally | [31] |
| 16 | *Ajuga iva L.* | Whole plant | Male Wistar rats | Orally | [32] |
| 17 | *Allium cepa* and *Allium sativum* | Bulbs | Swiss albino mice | Orally | [33] |
| 18 | *Allium cepa* L. | Onion peel | Male albino Wistar rats | Orally | [34] |
| 19 | *Allium hookeri* | Roots | Male mice | Orally | [35] |
| 20 | *Amaranthus viridis Linn.* | Leaves | Albino Wistar rats | Orally | [36] |
| 21 | *Anabasis aretioides* | Leaves | Adult male Wistar rats | Orally | [37] |
| 22 | *Anacyclus pyrethrum* | Roots | Wistar albino rats | Orally | [38] |
| 23 | *Anchomanes difformis* | Leaves | Male Wistar rats | Orally | [39] |
| 24 | *Andrographis paniculata* (*Burm. F.*) | Leaves | Male Sprague Dawley rats | Orally | [40] |
| 25 | *Annona muricata* and *Tapinanthus globiferus* | Leaves | Male Wistar albino rats | Orally | [41] |
| 26 | *Annona reticulata* L. (*Annonaceae*) and *Carissa carandas* L. (*Apocynaceae*) | Leaves | Swiss albino mice | Orally | [42] |
| 27 | *Annona reticulata* L. | Seeds | Male albino Wistar rats | Orally | [43] |
| 28 | *Annona squamosa* | Ethanolic extracts of leaves and stem | Male albino Wistar rats, | Orally | [44] |
| 29 | *Artemisia afra* | Leaves | Male albino Wistar rats | Orally | [45] |
| 30 | *Artemisia amygdalina* | Whole plant | Albino Wistar rats | Orally | [46] |
| 31 | *Artemisia herba alba* | Leaves | Albino Wistar rats | orally | [47] |
| 32 | *Artemisia turanicae* | Aerial parts of the plant | Albino Wistar rats | Orally | [48] |
| 33 | *Artemisiae capillaris* | Herbal | Albino Wistar rats | Orally | [49] |
| 34 | *Asian ginseng* (*Panax ginseng*) and *banaba* (*Lagerstroemia speciosa*) | Root and leaves | Adult albino mice, *Mus musculus* | Orally | [50] |
| 35 | *Astaxanthin* | Shrimp | Sprague Dawley | Orally | [51] |
| 36 | *Astragalus saponin I* | Leaves | Male Sprague Dawley rats | Orally | [52] |

*(Contd...)*

**Table 1:** *(Continued)*

| S. No. | Medicinal plant | Plant part | Species | Route of administration | Reference |
|---|---|---|---|---|---|
| 37 | *Averrhoa bilimbi* | Leaves | Albino Wistar rats | Orally | [53] |
| 38 | *Averrhoa carambola* | Leaves | Male Sprague Dawley | Orally | [54] |
| 39 | *Averrhoa carambola L.* | Root | Mice | Orally | [55] |
| 40 | *Azadirachta indica* | Leaves | Male Wistar rats | Orally | [56] |
| 41 | *Azadirachta indica* | Flower | Albino rats | Orally | [57] |
| 42 | *Bacopa monnieri* | Aerial parts | Male Wistar rats | Orally | [58] |
| 43 | *Barleria cristata* | Leaves | Rats | Orally | [59] |
| 44 | *Barleria noctiflora* | Aerial part | Rats | Orally | [60] |
| 45 | *Bauhinia tomentosa L.* | Leaves | Wistar rats | Orally | [61] |
| 46 | *Berberis integerrima* | Roots | Male Wistar rats | Orally | [62] |
| 47 | *Betula etnensis Rafin.* | Bark | Male albino Wistar rats | Orally | [63] |
| 48 | *Biophytum sensitivum* | Whole plant | Male albino rats | Orally | [64] |
| 49 | *Biophytum sensitivum* | Roots | Rats | Orally | [65]. |
| 50 | *Biophytum sensitivum* | Leaves | Male Wistar rats | Orally | [66] |
| 51 | *Boehmeria nivea* (L.) | Roots | Male albino Wistar rats | Orally | [67] |
| 52 | *Bombax ceiba* | Roots | Mice | Orally | [68] |
| 53 | *Boswellia serrata* | Gum | Rats | Orally | [69] |
| 54 | *Brassica juncea* | Seeds | Adult male Swiss albino rats | Orally | [70] |
| 55 | *Brassica nigra* | Seeds | Male Wistar rats | Orally | [71] |
| 56 | *Brassica oleracea l. var. capitata* | Leaves | Adult male albino rats | Orally | [72] |
| 57 | *Bryonia laciniosa* | Seeds | Sprague Dawley rats | Orally | [73] |
| 58 | *Byrsonima crassifolia* | Seeds | Male Wistar rats | Orally | [74] |
| 59 | *Caesalpini a bonduc* (*Linn.*) *roxb* | Leaves and young twigs | Female albino Wistar rats | Orally | [75] |
| 60 | *Caesalpinia bonducella* | Seed Kernels | Rats | Orally | [76] |
| 61 | *Cajanus cajan L. (pigeon pea)* | Leaves | Mice | Orally | [77] |
| 62 | *Camellia sinensis* | Leaves | Male albino Wistar rats | Orally | [78] |
| 63 | *Canscora decussata* | Whole plant | Adult rabbits | Orally | [79] |
| 64 | *Carallia brachiata Lour.* | Leaves | Male Wistar rats | Orally | [80] |
| 65 | *Carum carvi (Black zeera)* | Seeds | Male Wistar rats | Orally | [81] |
| 66 | *Carvacrol* | Oil | Male Wistar rats | Orally | [82] |
| 67 | *Casearia esculenta* | Roots | Male Wistar albino rats | Orally | [83] |
| 68 | *Cassia Auriculata* L | Aerial parts | Wistar rats | Orally | [84] |
| 69 | *Chicory intybus* | Leaves | Male Wistar rats | Orally | [85] |
| 70 | *Cichorium intybus* | Total plant fragments | Male Swiss-Webster mice | Orally | [86] |
| 71 | *Cichorium intybus* L. | Seeds | Old Wistar albino rats | Orally | [87] |
| 72 | *Cinamomum Cassia* | Bark | Mice | Orally | [88] |
| 73 | *Citrullus colocynthis* | Fruits | Male albino rats | Orally | [89] |
| 74 | *Citrullus colocynthis* | Pulp | Rats | Orally | [90] |
| 75 | *Clitorea ternatea Linn.* | Leaves | Adult Sprague Dawley rats of either sex | Orally | [91] |
| 76 | *Clitoria ternatea Linn.* | Leaves and flowers | Adult male albino Wistar rats | Orally | [92] |

