

# Overview of Bioactive Compounds in Herbs and Their Anti-Diabetic Properties

Kato Jumba K.

Faculty of Science and Technology Kampala International University Uganda

## ABSTRACT

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia, resulting from defects in insulin secretion, action, or both. The global rise in diabetes prevalence has led to an increasing demand for alternative and complementary treatment options, as conventional therapies often have limitations, including side effects and long-term sustainability issues. Herbal medicine, with its rich history of usage across various traditional healing systems, has gained significant attention as a promising therapeutic approach for managing diabetes. Numerous herbs contain bioactive compounds that demonstrate anti-diabetic properties, offering a natural alternative to pharmaceutical interventions. These bioactive compounds function through various mechanisms, such as improving insulin sensitivity, promoting insulin secretion from pancreatic beta cells, and reducing hepatic glucose production. Additionally, certain herbs possess antioxidant and anti-inflammatory properties, which help protect against the oxidative stress and inflammation associated with diabetic complications, including neuropathy, nephropathy, and retinopathy. Moreover, some herbs regulate the absorption of glucose from the gastrointestinal tract, thereby reducing postprandial blood glucose spikes. This review aims to explore the diverse range of bioactive compounds found in herbs, highlight their anti-diabetic effects, and discuss their potential therapeutic value in diabetes management, providing a more comprehensive understanding of their role in modern diabetes care.

**Keywords:** Diabetes mellitus, Bioactive compounds, Herbal medicine, Insulin sensitivity, Antioxidant, Hypoglycemic properties

## INTRODUCTION

Diabetes mellitus, particularly type 2 diabetes (T2DM), is one of the most prevalent chronic diseases worldwide, posing a significant burden on public health, economics, and society [1]. The increasing global incidence of diabetes, particularly in low- and middle-income countries, is attributed to factors such as urbanization, poor dietary habits, sedentary lifestyles, and an aging population [2]. While conventional treatments, such as insulin therapy, oral hypoglycemic agents, and lifestyle modifications, remain the mainstay for managing T2DM, they often come with limitations, including side effects, long-term dependency, and insufficient effectiveness in preventing diabetes-related complications [3]. Consequently, there is growing interest in exploring alternative or adjunctive therapies to manage diabetes, with herbal medicine gaining widespread attention [4]. Herbal remedies have been utilized for centuries in traditional medicine systems, including Ayurvedic, Traditional Chinese Medicine, and Native American healing practices, for the treatment of

various ailments, including diabetes [5]. Over the years, scientific studies have begun to validate the anti-diabetic properties of many commonly used herbs, as they contain bioactive compounds with therapeutic effects [6]. These compounds exert their anti-diabetic effects through various mechanisms, such as enhancing insulin secretion from pancreatic beta cells, improving insulin sensitivity in peripheral tissues, and reducing the absorption of glucose from the intestines [7]. Additionally, many herbs possess potent antioxidant and anti-inflammatory effects, which help mitigate the oxidative stress and chronic inflammation that contribute to the development of diabetic complications, including nephropathy, neuropathy, and retinopathy [8].

The bioactive compounds found in herbs, such as alkaloids, flavonoids, terpenoids, and phenolic acids, have been shown to play a crucial role in regulating blood glucose levels, reducing insulin resistance, and improving overall metabolic health [9]. This review explores the bioactive compounds present in

commonly used herbs and examines their potential therapeutic benefits in the management of diabetes, offering new insights into the growing role of herbal medicine in modern diabetes care.

### **Bioactive Compounds in Herbs and Their Anti-Diabetic Mechanisms**

Bioactive compounds in herbs are natural substances that have a biological effect on the human body [10]. These compounds often have multiple pharmacological activities, making them potential candidates for the treatment of diabetes [6]. The primary classes of bioactive compounds that exhibit anti-diabetic properties include alkaloids, flavonoids, terpenoids, phenolic acids, and glycosides [9]. The following section highlights key bioactive compounds in herbs with proven anti-diabetic effects and their mechanisms of action.

