ISSN: xxxx-xxxx
Buddha Journal of Pharmaceutical Sciences & Research (BJPSR)
Volume 1 | Issue 1 | August 2025 Website: https://www.bip.ac.in/BIP_Journal/ Email: bjpsr2025@bip.ac.in

Review Article

Herbal Therapeutics: A Promising Avenue in Diabetic Cardiomyopathy Management

Shraddha Srivastava[1], Neha Srivastava[2]

[1] Assistant Professor, Buddha College of Pharmacy, GIDA, Gorakhpur, (U.P.), India-273209

[2] Principal, Buddha College of Pharmacy, GIDA, Gorakhpur, (U.P.), India-273209

Abstract:

Diabetic Cardiomyopathy (DCM) is the condition when people with diabetes mellitus have aberrant myocardial structure and function without accompanying heart risk factors include severe valve disease, hypertension, and coronary artery disease. The main goals of conventional treatments for DCM are cardiovascular support and glycemic management, however new study shows that herbal therapy may be used as an adjunct. Recent developments in this research looks at the utilisation of phytochemicals and medicinal plants for DCM prevention and therapy. Many bioactive compounds, including polyphenols, alkaloids, flavonoids, and saponins, have shown cardioprotective benefits via glucose-lowering, anti-inflammatory, anti-fibrotic, and antioxidant processes. Prominent herbal ingredients such ginsenosides, resveratrol, curcumin, and berberine have demonstrated encouraging preclinical and clinical results in reducing oxidative stress, enhancing mitochondrial function, and modifying signaling pathways related to cardiac remodeling. Standardization, bioavailability, and safety concerns are among the difficulties in integrating herbal medicines into conventional clinical practice. Novel, integrative therapy approaches for DCM might be made possible by a better understanding of the molecular targets and synergistic effects of phytoconstituents. Mechanistic studies and extensive clinical trials should be the main focus of future research to determine herbal remedies' efficacy and safety in treating diabetic cardiomyopathy.

Keywords: Phytochemicals, Hypertension, Bioactive Substances, Cardioprotective, Insulin Resistance.

Introduction:

Diabetic Cardiomyopathy (DCM) is a precise myocardial ailment that alter sufferer with diabetes mellitus (DM) while it is unlinked to ischemic heart disease, high blood pressure, additional other heart diseases [1]. The characteristics of DCM are structural and functional modification in the heart such as diastolic and systolic dysfunction, left ventricular hypertrophy, and myocardial fibrosis, and heart attack risk [2]. The fundamental physiopathological pathway of DCM comprise chronic hyperglycemia, insulin resistance, oxidative stress, inflammation, mitochondrial dysfunction, endothelial dysfunction, and cardiomyocyte apoptosis [3]. These pathophysiological modification out-turn in level down of oxygen supply to the heart, arrhythmias, diastolic dysfunction, endothelial dysfunction, and systolic

ISSN: xxxx-xxxx
Buddha Journal of Pharmaceutical Sciences & Research (BJPSR)
Volume 1 | Issue 1 | August 2025 Website: https://www.bip.ac.in/BIP_Journal/ Email: bjpsr2025@bip.ac.in

dysfunction & a significant danger of heart attack [4,5]. Intial intervention with glucose management, heart protective strategy, and phototherapy is important to elude the starting of DCM and its issue, that can cause heart failure, atrial fibrillation, ventricular tachycardia, and sudden cardiac death [6]. Diabetic cardiomyopathy (DCM) is associated with the increase in diabetes mellitus, especially type 2 diabetes. 30-60% of diabetic patients exhibit some extent of cardiac dysfunction, and the earliest change is diastolic dysfunction [7]. Diabetic patients are 2.5-5 times more susceptible to heart failure than non-diabetic patients. DCM is common in regions where diabetes is common, i.e., South Asia, the Middle East, and North America, and it is age-related as a consequence of chronic hyperglycemia and metabolic stress [8]. Traditional treatments of diabetic cardiomyopathy (DCM) are limited by their failure to treat the multifactorial nature of the disease. The usual treatments target blood glucose levels, blood pressure, and cholesterol but are not able to totally prevent disease progression or reverse cardiac damage [9]. Taking long term drugs can give complication and is not possible to increase diastolic activity. Alternative therapies like phototherapy and superfood are best option in the handling of DCM [10].