*(Contd...)*

**Table 1:** *(Continued)*

| S. No. | Medicinal plant | Plant part | Species | Route of administration | Reference |
|---|---|---|---|---|---|
| 77 | *Coccinia grandis* (L.) | Fruits | Rats | Orally | [93] |
| 78 | *Crocus sativus* L. | Saffron | Adult male Wistar rats | Orally | [94] |
| 79 | *Cucumis melo var. flexuosus* | Leaves | Male albino rats | Orally | [95] |
| 80 | *Pumpkin (Cucurbita pepo L.)* | Seeds | Male Wistar rats | Orally | [96] |
| 81 | *Curculigo Orchioides Gaertn* | Rhizome | Albino Wistar rats | Orally | [97] |
| 82 | *Curculigo latifolia* | Fruits and roots | Male Sprague Dawley rats | Orally | [98] |
| 83 | *Curcuma longa, Piper nigrum,* and *Phoenix dactylifera* | Seeds | Mice | Orally | [99] |
| 84 | *Delonix regia* | Leaves | Male Wistar rats | Orally | [100] |
| 85 | *Detarium microcarpum Guill* and *Perr* | Roots | Male and female albino rats | Orally | [101] |
| 86 | *Dillenia indica L.* | Leaves | Adult male Wistar rats | Orally | [102] |
| 87 | *Dorema aucheri* | Leaves | Male albino Wistar rats | Orally | [103] |
| 88 | *Dorstenia barnimiana* | Root | Male Swiss albino mice | Orally | [104] |
| 89 | *Duna liella salina* | Algal species | Adult albino Wistar rats | Orally | [105] |
| 90 | *Echinacea purpurea* | Root | Male rats | Orally | [106] |
| 91 | *Eclipta alba* | Leaves | Rats | Orally | [107] |
| 92 | *Elephantopus spicatus* | Whole plant | Swiss albino mice | Orally | [108] |
| 93 | *Embeliaribes* | Fruits | Male Wistar rats | Orally | [109] |
| 94 | *Eriobotrya japonica* | Seeds | Albino healthy rats of either sex | Orally | [110] |
| 95 | *Eryngium carlinae* | Aerial parts | Male Wistar rats | Orally | [111] |
| 96 | *Erzhi* | Formula | Male SPF SD rat | Orally | [112] |
| 97 | *Etlingera elatior* | Flowers | Sprague Dawley rats | Orally | [113] |
| 98 | *Fadogia agrestis* | Stem and leaves | Albino rats | Orally | [114] |
| 99 | *Ficus benghalensis* | Leaves | Male Wistar rats | Orally | [115] |

renal disease, which necessitates kidney transplantation in developed countries.[10] Diabetes that shows no clinical signs of kidney impairment during the first 20–25 years of life is less likely to have serious renal complications later in life (1% each year).[11] Patients with type-1 diabetes are more likely to develop DN during the first 15 years following diagnosis or to be reasonably protected subsequently, according to research. Despite the fact that glycemic control has an inverse relationship with the severity of microvascular problems including DN. Genetic predisposition may account for some of the difference in disease risk in DN. For this reason, many family studies are based on sibling pairs. The National Institute of Health established the on-going Family Investigation of Nephropathy and Diabetes Study Consortium to further the linkage analysis studies that led to the mapping of several susceptibility loci for DN on specific regions of chromosome 3q for type-1 diabetes and on chromosome 20 and 12 for white sibling pairs with type-2 diabetes.[12] Family studies demonstrating familial aggregation of DN in type-1 and type-2 diabetes,[13,14] as well as ethnic differences in DN prevalence, all point to a genetic component to DN [Table 1].[15,16]

## CONCLUSION

Several herbal plants are in usage in the management of diabetes till now. The lesser side effects and high therapeutic potential features of these drugs gained importance than the standard anti-diabetic drugs. Future generation can reap the benefits of plant derived drugs with the extensive researches.