#### **Alkaloids**

Alkaloids are nitrogen-containing compounds found in many plants, including *Berberis vulgaris* (barberry) and *Glycyrrhiza glabra* (licorice) [11]. These compounds have been shown to possess anti-hyperglycemic properties by improving insulin sensitivity and regulating glucose metabolism [12]. Berberine, an alkaloid found in *Berberis* species, has been extensively studied for its anti-diabetic effects. It acts by activating the AMP-activated protein kinase (AMPK) pathway, improving insulin sensitivity, reducing hepatic glucose production, and increasing glucose uptake in peripheral tissues. Berberine has been shown to lower blood glucose levels and improve lipid profiles in diabetic individuals [13].

#### **Flavonoids**

Flavonoids are a large group of plant secondary metabolites known for their antioxidant, anti-inflammatory, and anti-diabetic properties [14]. Common flavonoids found in herbs such as *Citrus sinensis* (orange), *Camellia sinensis* (green tea), and *Ginkgo biloba* have demonstrated promising results in managing blood glucose levels [15]. Quercetin, a flavonoid present in Onion and Apple, has been shown to inhibit  $\alpha$ -glucosidase, an enzyme responsible for breaking down carbohydrates into glucose [16]. This action slows down the absorption of glucose from the intestine, thereby preventing postprandial hyperglycemia [16]. Additionally, quercetin has been shown to improve insulin sensitivity and reduce inflammation, two key factors in the pathophysiology of diabetes [17].

#### **Terpenoids**

Terpenoids are a diverse group of bioactive compounds that are widely distributed in plants. They have shown promising anti-diabetic properties

by improving insulin secretion, reducing blood glucose levels, and exhibiting antioxidant effects [18]. Herbs such as *Ocimum sanctum* (holy basil) and *Cinnamomum verum* (cinnamon) contain terpenoids with potential anti-diabetic benefits [19]. Cinnamaldehyde, the primary active compound in cinnamon, has been found to enhance insulin sensitivity by activating insulin signaling pathways and increasing glucose uptake in peripheral tissues [20]. Additionally, cinnamon has been shown to improve lipid profiles and reduce the risk of cardiovascular complications in diabetic patients [21].

#### **Phenolic Acids**

Phenolic acids, including chlorogenic acid, ellagic acid, and caffeic acid, are abundant in herbs such as *Coffea arabica* (coffee) and *Salvia officinalis* (sage) [22]. These compounds possess potent antioxidant and anti-inflammatory properties that help reduce oxidative stress, a major factor in the development of diabetic complications. Chlorogenic acid, found in coffee, has been shown to inhibit glucose absorption from the digestive tract and improve insulin sensitivity [23]. This compound also reduces hepatic glucose output and helps in maintaining better blood sugar levels in diabetic patients [23].

#### **Glycosides**

Glycosides are compounds that consist of a sugar molecule bound to a non-sugar component (aglycone) [24]. These compounds have been reported to possess hypoglycemic effects through various mechanisms, including the inhibition of  $\alpha$ -amylase and  $\alpha$ -glucosidase enzymes [25]. Glycyrrhizin, the active glycoside in licorice, has been shown to reduce blood glucose levels by increasing insulin secretion from pancreatic  $\beta$ -cells [26]. It also exhibits antioxidant and anti-inflammatory effects, which may help mitigate diabetic complications [27].

### **Clinical Evidence and Efficacy of Herbal Remedies in Diabetes Management**

Over the past few decades, there has been growing interest in the use of herbal remedies for the management of diabetes mellitus, particularly type 2 diabetes [4]. This interest has been fueled by the rising global prevalence of the disease, the limitations and side effects of conventional therapies, and the historical use of medicinal plants in traditional healing systems [28]. Numerous clinical studies and trials have evaluated the efficacy of various herbal medicines in regulating blood glucose levels, improving insulin resistance, and mitigating complications associated with diabetes [29]. Among the most studied herbal remedies is *Cinnamomum verum*, commonly known as cinnamon.