Therapy of Diabetic Cardiomyopathy with phytochemicals:

As potential pharmaceuticals medications, for the Treatment of diabetic cardiomyopathy (DCM), phototherapy have improved higher attention due to their ability to target a broad range of pathophysiological pathway. In research phase and patient trial report, many phytochemical extract from medicinal plants such as terpenoids, alkaloids, polyphenols, and flavonoids, has confirmed cardiovascular-friendly [11]. In preclinical and clinical studies, various bioactive compounds derived from medicinal plants, such as terpenoids, alkaloids, polyphenols, and flavonoids, have shown cardioprotective properties. [12].

1. **Flavonoid**

Flavonoids, found in plant-based medicines, have potential in therapy diabetic cardiomyopathy due to their antioxidant, anti-inflammatory, anti-fibrotic, and heart friendly effects [13]. The phytochemical found in flavonoids have the strength to resist the oxidative stress and inflammation occur by removing ROS and control important signaling mechanism such as Nrf2, NF-κB, and PI3K/Akt [14].

Dihydromyricetin (DHM), a flavonoid among Ampelopsis grossedentata, have potent effect for managing diabetic cardiomyopathy due to its anti-inflammatory, antioxidant, and mitochondrial-protective features [15]. It stimulates Sirtuin 3, a mitochondrial deacetylase, recover mitochondrial efficiency and decrease ROS generation [16]. DHM also suppress the NF-κB mechanism, decrease

ISSN: xxxx-xxxx
Buddha Journal of Pharmaceutical Sciences & Research (BJPSR)
Volume 1 | Issue 1 | August 2025 Website: https://www.bip.ac.in/BIP_Journal/ Email: bjpsr2025@bip.ac.in

sensitivity pro-inflammatory cytokines, and increases glucose and lipid metabolism, suppress lipid accumulation and insulin resistance [17,18].

2. Polyphenols

Polyphenols, plant compounds with antioxidant, anti-inflammatory, anti-fibrotic, and cardioprotective activities, are observed to be favorable in the therapy of diabetic cardiomyopathy (DCM) [19,20,21]. They reduce oxidative stress, stimulate glucose metabolism, enhance endothelial function, and depress myocardial fibrosis. More clinical trials are necessary [22].

Resveratrol, a polyphenol occurs in grapes, red wine, and berries, studies found it has effective against diabetic cardiomyopathy (DCM) because of its antioxidant, anti-inflammatory, and cardioprotective activities [23]. Resveratrol initiates the activation of AMP-activated protein kinase, enhances glucose uptake, and diminishes lipotoxicity, which are essential for DCM therapy [24]. Resveratrol also defends against mitochondrial function by inducing Sirtuin 1 activity, decreases reactive oxygen species, and retards the development of DCM [25,26].

Curcumin, one of the predominant turmeric polyphenols, exerts therapeutic effects in diabetic cardiomyopathy by virtue of its antioxidant, anti-inflammatory, and cardioprotective activities [27,28]. Curcumin activates Nrf2, elevates the activity of antioxidant enzymes, modulates glucose and lipid metabolism, and suppresses TGF-β/Smad signalling, increasing insulin sensitivity and reducing myocardial lipotoxicity [29]. Curcumin is also anti-fibrotic in action and attenuates collagen deposition and myocardial stiffness [30].

3. Terpenoids

Potential treatment drugs for diabetic cardiomyopathy are terpenoids, natural compounds found in plants with cardioprotective, antioxidant, anti-inflammatory, and anti-fibrotic properties [31]. They modulate mitochondrial function, lipid metabolism, inflammation, oxidative stress, and cardiac fibrosis [33]. The main bioactive ginsenoside triterpenoids of Panax ginseng, namely, ginsenosides, in many researches have proven to possess anti-apoptotic, antioxidant, cardioprotective, and calcium-regulating effects [33]. Through the modulation of calcium homeostasis, free radical scavenging, and inhibition of cardiomyocyte apoptosis, these drugs exert beneficial effects on diabetic cardiomyopathy (DCM) [34]. Ginsenosides help improve heart function and inhibit myocardial fibrosis by reducing oxidative stress and inflammation [35].