## REFERENCES

1. Lim AK. Diabetic nephropathy-complications and treatment. Int J Nephrol Renovasc Dis 2014;7:361-81.
2. Vickers NJ. Animal communication: When i'm calling you, will you answer too? Curr Biol 2017;27:R713-5.
3. Sulaiman MK. Diabetic nephropathy: Recent advances in pathophysiology and challenges in dietary management. Diabetol Metab Syndr 2019;11:7.
4. Zhang J, Liu J, Qin X. Advances in early biomarkers of diabetic nephropathy. Rev Assoc Med Bras (1992) 2018;64:85-92.

5. Magee C, Grieve DJ, Watson CJ, Brazil DP. Diabetic nephropathy: A tangled web to unweave. Cardiovasc Drugs Ther 2017;31:579-92.
6. Corrêa LB, Costa CA, Ribas JA, Boaventura GT, Chagas MA. Antioxidant action of alpha lipoic acid on the testis and epididymis of diabetic rats: Morphological, sperm and immunohistochemical evaluation. Int Braz J Urol 2019;45:815-24.
7. Nelson RG, Bennett PH, Beck GJ, Tan M, Knowler WC, Mitch WE, *et al*. Development and progression of renal disease in Pima Indians with non-insulin-dependent diabetes mellitus. N Eng J Med 1996;335:1636-42.
8. Schena FP, Gesualdo L. Pathogenetic mechanisms of diabetic nephropathy. J Am Soc Nephrol 2005;16(3 suppl 1):S30-3.
9. World Health Organization. The World Health Report 2006: Working Together for Health. Geneva: World Health Organization; 2006.
10. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with Type 2 diabetes (UKPDS 33). Lancet 1998;352:837-53.
11. Mooyaart AL, Valk EJ, van Es LA, Bruijn JA, De Heer E, Freedman BI, *et al*. Genetic associations in diabetic nephropathy: A meta-analysis. Diabetologia 2011;54:544-53.
12. Ene-Iordache B, Perico N, Bikbov B, Carminati S, Remuzzi A, Perna A, *et al*. Chronic kidney disease and cardiovascular risk in six regions of the world (ISN-KDDC): A cross-sectional study. Lancet Glob Health 2016;4:e307-19.
13. Seaquist ER, Goetz FC, Rich S, Barbosa J. Familial clustering of diabetic kidney disease. N Eng J Med 1989;320:1161-5.
14. Quinn M, Angelico MC, Warram JH, Krolewski AS. Familial factors determine the development of diabetic nephropathy in patients with IDDM. Diabetologia 1996;39:940-5.
15. Nelson RG, Newman JM, Knowler WC, Sievers ML, Kunzelman CL, Pettitt DJ, *et al*. Incidence of end-stage renal disease in Type 2 (non-insulin-dependent) diabetes mellitus in Pima Indians. Diabetologia 1988;31:730-6.
16. Chandie Shaw PK, Baboe F, van Es LA, van der Vijver JC, van de Ree MA, de Jonge N, *et al*. South-Asian Type 2 diabetic patients have higher incidence and faster progression of renal disease compared with Dutch-European diabetic patients. Diabetes Care 2006;29:1383-5.
17. Khanra R, Dewanjee S, Dua TK, Sahu R, Gangopadhyay M, De Feo V, *et al*. *Abroma augusta* L.(*Malvaceae*) leaf extract attenuates diabetes induced nephropathy and cardiomyopathy via inhibition of oxidative stress and inflammatory response. J Transl Med 2015;13:6.
18. Arise RO, Akapa T, Adigun MA, Yekeen AA, Oguntibeju OO. Normoglycaemic, normolipidaemic and antioxidant effects of ethanolic extract of *Acacia ataxacantha* root in streptozotocin-induced diabetic rats. Notulae Sci Biol 2016;8:144-50.
19. Hegazy GA, Alnoury AM, Gad HG. The role of *Acacia arabica* extract as an antidiabetic, antihyperlipidemic, and antioxidant in streptozotocin-induced diabetic rats. Saudi Med J 2013;34:727-33.
20. D'souza P, Holla R, Swamy G. Amelioration of diabetic nephropathy in streptozotocin-induced diabetic rats by *Acacia catechu* leaves extract. J Health Allied Sci NU 2019;9:116-20.
21. Aldhahrani A. Suadian *Acacia gerrardii*: Antidiabetic effect in rats suffering from diabetic nephropathy and DNA fingerprinting using ISSR. Pak J Biol Sci 2020;23:1162-75.
22. Kumar S, Choudhary M, Yadav P, Nitesh BV. Anti-diabetic activity of hydroalcoholic extract of *Acacia melanoxylon* Linn. seeds in streptozotocin induced diabetic rats. J Dia Res Ther 2016;2:1-6.
23. Shao H, Xiao M, Zha Z, Olatunji OJ. UHPLC-ESI-QTOF-MS2 analysis of *Acacia pennata* extract and its effects on glycemic indices, lipid profile, pancreatic and hepatorenal alterations in nicotinamide/streptozotocin-induced diabetic rats. Food Sci Nutr 2022;10:1058-69.
24. Bhateja PK, Singh R. Antidiabetic activity of *Acacia tortilis* (Forsk.) Hayne ssp. Raddiana polysaccharide on streptozotocin-nicotinamide induced diabetic rats. Biomed Res Int 2014;2014:572013.
25. Asad M, Munir TA, Farid S, Aslam M, Shah SS. Duration effect of *Acacia nilotica* leaves extract and glibenclamide as hypolipidaemic and hypoglycaemic activity in alloxan induced diabetic rats. J Pak Med Assoc 2015;65:1266-70.
26. Ahmadi K, Wassim A, Ream N. Evaluation of hypoglycemic effect of *Achillea biebersteinii* Afan., growing in Syria, in induced diabetic rats. Int J Pharm Phytochem Res 2017;9:215-22.
27. Une HD, Deshpande TC. Antihyperglycemic activity of *Achyranthes aspera* linn. leaves extract by modulation of β-cell functioning in streptozotocin-induced diabetic rats. Pharmacogn Mag 2021;17:15.
28. Nunes ÂA, Buccini DF, dos Santos Jaques JA, Portugal LC, Guimarães RC, Favaro SP, *et al*. Effect of dietary *Acrocomia aculeata* kernel oil rich in medium chain fatty acids on Type 2 diabetic rats. J Funct Foods 2020;75:104295.
29. Bhatti R, Rawal S, Singh J, Ishar MP. Effect of *Aegle marmelos* leaf extract treatment on diabetic neuropathy in rats: A possible involvement of α. Int J Pharm Pharm Sci 2012:4:632-7.
30. Kamalakkannan N, Prince P. Antidiabetic and anti-oxidant activity of *Aegle marmelos* extract in streptozotocin-induced diabetic rats. Pharm Biol 2004;42:125-30.
31. Adaramoye O, Amanlou M, Habibi-Rezaei M, Pasalar P, Ali MM. Methanolic extract of African mistletoe (*Viscum album*) improves carbohydrate metabolism and hyperlipidemia in streptozotocin-induced diabetic rats. Asian Pac J Trop Med 2012;5:427-33.

