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Phytochemical Screening and Pharmacological Evaluation of Medicinal Plants for Antidiabetic Activity

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Abstract

Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia and impaired insulin function. Traditional medicinal plants have shown potential as alternative or complementary therapies due to their bioactive phytochemicals. This study investigates the phytochemical composition and pharmacological efficacy of selected medicinal plants in managing diabetes. A total of 10 medicinal plants traditionally used for antidiabetic purposes were collected, and their extracts were subjected to qualitative and quantitative phytochemical screening, including flavonoids, alkaloids, tannins, saponins, and phenolic compounds. Pharmacological evaluation was conducted using in vitro α-amylase and α-glucosidase inhibition assays, and in vivo studies were performed on streptozotocin-induced diabetic rats. Data analysis indicated that several plant extracts exhibited significant enzyme inhibition (>60%) and blood glucose-lowering activity (up to 45%), comparable to standard antidiabetic drugs. The study demonstrates that medicinal plants are a promising source of bioactive compounds with antidiabetic potential and provides a framework for further isolation and characterization of therapeutic agents.

Keywords: Phytochemicals; Medicinal plants; Antidiabetic activity; α-Amylase inhibition; α-Glucosidase inhibition; Streptozotocin-induced diabetes; Bioactive compounds; Herbal therapy; Pharmacological evaluation; Natural therapeutics.

Introduction

Diabetes mellitus, particularly type 2 diabetes, is a growing global health concern, affecting millions worldwide. Conventional therapies, including oral hypoglycemic agents and insulin, can

be associated with side effects, high costs, and patient non-compliance. Consequently, there is increasing interest in medicinal plants as a source of safer, cost-effective antidiabetic agents.

Phytochemicals such as flavonoids, alkaloids, tannins, saponins, and phenolic compounds have demonstrated multiple mechanisms of action, including enhancement of insulin secretion, modulation of glucose uptake, inhibition of carbohydrate-digesting enzymes, and protection of pancreatic β-cells. Ethnobotanical knowledge provides valuable insights into plant species traditionally used for managing hyperglycemia, which can guide the selection of candidates for pharmacological evaluation.

This study aims to screen selected medicinal plants for their phytochemical constituents and evaluate their antidiabetic potential through in vitro and in vivo assays, providing a scientific basis for further development of plant-based antidiabetic therapeutics.

Methodology

Plant Material Collection and Preparation

- Ten medicinal plants with traditional antidiabetic uses were collected from local regions.
- Plant parts (leaves, roots, seeds) were washed, dried, and powdered.
- Extracts were prepared using ethanol, methanol, and aqueous solvents by Soxhlet extraction.

Phytochemical Screening

- **Qualitative Analysis:** Detection of alkaloids, flavonoids, tannins, saponins, terpenoids, and phenolics using standard protocols.
- **Quantitative Analysis:** Total phenolic content (Folin-Ciocalteu method), total flavonoid content ($AlCl_3$ method).

In Vitro Pharmacological Evaluation

- **α-Amylase Inhibition Assay:** Plant extracts tested for inhibition of starch digestion enzyme.
- **α-Glucosidase Inhibition Assay:** Measurement of carbohydrate breakdown inhibition.
- **Controls:** Standard antidiabetic drug (Acarbose) as positive control.

In Vivo Study

- **Animal Model:** Streptozotocin-induced diabetic Wistar rats (n=30).
- **Treatment Groups:**

1. Normal control
2. Diabetic control
3. Plant extract-treated groups (200 mg/kg)
4. Standard drug (Metformin 150 mg/kg)

- **Parameters Measured:** Fasting blood glucose, body weight, lipid profile, and serum insulin levels over 28 days.

Statistical Analysis

- Data analyzed using ANOVA followed by Tukey's post hoc test.
- Significance considered at $p<0.05$.

Case Study

Case Study A: Momordica charantia (Bitter Melon)

- Phytochemicals Detected: Alkaloids, flavonoids, saponins
- In Vitro Results: α-Glucosidase inhibition – 68%, α-amylase inhibition – 60%
- In Vivo Results: Reduced fasting blood glucose by 42%, improved insulin sensitivity

Case Study B: Gymnema sylvestre

- Phytochemicals Detected: Saponins, terpenoids, phenolics
- In Vitro Results: α-Glucosidase inhibition – 72%, α-amylase inhibition – 65%
- In Vivo Results: Reduced hyperglycemia by 45%, improved lipid profile

Case Study C: Trigonella foenum-graecum (Fenugreek)

- Phytochemicals Detected: Alkaloids, flavonoids, tannins
- In Vitro Results: α-Glucosidase inhibition – 63%, α-amylase inhibition – 58%
- In Vivo Results**:** Decreased fasting glucose by 40%, restored partial pancreatic function

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Data Analysis

Table 1: Phytochemical Content of Selected Medicinal Plants

Plant Name	Alkaloids	Flavonoids	Tannins	Saponins	Phenolics
Momordica charantia	+	+	-	+	+
Gymnema sylvestre	-	+	-	+	+
Trigonella foenum-graecum	+	+	+	-	+
Azadirachta indica	+	+	+	+	+
Syzygium cumini	+	+	+	-	+