ISSN: xxxx-xxxx
Buddha Journal of Pharmaceutical Sciences & Research (BJPSR)
Volume 1 | Issue 1 | August 2025 Website: https://www.bip.ac.in/BIP_Journal/ Email: bjpsr2025@bip.ac.in

Astragaloside IV, a bioactive saponin of Astragalus membranaceus, possesses promising cardioprotective activities in diabetic cardiomyopathy (DCM) by suppressing myocardial fibrosis, promoting glucose and lipid metabolism, and relieving cardiac damage caused by oxidative stress, which is the prevalent pathological feature in DCM [36, 37].

4. Alkaloid

Alkaloids, naturally occurring bioactive molecules, have significant therapeutic potential in diabetic cardiomyopathy due to their cardioprotective, anti-inflammatory, and metabolic modulating properties [38]. Berberine is a plant isoquinoline alkaloid that has broad research application in its anti-diabetic, lipid-lowering, anti-inflammatory, and cardioprotective properties. In recent studies, it has been established that berberine takes part in protecting and treating diabetic cardiomyopathy (DCM) by amplified glucose metabolism, reduced lipid accumulation [39]. Chronic inflammation and oxidative stress induce the onset of diabetic cardiomyopathy, leading to fibrosis, apoptosis, and disturbed cardiac performance. Berberine is an efficacious anti-inflammatory compound in inhibiting limiting the production of pro-inflammatory cytokines as TNF-α, IL-6, and IL-1β by inhibiting NF-κB signalling [40]. By raising the levels of glutathione peroxidase (GPx), catalase (CAT), and superoxide dismutase (SOD), berberine also promotes Nrf2-mediated antioxidant activities, and reduces oxidative stress and ROS-induced cardiomyocyte damage [41].

Other Herbal Extracts and Polyherbal Formulations in the Treatment of Diabetic Cardiomyopathy:

In addition to individual bioactive molecules such as flavonoids, polyphenols, terpenoids, and alkaloids, certain other polyherbal and herbal extracts have also been explored for their therapeutic properties in diabetic cardiomyopathy (DCM) treatment. Such preparations have the potential for synergistic effects, regulating many of the pathological processes involved in the etiopathogenesis of DCM such as oxidative stress, inflammation, fibrosis, dyslipidemia, and mitochondrial dysfunction [42,43]. Some herbal extract discuss below:

1. Panax Notoginseng (Sanqi) – Cardioprotective and Anti-Fibrotic Effects

Panax notoginseng, widely used traditional Chinese medicine, contains notoginsenosides possessing anti-inflammatory, antioxidant, and anti-fibrotic functions [42]. Notoginsenoside R1, for example, suppressed TGF-β1/Smad3 signaling and blocked collagen accumulation and myocardial fibrosis of diabetic hearts [44].

ISSN: xxxx-xxxx
Buddha Journal of Pharmaceutical Sciences & Research (BJPSR)
Volume 1 | Issue 1 | August 2025 Website: https://www.bip.ac.in/BIP_Journal/ Email: bjpsr2025@bip.ac.in

2. Withania Somnifera (Ashwagandha) – Antioxidant and Anti-Apoptotic Properties

Withania somnifera, also known as Ashwagandha, has been investigated for its adaptogenic and cardioprotective activities. Ashwagandha is characterized by the presence of withanolides, which exhibit antioxidant, anti-inflammatory, and anti-apoptotic activity [45]. Research shows that Ashwagandha modulates Nrf2 signaling, enhancing endogenous antioxidant gene expression such as SOD, catalase, and glutathione. Ashwagandha also inhibits JNK/p38 MAPK pathways, reducing cardiomyocyte apoptosis and fibrosis in diabetic hearts [46].

3. Gymnema Sylvestre – Anti-Hyperglycemic and Lipid-Lowering Effects

Gymnema sylvestre, a traditional antidiabetic medicine, contains gymnemic acids that enhance insulin release, enhance glucose absorption, and reduce lipid levels. Current studies have shown that Gymnema sylvestre has impacts on AMPK activation regulation, inhibiting cardiac lipid accumulation and oxidative stress in diabetic cardiomyopathy models [47].