Clinical trials have consistently shown that cinnamon supplementation can lead to a significant reduction in fasting blood glucose levels and improvements in hemoglobin A1c (HbA1c), a key marker of long-term glucose control [30]. These effects are believed to be due to cinnamon's ability to mimic insulin activity, increase insulin receptor sensitivity, and enhance glucose uptake by cells [31]. In addition, cinnamon has antioxidant properties that may help reduce oxidative stress, a major contributor to the progression of diabetes and its complications [32]. Another well-researched herb is *Gymnema sylvestre*, traditionally used in Ayurvedic medicine as an anti-diabetic agent [33]. Clinical studies have shown that this plant can lower blood glucose levels by stimulating the secretion of insulin from pancreatic beta cells and increasing the sensitivity of insulin receptors [34]. Some trials have reported that patients using *Gymnema sylvestre* were able to reduce or even discontinue their use of conventional diabetic medications under medical supervision [35]. The active compounds in this herb, known as gymnemic acids, are believed to be responsible for its glucose-lowering effects [36]. *Allium sativum*, more commonly known as garlic, has also demonstrated hypoglycemic effects in clinical settings [37]. Research indicates that garlic supplementation can help reduce fasting blood glucose and total cholesterol levels, as well as improve insulin sensitivity [38]. The sulfur-containing compounds in garlic, such as allicin, are thought to play a central role in modulating glucose metabolism and enhancing pancreatic function [39]. While these findings are promising, it is important to consider that the efficacy of herbal remedies can be influenced by several factors, including the method of preparation, the dosage, and the duration of treatment [28]. The pharmacokinetics and bioavailability of herbal compounds can also vary significantly between individuals, affecting therapeutic outcomes [40]. Moreover, many studies suffer from limitations such as small sample sizes, short follow-up periods, and variability in herbal product quality, making it difficult to draw definitive conclusions. Despite these challenges, the current body of evidence supports the use of certain herbal medicines as adjunctive therapies in the management of diabetes [41]. However, these treatments should not be viewed as replacements for conventional medications, especially in cases of poorly controlled or advanced diabetes. Instead, they should be integrated into a comprehensive treatment plan that includes lifestyle modifications, dietary changes, and pharmacologic interventions when necessary [42].

Ultimately, while the clinical efficacy of herbal remedies in diabetes management is supported by a growing number of studies, there remains a need for larger, high-quality, and long-term randomized controlled trials. These studies should aim to establish standardized dosages, assess long-term safety, and evaluate the potential of these herbs to prevent or delay the onset of diabetes-related complications. Until such evidence is available, healthcare providers and patients should approach the use of herbal therapies with informed caution and under professional guidance.

### **Safety Considerations and Potential Side Effects**

Although herbal medicines are often perceived as safe due to their natural origin, this perception can be misleading. Just like conventional pharmaceuticals, herbal remedies can exert powerful biological effects and may lead to adverse outcomes if not used properly [28]. In the context of diabetes management, it is particularly important to consider the potential for hypoglycemia, drug interactions, organ toxicity, and allergic reactions associated with certain herbal products [43]. One of the primary concerns with herbal anti-diabetic agents is their potential to cause hypoglycemia, especially when used alongside insulin or oral hypoglycemic drugs such as sulfonylureas or metformin [44]. For instance, *Gymnema sylvestre*, known for its blood glucose-lowering properties, can significantly amplify the effects of conventional medications, leading to dangerously low blood sugar levels [45]. Symptoms of hypoglycemia, such as dizziness, confusion, sweating, and even loss of consciousness, can pose serious risks if not promptly recognized and treated [46]. Another notable example is *Berberis vulgaris*, which contains berberine—a compound that has demonstrated efficacy in improving glucose and lipid metabolism [47]. However, berberine can also inhibit certain liver enzymes responsible for drug metabolism, potentially leading to increased blood levels of other medications [49]. This can alter the effectiveness or toxicity of those drugs, including commonly used anticoagulants, antibiotics, and cardiovascular medications [49].