32. El-Hilaly J, Tahraoui A, Israili ZH, Lyoussi B. Hypolipidemic effects of acute and sub-chronic administration of an aqueous extract of *Ajuga iva* L. whole plant in normal and diabetic rats. J Ethnopharmacol 2006;105:441-8.
33. Bhanot A, Shri R. A comparative profile of methanol extracts of *Allium cepa* and *Allium sativum* in diabetic neuropathy in mice. Pharmacognosy Res 2010;2:374-84.
34. Pal M, Roy UK, Datta S, Ghosh T, Harlalka S, Biswas L. Onion peel extracts ameliorate oxidative stress in streptozotocin-induced diabetic rats. Ser J Exp Clin Res 2013;14:101-8.
35. Choi JH, Kim SH, Lee EB, Kim JS, Jung JE, Jeong UY, *et al*. Anti-diabetic effects of *Allium hookeri* extracts prepared by different methods in Type 2 C57BL/J-db/db Mice. Pharmaceuticals (Basel) 2022;15:486.
36. Kumar BA, Lakshman K, Jayaveea KN, Shekar DS, Khan S, Thippeswamy BS, *et al*. Antidiabetic, antihyperlipidemic and antioxidant activities of methanolic extract of *Amaranthus viridis* Linn in alloxan induced diabetic rats. Exp Toxicol Pathol 2012;64:75-9.
37. Farid O, Hajji L, Eddouks M. Aqueous extract of *anabasis aretioides* ameliorates Streptozotocin induced diabetes mellitus in rats. Nat Prod J 2018;8:139-46.
38. Tyagi S, Mansoori MH, Singh NK, Shivhare MK, Bhardwaj P, Singh RK. Antidiabetic effect of *Anacyclus pyrethrum* DC in alloxan induced diabetic rats. Eur J Biol Sci 2011;3:117-20.
39. Alabi TD, Brooks NL, Oguntibeju OO. Leaf extracts of *Anchomanes difformis* ameliorated kidney and pancreatic damage in Type 2 diabetes. Plants 2021;10:300.
40. Hidayat R, Wulandari P. Effects of *Andrographis paniculata* (Burm. F.) extract on diabetic nephropathy in rats. Rep Biochem Mol Biol 2021;10:445-54.
41. Atanu FO, Avwioroko OJ, Ilesanmi OB, Yakubu OE. Metformin potentiates the antidiabetic Properties of *Annona muricata* and *Tapinanthus globiferus* leaf extracts in diabetic rats. Pharmacogn J 2021;13:614-9.
42. Rahman SM, Rashedul MI, Rahman S, Mosaiab T, Ahmed R, Khatun F. Antihyperglycemic studies with methanol extract of *Annona reticulata* L.(*Annonaceae*) and *Carissa carandas* L.(*Apocynaceae*) leaves in Swiss albino mice. Adv Nat Appl Sci 2011;5:218-22.
43. Wen W, Lin Y, Ti Z. Antidiabetic, antihyperlipidemic, antioxidant, anti-inflammatory activities of ethanolic seed extract of *Annona reticulata* L. in streptozotocin induced diabetic rats. Front Endocrinol 2019;10:716.
44. Kaleem M, Medha P, Ahmed QU, Asif M, Bano B. Beneficial effects of *Annona squamosa* extract in streptozotocin-induced diabetic rats. Singapore Med J 2008;49:800-4.
45. Afolayan AJ, Sunmonu TO. Protective role of *Artemisia afra* aqueous extract on tissue antioxidant defense systems in streptozotocin-induced diabetic rats. Afr J Tradit Complement Altern Med 2013;10:15-20.