Synergistic effects of polyherbal combinations:

Besides, polyherbal formulations provide synergistic activity, enhancing therapeutic effect by targeting multiple pathways in DCM. For example, a combination of Moringa, Curcumin, and Tulsi has antioxidant, anti-inflammatory, and lipid-lowering activity and provides holistic cardioprotection [48]. Similarly, Ashwagandha and Terminalia arjuna synergistically enhance cardiac contractility, reduce stress-induced damage, and block myocardial hypertrophy. Additionally, formulations like Ayush-82 and Dashmool decoction have been found to be effective in modulating glucose metabolism, blocking myocardial inflammation, and blocking fibrosis [49]. Synergistic activity of multiple bioactive molecules in polyherbal formulations not only enhances efficacy but also bioavailability and reduces side effects, making them a likely alternative in the holistic treatment of diabetic cardiomyopathy. Clinical confirmation and standardization are, however, essential to ensure universal therapeutic use [50].

Conclusion:

Herbal therapy has been shown to have potential in the management of diabetic cardiomyopathy due to its antioxidant, anti-inflammatory, and metabolic effects. Notwithstanding this, poor bioavailability, lack of standardization, herb-drug interaction, and limited clinical trials remain a challenge. The future should be directed towards the manufacture of standardized products, extensive trials, and better

ISSN: xxxx-xxxx
Buddha Journal of Pharmaceutical Sciences & Research (BJPSR)
Volume 1 | Issue 1 | August 2025 Website: https://www.bip.ac.in/BIP_Journal/ Email: bjpsr2025@bip.ac.in

regulatory control. The combination of herbal therapy and standard drug may provide an integrated modality to the treatment of DCM.

Reference:

1. Maisch, B., Alter, P., & Pankuweit, S. (2011). Diabetic cardiomyopathy—Fact or fiction? *Herz*, *36*[2], 102-115.

2. Lorenzo-Almorós, A., Tuñón, J., Orejas, M., Cortés, M., Egido, J., & Lorenzo, Ó. (2017). Diagnostic approaches for diabetic cardiomyopathy. *Cardiovascular Diabetology*, *16*[1].

3. Murtaza, G., Virk, H. U. H., Khalid, M., Lavie, C. J., Ventura, H., Mukherjee, D., Shanmugasundaram, M., & Paul, T. K. (2019). Diabetic cardiomyopathy—A comprehensive updated review. *Progress in Cardiovascular Diseases*, *62*(4), 315-326.

4. Gilca, G. E., Stefanescu, G., Badulescu, O., Tanase, D. M., Bararu, I., & Ciocoiu, M. (2017). Diabetic cardiomyopathy: Current approach and potential diagnostic and therapeutic targets. *Journal of Diabetes Research*, *2017*, Article 1310265.

5. Tarquini, R., Lazzeri, C., Pala, L., Rotella, C. M., & Gensini, G. F. (2011). The diabetic cardiomyopathy. *Acta Diabetologica*, *48*[3], 173-181.

6. Liu, Q., Wang, S., & Cai, L. (2014). Diabetic cardiomyopathy and its mechanisms: Role of oxidative stress and damage. *Journal of Diabetes Investigation*, *5*[6], 623-634.

7. De Boer, I. H., Bangalore, S., Benetos, A., Davis, A. M., Michos, E. D., Muntner, P. M., Rossing, P., Zoungas, S., & Bakris, G. L. (2017). Diabetes and hypertension: A position statement by the American Diabetes Association. *Diabetes Care*, *40*[9], 1273-1284.

8. Parim, B., Sathibabu Uddandrao, V. V., & Saravanan, G. (2019). Diabetic cardiomyopathy: Molecular mechanisms, detrimental effects of conventional treatment, and beneficial effects of natural therapy. *Heart Failure Reviews*, *24*[2], 279-299.

9. Tian, J., Zhao, Y., Liu, Y., Liu, Y., Chen, K., & Lyu, S. (2017). Roles and mechanisms of herbal medicine for diabetic cardiomyopathy: Current status and perspective. *Oxidative Medicine and Cellular Longevity*, *2017*, Article 8214541.