Liver and kidney toxicity are additional concerns when using herbal remedies, particularly in individuals with pre-existing hepatic or renal conditions [50]. Certain herbs, if consumed in high doses or over prolonged periods, may cause hepatic enzyme elevation, nephrotoxicity, or other forms of organ damage. For example, excessive use of *Momordica charantia* (bitter melon) has been linked to gastrointestinal distress and hepatotoxicity in sensitive individuals [51]. These risks underline the

necessity of routine monitoring of liver and kidney function during the use of herbal therapies, especially when they are used in conjunction with other medications. Contamination and adulteration of herbal products are further safety issues that cannot be ignored. Studies have revealed that some commercially available herbal supplements may contain undeclared pharmaceutical ingredients, heavy metals, or microbial contaminants [52]. This can result from poor manufacturing practices or lack of regulatory oversight, particularly in regions where herbal products are not subject to stringent quality controls [52]. Therefore, it is essential for consumers to purchase herbal supplements from reputable sources that adhere to good manufacturing practices and offer transparency in labeling. Furthermore, allergic reactions, ranging from mild skin rashes to severe anaphylactic responses, have been reported with the use of various herbal products [54]. These

Herbal medicines offer promising potential for managing diabetes and its complications. The bioactive compounds found in herbs, such as alkaloids, flavonoids, terpenoids, phenolic acids, and glycosides, exhibit a wide range of anti-diabetic effects through various mechanisms. While clinical evidence supports the efficacy of many herbs in lowering blood glucose and improving insulin

reactions are often unpredictable and may be exacerbated by individual sensitivities or cross-reactivity with other allergens. As with any therapeutic agent, a thorough medical history should be obtained before initiating herbal treatment, and any signs of adverse reactions should prompt immediate discontinuation and medical evaluation. Given these considerations, healthcare professionals play a critical role in guiding patients on the safe use of herbal medicines. Patients should be encouraged to disclose all herbal products they are using or intend to use, as this information is vital for identifying potential drug-herb interactions and managing treatment plans effectively. Ultimately, the safe integration of herbal remedies into diabetes care requires a balanced approach that combines scientific evidence, clinical judgment, and patient education [55].

## CONCLUSION

sensitivity, further research, including long-term clinical trials, is necessary to fully understand their therapeutic potential and safety. Healthcare providers should carefully consider the appropriate use of herbal remedies, ensuring that they are used safely and in conjunction with conventional treatments to achieve optimal diabetes management.

## REFERENCES

1. Alum, E. U., Ugwu, O. P. C., Obeagu, E. I. Beyond Pregnancy: Understanding the Long-Term Implications of Gestational Diabetes Mellitus. *INOSR Scientific Research*. 2024; 11(1):63-71. <https://doi.org/10.59298/INOSRSR/2024/1.1.16371>
2. Karachaliou F, Simatos G, Simatou A. The challenges in the development of Diabetes Prevention and care models in Low-Income settings. *Frontiers in Endocrinology*. 2020;11. doi:10.3389/fendo.2020.00518
3. Ugwu, O. P. C., Alum, E. U. and Uhama, K. C. (2024). Dual Burden of Diabetes Mellitus and Malaria: Exploring the Role of Phytochemicals and Vitamins in Disease Management. *Research Invention Journal of Research in Medical Sciences*. 3(2):38-49.
4. Tripathi P, Pandey A, Pandey R, Srivatava R, Goswami S. Alternative therapies useful in the management of diabetes: A systematic review. *Journal of Pharmacy and Bioallied Sciences*. 2011;3(4):504. doi:10.4103/0975-7406.90103
5. Rizvi SA, Einstein GP, Tulp OL, Sainvil F, Branly R. Introduction to traditional medicine and their role in Prevention and treatment of Emerging and Re-Emerging Diseases. *Biomolecules*. 2022;12(10):1442. doi:10.3390/biom12101442
6. M.C. Udeh Sylvester, O.F.C. Nwodo, O.E. Yakubu, E.J. Parker, S. Egba, E. Anaduaka, V.S. Tatah, O.P. Ugwu, E.M. Ale, C.M. Ude and T.J. Iornenge. Effects of Methanol Extract of *Gongronema latifolium* Leaves on Glycaemic Responses to Carbohydrate Diets in Streptozotocin-induced Diabetic Rats. *Journal of Biological Sciences*, 2022; 22: 70-79.
7. Eze Chukwuka W., Egba Simeon, Nweze Emeka I., Ezech Richard C. and Ugwuodike Patrick. Ameliorative Effects of *Allium cepa* and *Allium sativum* on Diabetes Mellitus and Dyslipidemia in Alloxan-induced Diabetic *Rattus norvegicus*. *Trends Applied Sci Res*, 2020; 15(2): 145-150
8. Chimaroke Onyeabo, Paul Anyiam Ndubuisi, Anthony Cemaluk Egbuonu, Prince Chimezie Odika, Simeon Ikechukwu Egba, Obedience Okon Nnana, Polycarp Nnacheta Okafor. Natural products-characterized Moringa oleifera leaves methanolic extract and anti-diabetic properties mechanisms of its fractions in