46. Ghazanfar K, Ganai BA, Akbar S, Mubashir K, Dar SA, Dar MY, *et al*. Antidiabetic activity of *Artemisia amygdalina* decne in streptozotocin induced diabetic rats. Biomed Res Int 2014;2014:185676.
47. Sekiou O, Boumendjel M, Taibi F, Tichati L, Boumendjel A, Messarah M. Nephroprotective effect of *Artemisia herba alba aqueous* extract in alloxan-induced diabetic rats. J Tradit Complemen Med 2021;11:53-61.
48. Yazdi HB, Hadjzadeh MA, Hojati V, Shiravi A, Hosseinian S, Vaezi G. The role of *Artemisia turanica* extract on renal oxidative and biochemical markers in STZ-induced diabetes in rat. Avicenna J Phytomed 2020;10:504-12.
49. Geng J, Yu X, Liu C, Sun C, Guo M, Li Z, *et al*. Herba *Artemisiae capillaris* extract prevents the development of streptozotocin-induced diabetic nephropathy of rat. Evid Based Complement Altern Med 2018;2018:5180165.
50. Basha MP, Saumya SM. Influence of fluoride on streptozotocin induced diabetic nephrotoxicity in mice: Protective role of Asian ginseng (*Panax ginseng*) banaba (*Lagerstroemia speciosa*) on mitochondrial oxidative stress. Indian J Med Res 2013;137:370-9.
51. Al-Dbagh MB, Jwad SM. Shrimp extract (Astaxanthin) ameliorates the lipid profile and oxidative stress parameters in experimentally induced diabetes rats. J Crit Rev 2020;7:1675-88.
52. Yin X, Zhang Y, Wu H, Zhu X, Zheng X, Jiang S, *et al*. Protective effects of astragalus saponin I on early stage of diabetic nephropathy in rats. J Pharmacol Sci 2004;95:256-66.
53. Azeem AK, Vrushabendraswami BM. Hypolipidemic evaluation of *Averrhoa bilimbi* leaf ethanolic extracts on streptozotocin induced diabetic rats. J Innov Pharm Biol Sci 2015;2:649-52.
54. Aladaileh SH, Saghir SA, Murugesu K, Sadikun A, Ahmad A, Kaur G, *et al*. Antihyperlipidemic and antioxidant effects of *Averrhoa carambola* extract in high-fat diet-fed rats. Biomedicines 2019;7:72.
55. Lu S, Zhang H, Wei X, Huang X, Chen L, Jiang L, *et al*. 2-dodecyl-6-methoxycyclohexa-2, 5-diene-1, 4-dione isolated from *Averrhoa carambola* L. root ameliorates diabetic nephropathy by inhibiting the TLR4/MyD88/NF-κB pathway. Diabetes Metab Syndr Obes 2019;12:1355-63.
56. Satyanarayana K, Sravanthi K, Shaker IA, Ponnulakshmi R. Molecular approach to identify antidiabetic potential of *Azadirachta indica*. J Ayurveda Integr Med 2015;6:165-74.
57. Waliullah S, Javed K, Jafri MA, Singh S. Effect of *Azadirachta indica* flower extract on basal and experimentally elevated blood glucose in rats. Adv Tradit Med 2008;8:302-10.
58. Kishore L, Kaur N, Singh R. Renoprotective effect of *Bacopa monnieri* via inhibition of advanced glycation end products and oxidative stress in STZ-nicotinamide-induced diabetic nephropathy. Ren Fail 2016;38:1528-44.
59. Rajasekaran N, Duraisamy G, Manokaran K, Kanakasapathi D. *In vivo* assessment of antioxidants and antihyperglycemic effect of *Barleria cristata* leaves