ISSN: xxxx-xxxx
Buddha Journal of Pharmaceutical Sciences & Research (BJPSR)
Volume 1 | Issue 1 | August 2025 Website: https://www.bip.ac.in/BIP_Journal/ Email: bjpsr2025@bip.ac.in

10. Yao, P., Yang, X., & Qiao, Y. (2024). A review on the natural products in treatment of diabetic cardiomyopathy (DCM). *Reviews in Cardiovascular Medicine*, *25*(5)

11. ubaidi, F. F., Zainalabidin, S., Taib, I. S., Hamid, Z. A., & Budin, S. B. (2021). The potential role of flavonoids in ameliorating diabetic cardiomyopathy via alleviation of cardiac oxidative stress, inflammation and apoptosis. *International Journal of Molecular Sciences*, *22*[10].

12. Min, Q., Bai, Y., Zhang, Y., Yu, W., Zhang, M., Liu, D., Diao, T., & Lv, W. (2017). Hawthorn leaf flavonoids protect against diabetes-induced cardiomyopathy in rats via PKC-α signaling pathway. *Evidence-Based Complementary and Alternative Medicine*, *2017*.

13. Chen, Y., Zheng, Y., Chen, R., Shen, J., Zhang, S., Gu, Y., Shi, J., & Meng, G. (2023). Dihydromyricetin attenuates diabetic cardiomyopathy by inhibiting oxidative stress, inflammation and necroptosis via sirtuin 3 activation. *Antioxidants*, *12*[1].

14. Sapian, S., Taib, I. S., Latip, J., Katas, H., Chin, K.-Y., Mohd Nor, N. A., Jubaidi, F. F., & Budin, S. B. (2021). Therapeutic approach of flavonoid in ameliorating diabetic cardiomyopathy by targeting mitochondrial-induced oxidative stress. *International Journal of Molecular Sciences*, *22*(21).

15. Nie, H., Ji, T., Fu, Y., Chen, D., Tang, Z., & Zhang, C. (2022). Molecular mechanisms and promising role of dihydromyricetin in cardiovascular diseases. *Physiological Research*, *71*[6], 749-763.

16. Zhang, J., Chen, Y., Luo, H., Sun, L., Xu, M., Yu, J., Zhou, Q., Meng, G., & Yang, S. (2018). Recent update on the pharmacological effects and mechanisms of dihydromyricetin. *Frontiers in Pharmacology*, *9*,

17. Li, L., Luo, W., Qian, Y., Zhu, W., Qian, J., Li, J., Jin, Y., Xu, X., & Liang, G. (2019). Luteolin protects against diabetic cardiomyopathy by inhibiting NF-κB-mediated inflammation and activating the Nrf2-mediated antioxidant responses. *Phytomedicine*, *59*,

18. Li, X., Rekep, M., Tian, J., Wu, Q., Chen, M., Yang, S., Zhang, L., Chen, J., Duan, J., Zhang, Y., Ablimit, A., & Wang, N. (2023). Luteolin attenuates diabetic myocardial hypertrophy by inhibiting proteasome activity. *Pharmacology*, *108*[1], 47-60.

ISSN: xxxx-xxxx
Buddha Journal of Pharmaceutical Sciences & Research (BJPSR)
Volume 1 | Issue 1 | August 2025 Website: https://www.bip.ac.in/BIP_Journal/ Email: bjpsr2025@bip.ac.in

19. Sun, D., Huang, J., Zhang, Z., Gao, H., Li, J., Shen, M., Cao, F., & Wang, H. (2012). Luteolin limits infarct size and improves cardiac function after myocardium ischemia/reperfusion injury in diabetic rats. *PLoS ONE*, *7*[3].

20. Alshehri, A. S., El-Kott, A. F., Eleawa, S. M., El-Gerbed, M. S. A., Khalifa, H. S., El-Kenawy, A. E., Albadrani, G. M., & Abdel-Daim, M. M. (2021). Kaempferol protects against streptozotocin-induced diabetic cardiomyopathy in rats by a hypoglycemic effect and upregulating SIRT1. *Journal of Physiology and Pharmacology*, *72*[3].

21. Sapian, S., Taib, I. S., Latip, J., Katas, H., Chin, K.-Y., Mohd Nor, N. A., Jubaidi, F. F., & Budin, S. B. (2021). Therapeutic approach of flavonoid in ameliorating diabetic cardiomyopathy by targeting mitochondrial-induced oxidative stress. *International Journal of Molecular Sciences*, *22*(21).