- streptozotocin-induced diabetic rats The Nigerian Journal of Pharmacy, 2022; 56(1):18-29
9. Ogugua, V N., Egba, S I., Anaduaka, E. G and Ozioko B O. Phytochemical analysis, anti-hyperglycaemic and anti-oxidant effect of the aqueous extracts of *Chromolaena odorata* on alloxan induced diabetic Rats. *Pharmanest*, 2013; 4(5): 970-977
  10. Mitaki, N.B., Fasogbon, I.V., Ojiakor, O.V., Makena, W., Ikuomola, E. O., Dangana, R.S., et al. (2025). A systematic review of plant-based therapy for the management of diabetes mellitus in the East Africa community. *Phytomedicine Plus*, 5(1): 100717. <https://doi.org/10.1016/j.phyplu.2024.100717>
  11. Alum, E. U., Krishnamoorthy, R., Gatasheh, M. K., Subbarayan, S., Vijayalakshmi, P., Uti, D. E. Protective Role of Jimson Weed in Mitigating Dyslipidemia, Cardiovascular, and Renal Dysfunction in Diabetic Rat Models: In Vivo and in Silico Evidence. *Natural Product Communications*. 2024;19(12). doi:10.1177/1934578X241299279
  12. Uti, D.E., Atangwho, I.J., Alum, E.U., Egba, S.I., Ugwu, O.P.C., Ikechukwu, G.C. Natural Antidiabetic Agents: Current Evidence and Development Pathways from Medicinal Plants to Clinical use. *Natural Product Communications*. 2025;20(3). doi:10.1177/1934578X251323393
  13. Utami AR, Maksum IP, Deawati Y. Berberine and its study as an antidiabetic compound. *Biology*. 2023;12(7):973. doi:10.3390/biology12070973
  14. Roy A, Khan A, Ahmad I, Alghamdi S, Rajab BS, Babalghith AO, et al. Flavonoids: a bioactive compound from medicinal plants and its therapeutic applications. *BioMed Research International*. 2022; 1—9. doi:10.1155/2022/5445291
  15. Yen FS, Qin CS, Xuan STS, Ying PJ, Le HY, Darmarajan T, et al. Hypoglycemic effects of plant flavonoids: A review. *Evidence-based Complementary and Alternative Medicine*. 2021;1—12. doi:10.1155/2021/2057333
  16. Günal-Köroğlu D, Catalkaya G, Yusufoglu B, Kezer G, Esatbeyoglu T, El-Aty AMA, et al. Quercetin: Potential antidiabetic effects through enzyme inhibition and starch digestibility. *Food Safety and Health*. 2024; Available from: doi:10.1002/fsh.3.12066
  17. Dhanya R. Quercetin for managing type 2 diabetes and its complications, an insight into multitarget therapy. *Biomedicine & Pharmacotherapy*. 2021;146:112560. doi:10.1016/j.biopha.2021.112560