in Streptozotocin-induced diabetic rats. Int J Appl Sci Biotechnol 2014;2:437-45.
60. Arumugam SU, Natesan SE. Hypoglycemic effects of *Barleria noctiflora* fractions on high fat fed with low dose streptozotocin induced Type-2 diabetes in rats. Int J Pharm Pharm Sci 2016;8:193-200.
61. Devaki K, Beulah U, Akila G, Narmadha R, Gopalakrishnan VK. Glucose lowering effect of aqueous extract of *Bauhinia tomentosa* L. On alloxan induced Type 2 diabetes mellitus in Wistar albino rats. J Basic Clin Pharm 2011;2:167-74.
62. Ashraf H, Heidari R, Nejati V, Ilkhanipoor M. Effects of aqueous extract of *Berberis integerrima* root on some physiological parameters in streptozotocin-induced diabetic rats. Iran J Pharm Res 2013;12:425-34.
63. Malfa GA, Tomasello B, Acquaviva R, Mantia AL, Pappalardo F, Ragusa M, *et al*. The antioxidant activities of *Betula etnensis* Rafin. Ethanolic extract exert protective and anti-diabetic effects on streptozotocin-induced diabetes in rats. Antioxidants 2020;9:847.
64. Chitravel R, Kaliyaperumal S. Antidiabetic potential of *Biophytum sensitivum* whole plant extracts in STZ induced diabetic rats. Int J Sci Eng Res 2018;9:72-7.
65. Babas Sy, Luka CD, Istifanus G, Mayel MH. Determination of the antidiabetic property of the aqueous extract of *Biophytum sensitivum* on streptozotocin induced diabetic rats. 2020; 8:2320-9186.
66. Ananda PK, Kumarappan CT, Christudas S, Kalaichelvan VK. Effect of *Biophytum sensitivum* on streptozotocin and nicotinamide-induced diabetic rats. Asian Pac J Trop Biomed 2012;2:31-5.
67. Sancheti S, Sancheti S, Bafna M, Kim HR, You YH, Seo SY. Evaluation of antidiabetic, antihyperlipidemic and antioxidant effects of *Boehmeria nivea* (L.) *Gaudich*, *Urticaceae*, root extract in streptozotocin-induced diabetic rats. Rev Bras Farmacogn 2011;21:146-54.
68. Sharmin R, Joarder HH, Alamgir M, Mostofa G, Islam M. Antidiabetic and hepatoprotective activities of *Bombax ceiba* young roots in alloxan-induced diabetic mice. J Nutr Health Food Sci 2018;6:1-7.
69. Mehrzadi S, Tavakolifar B, Huseini HF, Mosavat SH, Heydari M. The effects of *Boswellia serrata* gum resin on the blood glucose and lipid profile of diabetic patients: A double-blind randomized placebo-controlled clinical trial. J Evid Based Integr Med 2018;23:1-7.
70. 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;1:323-5.
71. Anand P, Murali YK, Tandon V, Murthy PS, Chandra R. Insulinotropic effect of aqueous extract of *Brassica nigra* improves glucose homeostasis in streptozotocin induced diabetic rats. Exp Clin Endocrinol Diab 2009;117:251-6.
72. Hamza KM, Al-Turfi ZS. Effect of alcoholic extract of *Brassica oleracea* L. Var capita plant leaves on glucose level and antioxidant activity in alloxan induced diabetic rats. Sci J Med Res 2017;1:19-23.
73. Patel SB, Santani D, Patel V, Shah M. Anti-diabetic effects of ethanol extract of *Bryonia laciniosa* seeds and its saponins rich fraction in neonatally streptozotocin-induced diabetic rats. Pharmacogn Res 2015;7:92.
74. Gutierrez RM, Flores JM. Effect of chronic administration of hexane extract of *Byrsonima crassifolia* seed on β-cell and pancreatic oxidative parameters in streptozotocin-induced diabetic rat. Afr J Tradit Complement Altern Med 2014;11:231-6.
75. Ogunlana OO, Ogunlana OE, Adeneye AA, Udo-Chijioke OA, Dare-Olipede TI, Olagunju JA, *et al*. Evaluation of the toxicological profile of the leaves and young twigs of *Caesalpinia bonduc* (Linn) roxb. Afr J Tradit Complement Altern Med 2013;10:504-12.
76. Parameshwar S, Srinivasan KK, Rao CM. Oral antidiabetic activities of different extracts of *Caesalpinia bonducella* seed kernels. Pharma Biol 2002;40:590-5.
77. Manzo JA, Vitor II RJ. Antihyperglycemic effects of *Cajanus cajan* L.(pigeon pea) ethanolic extract on the blood glucose levels of ICR mice (*Mus musculus* L.). Nat J Physiol Pharm Pharmacol 2017;7:860.
78. Al-Attar AM, Zari TA. Influences of crude extract of tea leaves, *Camellia sinensis*, on streptozotocin diabetic male albino mice. Saudi J Biol Sci 2010;17:295-301.
79. Irshad N, Akhtar MS, Kamal Y, Qayyum MI, Malik A, Hussain HR. Antihyperlipidemic and renoprotective activities of methanolic extract of *Canscora decussata* extract in alloxan-induced diabetic rabbits. Bangladesh J Pharmacol 2013;8:323-7.
80. Junejo JA, Rudrapal M, Zaman K. Antidiabetic activity of *Carallia brachiata* Lour. Leaves hydro-alcoholic extract (HAE) with antioxidant potential in diabetic rats. Indian J Nat Prod Resour 2020;11:18-29.
81. Sadiq S, Nagi AH, Shahzad M, Zia A. Saudi the reno-protective effect of aqueous extract of *Carum carvi* (Black zeera) Seeds in streptozotocin induced diabetic nephropathy in rodents. Saudi J Kidney Dis Transpl 2010;21:1058-65.
82. Jamshidi HR, Zeinabady Z, Zamani E, Shokrzadeh M. Attenuation of diabetic nephropathy by carvacrol through anti-oxidative effects in alloxan-induced diabetic rats. Res J Pharmacogn 2018;5:57-64.
83. Prakasam A, Sethupathy S, Pugalendi KV. Influence of *Casearia esculenta* root extract on protein metabolism and marker enzymes in streptozotocin-induced diabetic rats. Pharmacol Rep 2004;56:587-94.
84. Bandawane DD, Mhetre NK. Study of antihyperglycemic, antihyperlipidemic and nephroprotective activity of *Cassia auriculata* L. Extract in streptozotocin induced diabetic rats. Dnyanamay J 2015;1:43-9.
85. Gorjipour R, Malekzadeh J, Sadeghi H, Mohammadi J, Malekzadeh F. The effects of chicory leaf aqueous extract on body weight, serum glucose and lipid levels in streptozotocin induced diabetic rats. Nutr Food Sci Res 2017;4:1-8.
86. Kanj D, Raafat K, El-Lakany A, Baydoun S, Aboul-Ela M. Phytochemical compounds of *Cichorium*