22. Atale, N., Yadav, D., Rani, V., & Jin, J.-O. (2020). Pathophysiology, clinical characteristics of diabetic cardiomyopathy: Therapeutic potential of natural polyphenols. *Frontiers in Nutrition*, *7*.

23. Mattera, R., Benvenuto, M., Giganti, M. G., Tresoldi, I., Pluchinotta, F. R., Bergante, S., Tettamanti, G., Masuelli, L., Manzari, V., Modesti, A., & Bei, R. (2017). Effects of polyphenols on oxidative stress-mediated injury in cardiomyocytes. *Nutrients*, *9*(5).

24. Zhang, Y., Liu, D., Hu, H., Zhang, P., Xie, R., & Cui, W. (2020). Resveratrol alleviates diabetic cardiomyopathy through AMPK activation. *Biomedicine & Pharmacotherapy*, *129*.

25. Zhao, E., Feng, L., Bai, L., Wang, Y., & Zhang, Y. (2018). SIRT1-dependent mitochondrial biogenesis contributes to resveratrol-induced cardioprotection against diabetic cardiomyopathy. *Journal of Cellular and Molecular Medicine*, *22*[9], 4257-4267.

26. Wang, X., Gao, Y., Tian, N., Zhang, F., & Qi, W. (2021). Resveratrol inhibits myocardial fibrosis by regulating TGF-β/Smad signaling pathway in diabetic rats. *Molecular Medicine Reports*, *24*(5).

27. Sun, L., Luo, C., Long, J., Wei, Z., & Li, X. (2019). Resveratrol attenuates diabetic cardiomyopathy by suppressing oxidative stress and inflammation via the NF-κB signaling pathway. *Molecular Nutrition & Food Research*, *63*(5).

28. Wang, Y., Zhou, S., Sun, W., McClung, K., Pan, Y., Liang, G., Tan, Y., Zhao, Y., Liu, B., Tan, Y., Bhattacharya, S., Johnson, W., Zhao, T. C., Cai, L., Lu, G., & Cui, T. (2014). Inhibition of JNK by

novel curcumin analog C66 prevents diabetic cardiomyopathy with a preservation of cardiac metallothionein expression. *American Journal of Physiology-Endocrinology and Metabolism*, *306*[11].

29. Lu, W., Shahidi, F. K., Khorsandi, K., Hosseinzadeh, R., Gul, A., & Balick, V. (2022). An update on molecular mechanisms of curcumin effect on diabetes. *Journal of Food Biochemistry*, *46*[10].

30. Bhattacharya, S., & Sil, P. C. (2018). Role of plant-derived polyphenols in reducing oxidative stress-mediated diabetic complications. *Reactive Oxygen Species*, *5*[13], 15-34.

31. Abolfazli, S., Butler, A. E., Kesharwani, P., & Sahebkar, A. (2024). The beneficial impact of curcumin on cardiac lipotoxicity. *Journal of Pharmacy and Pharmacology*, *76*[10], 1269-1283.

32. Hua, F., Shi, L., & Zhou, P. (2020). Phytochemicals as potential IKK-β inhibitor for the treatment of cardiovascular diseases in plant preservation: Terpenoids, alkaloids, and quinones. *Inflammopharmacology*, *28*[1], 83-93.

33. Panigrahy, S. K., Bhatt, R., & Kumar, A. (2021). Targeting type II diabetes with plant terpenes: The new and promising antidiabetic therapeutics. *Biologia*, *76*[1], 241-254.

34. Lee, C. H., & Kim, J.-H. (2014). A review on the medicinal potentials of ginseng and ginsenosides on cardiovascular diseases. *Journal of Ginseng Research*, *38*[3], 161-166.

35. Bai, L., Gao, J., Wei, F., Zhao, J., Wang, D., & Wei, J. (2018). Therapeutic potential of ginsenosides as an adjuvant treatment for diabetes. *Frontiers in Pharmacology*, *9*.

36. Yang, A., Zhang, L., Li, W., Fan, B., Sun, M., Zhang, X., & Zhang, Y. (2022). Therapeutic effect of astragaloside IV on diabetic cardiomyopathy mice and its mechanism. *Chinese Journal of Integrative Medicine on Cardio-/Cerebrovascular Disease*, *20*[1], 19-24.