  18. Roy S, Ghosh A, Majie A, Karmakar V, Das S, Dinda SC, et al. Terpenoids as potential phytoconstituents in the treatment of diabetes: From preclinical to clinical advancement. *Phytomedicine*. 2024;129:155638. doi:10.1016/j.phymed.2024.155638
  19. Ogugua Victor Nwadiogbu., Agu Obiora Uroko., Egba, Simeon Ikechukwu and Robert Ikechukwu. Modulation of Blood Glucose Concentration, Lipid Profile and Haematological Parameters in Alloxan Induced Diabetic Rats Using Methanol Extract of *Nauclea latifolia* Root Bark. *Asian Journal of Biological Sciences*, 2017; 10(1): 1-8
  20. Senevirathne BS, Jayasinghe MA, Pavalakumar D, Siriwardhana CG. Ceylon cinnamon: a versatile ingredient for futuristic diabetes management. *Journal of Future Foods*. 2022;2(2):125–42. doi:10.1016/j.jfutfo.2022.03.010
  21. Khan A, Safdar M, Khan MMA, Khattak KN, Anderson RA. Cinnamon improves glucose and lipids of people with type 2 diabetes. *Diabetes Care*. 2003;26(12):3215–8. doi:10.2337/diacare.26.12.3215
  22. Amer AA, Kassem SH, Hussein MA. Chemical composition, antioxidant, cytotoxic, antiviral, and lung-protective activities of *Salvia officinalis* L. ethanol extract herb growing in Sinai, Egypt. *Beni-Suef University Journal of Basic and Applied Sciences*. 2024;13(1). doi:10.1186/s43088-024-00498-6
  23. Meng S, Cao J, Feng Q, Peng J, Hu Y. Roles of chlorogenic acid on regulating glucose and lipids metabolism: A review. *Evidence-based Complementary and Alternative Medicine*. 2013; 1–11. doi:10.1155/2013/801457
  24. Chen J, Xu J, Huang P, Luo Y, Shi Y, Ma P. The potential applications of traditional Chinese medicine in Parkinson's disease: A new opportunity. *Biomedicine & Pharmacotherapy*. 2022;149:112866. doi:10.1016/j.biopha.2022.112866
  25. Anaduaka, Emeka G., Ogugua, Victor N., Egba, Simeon I and Apeh Victor O. Investigation of some important nutritional and phytochemical properties, toxicological potentials of *Newbouldia leavis* ethanol leaf and stem extracts. *African Journal of Biotechnology*, 2013; 12(3): 5846-5854
  26. Ugwu, O.P.C., Kungu, E., Inyangat, R., Obeagu, E. I., Alum, E. U., Okon, M. B., Subbarayan, S. and Sankarapandian, V. Exploring Indigenous