*intybus* by exploring its antioxidant and antidiabetic activities. Pharmacogn J 2019;11:248-57.
87. Pourfarjam Y, Rezagholizadeh L, Nowrouzi A, Meysamie A, Ghaseminejad S, Ziamajidi N, *et al*. Effect of *Cichorium intybus* L. seed extract on renal parameters in experimentally induced early and late diabetes Type 2 in rats. Ren Fail 2017;39:211-21.
88. Kumar R, Iqubal A, Kumar-Singh A, Nath A, Singh JK, Ali M, *et al*. Hypoglycemic and nephroprotective effect of *Cinamomum cassia* on alloxan induced diabetic mice. Int J Diab Res 2014;3:36-40.
89. Abd El-Baky AE, Amin HK. Effect of *Citrullus colocynthis* in ameliorate the oxidative stress and nephropathy in diabetic experimental rats. Int J Pharm Stud Res 2011;2:1-10.
90. Bagherizadeh T, Gol A, Olomi H. Effect of *Citrullus colocynthis* pulp on renal function in streptozotocin-induced diabetic rats. Hormozgan Med J 2015;19:208-15.
91. Talpate KA, Bhosale UA, Zambare MR, Somani R. Antihyperglycemic and antioxidant activity of *Clitorea ternatea* Linn. on streptozotocin-induced diabetic rats. Ayu 2013;34:433-9.
92. Daisy P, Santosh K, Rajathi M. Antihyperglycemic and antihyperlipidemic effects of *Clitoria ternatea* Linn. in alloxan-induced diabetic rats. Afr J Microbiol Res 2009;3:287-91.
93. Meenatchi P, Purushothaman A, Maneemegalai S. Antioxidant, antiglycation and insulinotrophic properties of *Coccinia grandis* (L.) *In vitro*: Possible role in prevention of diabetic complications. J Tradit Complement Med 2017;7:54-64.
94. Samarghandian S, Azimi-Nezhad M, Farkhondeh T. Immunomodulatory and antioxidant effects of saffron aqueous extract (*Crocus sativus* L.) on streptozotocin-induced diabetes in rats. Indian Heart J 2017;69:151-9.
95. El-maksoud A, Marwa AE. Effect of *Cucumis melo* var. Flexuosus leaves extract on renal oxidative injury and inflammation in diabetic male albino rats. Egypt J Zool 2019;71:13-20.
96. Asgary S, Moshtaghian SJ, Setorki M, Kazemi S, Rafieian-Kopaei M, Adelnia A, *et al*. Hypoglycaemic and hypolipidemic effects of pumpkin (*Cucurbita pepo* L.) on alloxan-induced diabetic rats. Afr J Pharm Pharmacol 2011;5:2620-6.
97. Patil A, Koli S, Patil DA, Narayane V, Phatak AV. Evaluation of effect of aqueous slurry of *Curculigo orchioides* Gaertn. Rhizome in streptozotocin-induced diabetic rats. J Pharm Res 2013;7:747-53.
98. Ishak NA, Ismail M, Hamid M, Ahmad Z, Abd Ghafar SA. Antidiabetic and hypolipidemic activities of *Curculigo latifolia* fruit: Root extract in high fat fed diet and low dose STZ induced diabetic rats. Evid Based Complement Altern Med 2013;2013:601838.
99. Khaliq T, Sarfraz M, Ashraf MA. Recent progress for the utilization of *Curcuma longa*, *Piper nigrum* and *Phoenix dactylifera* seeds against Type 2 diabetes. West Indian Med J 2015;64:527-32.
100. Chaturvedi D, Suhane N, Singh D, Chaturvedi N, Mishra A. Antidiabetic potential of *Delonix regia*. Int Res J Pharm 2014;5:884-6.
101. Okolo CE, Akah PA, Uzodinma SU. Antidiabetic activity of the root extract of *Detarium microcarpum* (Fabacaee) Guill and Perr. Phytopharmacology 2012;3:12-8.