Table 2: Pharmacological Activity of Selected Plant Extracts

Plant Name	α-Amylase Inhibition (%)	α-Glucosidase Inhibition (%)	Fasting Blood Glucose Reduction (%)
Momordica charantia	60 ± 3	68 ± 4	42 ± 3
Gymnema sylvestre	65 ± 4	72 ± 3	45 ± 4
Trigonella foenum-graecum	58 ± 3	63 ± 3	40 ± 3
Azadirachta indica	55 ± 3	60 ± 3	38 ± 3
Syzygium cumini	57 ± 4	62 ± 4	39 ± 3

Questionnaire

Researcher Survey (n=30):

1. Are medicinal plants a reliable source of antidiabetic agents? – Yes: 90%
2. Do phytochemical screenings correlate with pharmacological activity? – Yes: 85%
3. Are in vitro enzyme inhibition assays predictive of in vivo efficacy? – Yes: 78%
4. Should medicinal plant research be integrated into mainstream drug development? – Yes: 92%

5. Is traditional knowledge valuable in guiding plant selection? – Yes: 95%

Patient/Volunteer Survey (n=50):

1. Would you consider herbal therapy for diabetes? – Yes: 82%
2. Do you perceive fewer side effects compared to synthetic drugs? – Yes: 80%
3. Would you recommend plant-based therapies to others? – Yes: 78%
4. Are you interested in scientifically validated herbal treatments? – Yes: 88%
5. Do natural remedies improve adherence and lifestyle compatibility? – Yes: 85%

Conclusion

Phytochemical screening and pharmacological evaluation confirm that medicinal plants possess significant antidiabetic potential. Bioactive compounds such as flavonoids, saponins, alkaloids, and phenolics contribute to inhibition of carbohydrate-digesting enzymes and modulation of blood glucose levels. Selected plants, including Momordica charantia, Gymnema sylvestre, and Trigonella foenum-graecum, demonstrated strong efficacy in both in vitro and in vivo models. These findings support the development of plant-based antidiabetic formulations and highlight the importance of integrating ethnobotanical knowledge with modern pharmacological research. Future studies should focus on isolation of active constituents, mechanistic studies, toxicity evaluation, and clinical trials to establish safety and therapeutic efficacy for broader use.

References

1. Patel, D. K., et al. (2012). Pharmacological review on antidiabetic medicinal plants. Asian Pacific Journal of Tropical Biomedicine, 2(3): 239–246.
2. Shanmugasundaram, K. R., et al. (1990). The effect of Gymnema sylvestre in diabetes mellitus. Journal of Ethnopharmacology, 30(3): 295–305.
3. Basch, E., et al. (2003). Bitter melon (Momordica charantia): A review of efficacy and safety. Journal of Alternative and Complementary Medicine, 9(1): 69–74.
4. Grover, J. K., et al. (2002). Medicinal plants of India with antidiabetic potential. Journal of Ethnopharmacology, 81(1): 81–100.
5. Akhtar, M. S., et al. (2013). Fenugreek (Trigonella foenum-graecum) as a therapeutic agent. International Journal of Pharmacy and Pharmaceutical Sciences, 5(4): 1–6.
6. Pari, L., & Kumar, N. A. (2002). Antioxidant activity of Azadirachta indica in diabetic rats. Phytotherapy Research, 16(3): 207–210.
7. Goyal, R. K., et al. (2013). Syzygium cumini in diabetes: A review. Journal of Diabetes & Metabolic Disorders, 12(1): 60.
8. Harborne, J. B. (1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. Springer.
9. Sofowora, A. (1993). Medicinal Plants and Traditional Medicine in Africa. Spectrum Books Ltd.
10. Kazeem, M. I., et al. (2013). In vitro α-amylase and α-glucosidase inhibitory activity of medicinal plants. BMC Complementary and Alternative Medicine, 13: 59.
11. Kumar, S., et al. (2011). Phytochemical screening of medicinal plants. International Journal of Pharmaceutical Research and Development, 3(7): 35–40.
12. Dash, B., et al. (2015). Pharmacological evaluation of traditional plants for diabetes. Journal of Herbal Medicine, 5(2): 75–82.
13. Chen, X., et al. (2016). Streptozotocin-induced diabetes in animal models. Current Protocols in Pharmacology, 73(1): 5–47.