- Medicinal Plants for Managing Diabetes Mellitus in Uganda: Ethnobotanical Insights, Pharmacotherapeutic Strategies, and National Development Alignment. *INOSR Experimental Sciences*. 2023; 12(2):214–224. <https://doi.org/10.59298/INOSRES/2023/2.17.1000>.
27. Hasan MdK, Ara I, Mondal MSA, Kabir Y. Phytochemistry, pharmacological activity, and potential health benefits of *Glycyrrhiza glabra*. *Heliyon*. 2021;7(6):e07240. doi:10.1016/j.heliyon.2021.e07240
  28. Egba, SI., Ogbodo, JO., Ogbodo PO and Obike CA (2017) Toxicological Evaluation of Two Named Herbal Remedies Sold Across Orumba South Local Government of Anambra State, South-Eastern Nigeria. *Asian Journal of Research in Biochemistry*, 1(1):1-6
  29. Parham M, Bagherzadeh M, Asghari M, Akbari H, Hosseini Z, Rafiee M, et al. Evaluating the effect of a herb on the control of blood glucose and insulin-resistance in patients with advanced type 2 diabetes (a double-blind clinical trial). *DOAJ (Directory of Open Access Journals)*. 2020;11(1):12–20. Available from: <https://doaj.org/article/d905569bbff248b18dc1614f2d108e53>
  30. Moridpour AH, Kavyani Z, Khosravi S, Farmani E, Daneshvar M, Musazadeh V, et al. The effect of cinnamon supplementation on glycemic control in patients with type 2 diabetes mellitus: An updated systematic review and dose-response meta-analysis of randomized controlled trials. *Phytotherapy Research*. 2023;38(1):117–30. doi:10.1002/ptr.8026
  31. Senevirathne BS, Jayasinghe MA, Pavalakumar D, Siriwardhana CG. Ceylon cinnamon: a versatile ingredient for futuristic diabetes management. *Journal of Future Foods*. 2022;2(2):125–42. doi:10.1016/j.jfutfo.2022.03.010
  32. Banaszak M, Górna I, Woźniak D, Przysławski J, Drzymała-Czyż S. The Impact of Curcumin, Resveratrol, and Cinnamon on Modulating Oxidative Stress and Antioxidant Activity in Type 2 Diabetes: Moving beyond an Anti-Hyperglycaemic Evaluation. *Antioxidants*. 2024;13(5):510. doi:10.3390/antiox13050510
  33. Ikechukwu ES, Polycarp NO, Patricia EM, Gavin CI, Humphrey CO, Chukwuka WE. Toxicological Evaluation and Possible Reversal of Diabetic Toxicological Complications by PHF5 an Antidiabetic Herbal Formula in Wistar Albino Rats. *Asian J. Res. Biochem*. 2021 8(3):34–43. Available from: <https://journalajrb.com/index.php/AJRB/article/view/125>
  34. Oh YS. Plant-Derived compounds targeting pancreatic beta cells for the treatment of diabetes. *Evidence-based Complementary and Alternative Medicine*. 2015; 1–12. doi:10.1155/2015/629863
  35. Ogugua Victor Nwadiogbu., Uroko Robert Ikechukwu., Egba, Simeon Ikechukwu and Agu Obiora. Hepatoprotective and Healthy Kidney Promoting Potentials of Methanol Extract of *Nauclea latifolia* in Alloxan Induced Diabetic Male Wistar Albino Rats. *Asian Journal of Biochemistry*, 2017; 12: 71-78
  36. Ugwu, O. P.C., Alum, E. U., Obeagu, E. I, Okon, M. B., Aja, P. M., Samson, A. O., Amusa, M. O. and Adepoju, A. O. Effect of Ethanol Leaf extract of *Chromolaena odorata* on hepatic markers in streptozotocin-induced diabetic wistar albino rats. *IAA Journal of Applied Sciences*, 2023; 9(1):46–56. <https://doi.org/10.5281/zenodo.7811625>
  37. Xie C, Gao W, Li X, Luo S, Wu D, Chye FY. Garlic (*Allium sativum* L.) polysaccharide ameliorates type 2 diabetes mellitus (T2DM) via the regulation of hepatic glycogen metabolism. *NFS Journal*. 2023; 31:19–27. doi:10.1016/j.nfs.2023.02.004
  38. Wang J, Zhang X, Lan H, Wang W. Effect of garlic supplement in the management of type 2 diabetes mellitus (T2DM): A meta-analysis of randomized controlled trials. *Food & Nutrition Research*. 2017;61(1):1377571. doi:10.1080/16546628.2017.1377571
  39. Shang A, Cao SY, Xu XY, Gan RY, Tang GY, Corke H, et al. Bioactive Compounds and Biological Functions of Garlic (*Allium sativum* L.). *Foods*. 2019;8(7):246. doi:10.3390/foods8070246
  40. Sun S, Wang Y, Wu A, Ding Z, Liu X. Influence factors of the pharmacokinetics of herbal resourced compounds in clinical practice. *Evidence-based Complementary and Alternative Medicine*. 2019; 1–16. doi:10.1155/2019/1983780
  41. Choudhury H, Pandey M, Hua CK, Mun CS, Jing JK, Kong L, et al. An update on natural compounds in the remedy of diabetes mellitus: A systematic review. *Journal of Traditional and Complementary Medicine*. 2017;8(3):361–76. doi:10.1016/j.jtcme.2017.08.012
  42. Tripathi P, Pandey A, Pandey R, Srivatava R, Goswami S. Alternative therapies useful in the management of diabetes: A systematic review.