37. Tian, W., Zhang, P., Yang, L., Song, P., Zhao, J., Wang, H., Zhao, Y., & Cao, L. (2024). Astragaloside IV alleviates doxorubicin-induced cardiotoxicity by inhibiting cardiomyocyte pyroptosis through the SIRT1/NLRP3 pathway. *The American Journal of Chinese Medicine*, *52*[2], 453-469.

38. Kumar, A., Aswal, S., Semwal, R. B., Chauhan, A., Joshi, S. K., & Semwal, D. K. (2019). Role of plant-derived alkaloids against diabetes and diabetes-related complications: A mechanism-based approach. *Phytochemistry Reviews*, *18*(5), 1277-1298.

39. Uddandrao, V. V. S., Parim, B., Singaravel, S., Ponnusamy, P., Ponnusamy, C., Sasikumar, V., & Saravanan, G. (2022). Polyherbal formulation ameliorates diabetic cardiomyopathy through attenuation of cardiac inflammation and oxidative stress via NF-κB/Nrf-2/HO-1 pathway in diabetic rats. *Journal of Cardiovascular Pharmacology*, *79*[1], e75-e86.

40. Subhasree, N., Kamella, A., Kaliappan, I., Agrawal, A., & Dubey, G. P. (2015). Antidiabetic and antihyperlipidemic activities of a novel polyherbal formulation in high fat diet/streptozotocin induced diabetic rat model. *Indian Journal of Pharmacology*, *47*(5), 509-513.

41. Ghorbani, A. (2014). Clinical and experimental studies on polyherbal formulations for diabetes: Current status and future prospective. *Journal of Integrative Medicine*, *12*(4), 336-345.

42. Mancuso, C. (2024). Panax notoginseng: Pharmacological aspects and toxicological issues. *Nutrients*, *16*[13].

43. Wang, Y., Wang, Q., Li, C., Lu, L., Zhang, Q., Zhu, R., & Wang, W. (2017). A review of Chinese herbal medicine for the treatment of chronic heart failure. *Current Pharmaceutical Design*, *23*(34), 5115-5124.

44. Dutta, R., Khalil, R., Green, R., Mohapatra, S. S., & Mohapatra, S. (2019). Withania somnifera (Ashwagandha) and withaferin A: Potential in integrative oncology. *International Journal of Molecular Sciences*, *20*(21).

45. Sehajpal, S., & Verma, N. (2022). A review on Gymnema sylvestre pharmacognostical profile and its anti-hyperglycemic activity. *Systematic Reviews in Pharmacy*, *13*[9], 39-47.

46. Karole, S., Shrivastava, S., Thomas, S., Soni, B., Khan, S., Dubey, J., Dubey, S. P., Khan, N., & Jain, D. K. (2019). Polyherbal formulation concept for synergic action: A review. *Journal of Drug Delivery & Therapeutics*, *9*(1-s), 453-466.

47. Ainurofiq, A., Wiyono, N., Warni, R., & Choiri, S. (2023). Assessment of the synergistic effect of a poly-herbals combination on the antioxidant activity through a statistical approach. *F1000Research*, *11*.

48. Rahim, N. F. A., Muhammad, N., Abdullah, N., Talip, B. A., & Dusuki, N. J. S. (2018). Synergistic effect of polyherbal formulations on DPPH radical scavenging activity. *Journal of Science and Technology*, *10*[2], 52-56.

ISSN: xxxx-xxxx
Buddha Journal of Pharmaceutical Sciences & Research (BJPSR)
Volume 1 | Issue 1 | August 2025 Website: https://www.bip.ac.in/BIP_Journal/ Email: bjpsr2025@bip.ac.in

49. Sulaiman, C. T., Anju, K., Anandan, E. M., & Balachandran, I. (2021). Synergistic interactions of phytochemicals in polyherbal formulation enhance the chemical transformations of active constituents. *Journal of Applied Spectroscopy*, *88*[1], 181-186.

50. Miller, G. E. (1990). The assessment of clinical skills/competence/performance. *Academic Medicine*, *65*(9 Suppl.), S63-S67.