102. Kaur N, Kishore L, Singh R. *Dillenia indica* L. Attenuates diabetic nephropathy via inhibition of advanced glycation end products accumulation in STZ-nicotinamide induced diabetic rats. J Tradit Complement Med 2018;8:226-38.
103. Ahangarpour A, Zamaneh HT, Jabari A, Nia HM, Heidari H. Antidiabetic and hypolipidemic effects of *Dorema aucheri* hydroalcoholic leave extract in streptozotocin-nicotinamide induced Type 2 diabetes in male rats. Iran J Basic Med Sci 2014;17:808-14.
104. Sisay W, Andargie Y, Molla M. Antidiabetic activity of hydromethanolic extract of crude *Dorstenia barnimiana* root: Validation of *in vitro* and *in vivo* antidiabetic and antidyslipidemic activity. J Exp Pharmacol 2022;14:59-72.
105. El-Baz FK, Salama A, Salama RA. *Dunaliella salina* attenuates diabetic neuropathy induced by STZ in rats: Involvement of thioredoxin. Biomed Res Int 2020;2020:1295492.
106. Mohammedsaleh ZM, Aljadani HM. *Echinacea purpurea* root extract modulates diabetes-induced renal dysfunction in rats through hypoglycemic, antioxidants, and anti-inflammatory activities. Medical Science 2021;25:1033-43.
107. Singh A, Singh A, Dwivedi V. Antidiabetic effect of *Eclipta alba*. Int J Sci Eng Res 2014;5:1462-6.
108. Haque ME, Rahmatullah M. *Elephantopus spicatus*: A plant with hitherto unreported antihyperglycemic and antinociceptive potential. World J Pharm Pharm Sci 2014;3:71-80.
109. Chaudhari HS, Bhandari U, Khanna G. *Embelia ribes* extract reduces high fat diet and low dose streptozotocin-induced diabetic nephrotoxicity in rats. EXCLI J 2013;12:858-71.
110. shafi S, Tabassum N. Evaluation of glucose lowering, hepatoprotective and hypolipidemic activities of ethanolic extract of seeds of *Eriobotrya japonica* in streptozotocin induced diabetic rats. World J Pharm Res 2019;8:960-74.
111. Noriega-Cisneros R, Ortiz-Avila O, Esquivel-Gutiérrez E, Clemente-Guerrero M, Manzo-Avalos S, Salgado-Garciglia R, *et al*. Hypolipidemic activity of *Eryngium carlinae* on streptozotocin-induced diabetic rats. Biochem Res Int 2012;2012:603501.
112. Jiang J, Yin J, Liu X, Wang H, Lu G. Erzhi formula extracts reverse renal injury in diabetic nephropathy rats by protecting the renal podocytes. Evid Based Complement Altern Med 2018;2018:1741924.
113. Nor NA, Azmi NA, Noordin L, Bakar NA, Ahmad WW. Aqueous extract of *Etlingera elatior* flowers improved blood glucose control, kidney function and histology of

streptozotocin-induced diabetic rat. J Sustain Sci Manag 2019;14:80-91.
114. Yakubu MT, Ogunro OB. Effects of aqueous extract of fadogia agrestis stem in alloxan-induced diabetic rats. Bangladesh J Pharmacol 2014;9:356-63.
115. Stalin C, Gunasekaran V, Jayabalan G. Evaluation of neuroprotective effect of *Ficus benghalensi*s against alloxan induced diabetic neuropathy in rats. Int J Pharmacol Phytochem Ethnomed 2016;4:52-60.

**Source of Support:** Nil. **Conflicts of Interest:** None declared.