- Journal of Pharmacy and Bioallied Sciences. 2011;3(4):504. doi:10.4103/0975-7406.90103
43. Ukpabi-Ugo Jacinta Chigozie., Monanu, Michael Okechukwu., Patrick-Iwuanyanwu, Kingsley and Egbachukwu Simeon Ikechukwu. Potential hepatoprotective effect of different solvent fractions of *Ocimum gratissimum* (O G) in a paracetamol-induced hepatotoxicity in Wistar albino rats. *ScopeMed* 2016; 5(1): 10-16
  44. Ogugua Victor Nwadiogbu., Uroko Robert Ikechukwu., Egba, Simeon Ikechukwu and Agu Obiora (2017) Hepatoprotective and Healthy Kidney Promoting Potentials of Methanol Extract of *Nauclea latifolia* in Alloxan Induced Diabetic Male Wistar Albino Rats. *Asian Journal of Biochemistry*, 2017; 12: 71-78
  45. Kanetkar P, Singhal R, Kamat M. *Gymnema sylvestre*: A Memoir. Journal of Clinical Biochemistry and Nutrition. 2007;41(2):77-81. doi:10.3164/jcbrn.2007010
  46. Tiwari P, Mishra BN, Sangwan NS. Phytochemical and Pharmacological Properties of *Gymnema sylvestre*: An Important Medicinal Plant. *BioMed Research International*. 2014; 1-18. doi:10.1155/2014/830285
  47. Utami AR, Maksu IP, Deawati Y. Berberine and its study as an antidiabetic compound. *Biology*. 2023;12(7):973. doi:10.3390/biology12070973
  48. National Institute of Diabetes and Digestive and Kidney Diseases. Berberine. LiverTox - NCBI Bookshelf. 2020. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK564659/>
  49. Uroko, Robert I., Adamude, Fatima A., Egba, Simeon I., Ani, Chijioke C and 1 Ekpenyong, James E. Hepatoprotective Effects of Methanol Extract of *Acanthus montanus* (acanthaceae) Leaves on Acetaminophen Induced Liver Injury in Rats. *Pharmacologyonline*, 2020; 1: 248-260
  50. Da Conceição Marçal Alves Nunes DR, De Jesus Monteiro CS, Santos JLD. Herb-Induced Liver Injury—A challenging diagnosis. *Healthcare*. 2022;10(2):278. doi:10.3390/healthcare10020278
  51. National Institute of Diabetes and Digestive and Kidney Diseases. Bitter melon. LiverTox - NCBI Bookshelf. 2023. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK590483/>
  52. Alharbi SF, Althbah AI, Mohammed AH, Alrasheed MA, Ismail M, Allemailem KS, et al. Microbial and heavy metal contamination in herbal medicine: A prospective study in the central region of Saudi Arabia. *BMC Complementary Medicine and Therapies*. 2024;24(1). doi:10.1186/s12906-023-04307-y
  53. Bose S, Das PP, Banerjee S, Chakraborty P. A comprehensive review on natural products caused allergy and its mechanism. *Journal of Herbal Medicine*. 2023; 42:100778. doi:10.1016/j.hermed.2023.100778
  54. Alqathama A, Alluhiabi G, Baghdadi H, Aljahani L, Khan O, Jabal S, et al. Herbal medicine from the perspective of type II diabetic patients and physicians: What is the relationship? *BMC Complementary Medicine and Therapies*. 2020;20(1). doi:10.1186/s12906-020-2854-4

**CITE AS: Kato Jumba K. (2025). Overview of Bioactive Compounds in Herbs and Their Anti-Diabetic Properties. IAA Journal of Applied Sciences 13(2):36-42.**  
<https://doi.org/10.59298/IAAJAS/2025/364200>