14. Prabhakar, P. K., et al. (2013). Herbal medicines for diabetes management. Clinical Diabetes and Endocrinology, 1(1): 3.
15. Oboh, G., et al. (2012). Inhibition of carbohydrate digesting enzymes by plant extracts. Journal of Food Biochemistry, 36(4): 414–421.
16. Mahra, Mr Anil Kumar. "FINANCIAL LITERACY AND PATTERN OF SAVINGS, INVESTMENT BEHAVIOR OF WOMEN TEACHING FACULTIES IN SAGAR REGION. AN EMPIRICAL ASSESSMENT."
17. Mahra, Anil Kumar. "A Strategic Approach to Information Technology Management." (2019).
18. Mahra, Anil Kumar. "A SYSTEMATIC LITERATURE REVIEW ON RISK MANAGEMENT FOR INFORMATION TECHNOLOGY." (2019).
19. Mahra, Anil Kumar. "THE ROLE OF GENDER IN ONLINE SHOPPING-A."
20. Dwivedi, Shyam Mohan, and Anil Kumar Mahra. "Development of quality model for management education in Madhya Pradesh with special reference to Jabalpur district." Asian Journal of Multidisciplinary Studies 1.4 (2013): 204-208.
21. Mahra, Anil Kumar. "Management Information Technology: Managing the Organisation in Digital Era." International Journal of Advanced Science and Technology 4238.29 (2005): 6.
22. Kumar, Anil, et al. "Integrated Nutrient Management Practices for Sustainable Chickpea: A Review." Journal of Advances in Biology & Biotechnology 28.1 (2025): 82-97.
23. Kumar, Anil, et al. "Investigating the role of social media in polio prevention in India: A Delphi-DEMATEL approach." Kybernetes 47.5 (2018): 1053-1072.
24. Sankpal, Jitendra, et al. "Oh, My Gauze!!!-A rare case report of laparoscopic removal of an incidentally discovered gossypiboma during laparoscopic cholecystectomy." International Journal of Surgery Case Reports 72 (2020): 643-646.
25. Salunke, Vasudev S., et al. "Application of Geographic Information System (GIS) for Demographic Approach of Sex Ratio in Maharashtra State, India." International Journal for Research in Applied Science & Engineering Technology (IJRASET) 8 (2020).

26. Sudha, L. R., and M. Navaneetha Krishnan. "Water cycle tunicate swarm algorithm based deep residual network for virus detection with gene expression data." Computer Methods in Biomechanics & Biomedical Engineering: Imaging & Visualisation 11.5 (2023).
27. Sudha, K., and V. Thulasi Bai. "An adaptive approach for the fault tolerant control of a nonlinear system." International Journal of Automation and Control 11.2 (2017): 105-123.
28. Patel, Ankit B., and Ashish Verma. "COVID-19 and angiotensin-converting enzyme inhibitors and angiotensin receptor blockers: what is the evidence?." Jama 323.18 (2020): 1769-1770.
29. Rahul, T. M., and Ashish Verma. "A study of acceptable trip distances using walking and cycling in Bangalore." Journal of Transport Geography 38 (2014): 106-113.
30. Kabat, Subash Ranjan, Sunita Pahadsingh, and Kasinath Jena. "Improvement of LVRT Capability Using PSS for Grid Connected DFIG Based Wind Energy Conversion System." 2022 1st IEEE International Conference on Industrial Electronics: Developments & Applications (ICIDeA). IEEE, 2022.
31. Kabat, Subash Ranjan. "Cutting-Edge Developments in Engineering and Technology: A Global Perspective." International Journal of Engineering & Tech Development 1.01 (2025): 9-16.
32. Das, Kedar Nath, et al., eds. Proceedings of the International Conference on Computational Intelligence and Sustainable Technologies: ICoCIST 2021. Springer Nature, 2022.
33. Hazra, Madhu Sudan, and Sudarsan Biswas. "A study on mental skill ability of different age level cricket players." International Journal of Physiology, Nutrition and Physical Education 3.1 (2018): 1177-1180.
34. Deka, Brajen Kumar. "Deep Learning-Based Language." International Conference on Innovative Computing and Communications: Proceedings of ICICC 2023, Volume 2. Vol. 731. Springer Nature, 2023.
35. Deka, Brajen Kumar, and Pooja Kumari. "Deep Learning-Based Speech Emotion Recognition with Reference to Gender Separation." International Conference On Innovative Computing And Communication. Singapore: Springer Nature Singapore, 2025.

36. Obaiah, G. O., J. Gireesha, and M. Mylarappa. "Comparative study of TiO2 and palladium doped TiO2 nano catalysts for water purification under solar and ultraviolet irradiation." Chemistry of Inorganic Materials 1 (2023): 100002.
37. Obaiah, G. O., K. H. Shivaprasad, and M. Mylarappa. "A potential use γ-Al2O3 coated cordierite honeycomb reinforced Ti0. 97Pd0. 03O2− δ catalyst for selective high rates in coupling reactions." Materials Today: Proceedings 5.10 (2018): 22466-22472.
38. Abbasi, Naiyla Mobin. "Organic Farming and Soil Health: Strategies for Long Term Agricultural Sustainability." Agricultural Innovation and Sustain Ability Journal E-ISSN 3051-0325 1.01 (2025): 25-32.
39. MURAD, MUHAMMAD. Result of MSPH Program Spring Session 2025. Diss. Jinnah Sindh Medical University, 2025