Journal of Biomedical and Pharmaceutical Research
Available Online at www.jbpr.in
CODEN: - JBPRAU (Source: - American Chemical Society)
NLM (National Library of Medicine): ID: (101671502)
Index Copernicus Value 2022: 83.058
Volume 13, Issue 1; 2024, 44-49

ISSN (Online): 2279-0594
ISSN (Print): 2589-8752

Review Article

Review on the Therapeutic Role of *Asclepias tuberosa* Seeds in Diabetes Management

Shivangi Shukla[1], Prashant Singh[2], Rajeev Shukla[3]

[1]P.G., Student, Sheat College of Pharmacy Ayer Gahani Varanasi

[2]Assistant Professor, Sheat College of Pharmacy Ayer Gahani Varanasi

[3]Director, Sheat College of Pharmacy Ayer Gahani Varanasi

Article Info: Received: 13-01-2024 / Revised: 10-02-2024 / Accepted: 04-03-2024
Address for correspondence: Shivangi Shukla
DOI: https://doi.org/10.32553/jbpr.v13i1.1069
Conflict of interest statement: No conflict of interest

Abstract:

Diabetes mellitus (DM) presents a significant global health challenge characterized by elevated blood glucose levels, leading to debilitating complications. Despite various therapeutic approaches, effective glucose regulation remains elusive, often accompanied by adverse effects from current medications. Medicinal plants, including *Asclepias tuberosa*, have shown promise in managing blood glucose levels with fewer side effects. This review highlights the potential of *Asclepias tuberosa* as herbal antidiabetic agents based on recent literature, suggesting avenues for further research and therapeutic development in DM management. Considering the urgent need for safer and more effective antidiabetic treatments, exploring the therapeutic potential of *Asclepias tuberosa* presents a promising avenue for addressing this growing public health concern. Future studies should focus on elucidating the mechanisms of action, conducting clinical trials to validate the efficacy and safety of Centaurea-based interventions in DM management, and exploring synergistic effects with existing therapies.

Furthermore, within the context of utilizing plant materials for the treatment of Diabetes mellitus, particular attention is directed towards the utilization of *Asclepias tuberosa* seeds. *Asclepias tuberosa*, commonly known as butterfly weed or pleurisy root, is a medicinal plant native to North America. Traditionally, various parts of this plant, including the roots, leaves, and seeds, have been used in folk medicine for their purported therapeutic effects

Keywords: *Diabetes mellitus, Asclepias tuberosa, antidiabetic agents, herbal remedies, blood glucose regulation*.

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia and elevated blood sugar levels both after meals and during fasting. [1] It stems from defects in insulin secretion, insulin action, or a combination of both. The global prevalence of diabetes is projected to escalate from 171 million in 2000 to 366 million by 2030, making it a significant contributor to worldwide morbidity. [2] Diabetes manifests in various forms, including type 1 (insulin-dependent), type 2 (non-insulin-dependent), and gestational diabetes. [3] Type 2

diabetes, marked by insulin resistance in the body's cells, is the most prevalent type, with prolonged hyperglycemia leading to overproduction of insulin by pancreatic β-cells, eventually causing their exhaustion. [4] Complications of diabetes include retinopathy, neuropathy, nephropathy, cataracts, peripheral vascular insufficiencies, and nerve damage due to chronic hyperglycemia. Managing high blood glucose levels in type 2 diabetes typically involves insulin therapy or oral antidiabetic medications. [5] Various pathways and mechanisms are explored for halting the progression of the disease, such as inhibiting intestinal α-glucosidase and α-amylase, suppressing aldose reductase activity, enhancing insulin synthesis and secretion, reducing oxidative stress, inhibiting the formation of advanced glycation end products, and modulating enzyme activity related to glucose metabolism. [6,7]

1.1 Overview of *Asclepias tuberosa*[1,2]

Asclepias tuberosa, commonly known as butterfly weed, is a perennial herbaceous plant belonging to the Apocynaceae family. Native to North America, it is distinguished by its vibrant orange flowers, which attract butterflies and other pollinators. Beyond its ornamental appeal, A. tuberosa has a history of use in traditional medicine for its diverse therapeutic properties. Indigenous cultures have utilized it for treating respiratory ailments, skin conditions, and inflammation. With its substantial medicinal potential, A. tuberosa has captured the attention of the scientific community for its pharmacognostic and phytochemical attributes.

Taxonomic Classification:

Asclepias tuberosa is classified within the kingdom Plantae, division Magnoliophyta, class Magnoliopsida, order Gentianales, family Apocynaceae, and genus Asclepias.

Family and Characteristics:

Belonging to the Apocynaceae family, *Asclepias tuberosa* is characterized by milky sap and leaves arranged oppositely or in whorls.

Species Description:

Asclepias tuberosa is a herbaceous perennial plant featuring lance-shaped leaves, striking orange to reddish-orange flowers, and a clumping growth habit.

Significance of Seeds:

The seeds of *Asclepias tuberosa* are housed within narrow seed pods. Upon maturity, these pods split open, dispersing seeds adorned with silky hairs known as pappus.

Figure 1: Plant and seeds of *Asclepias tuberosa*

In this context, there is a growing interest in exploring alternative therapeutic approaches, including herbal medicine. Herbal remedies have long been recognized for their potential as a source of natural compounds with diverse pharmacological activities. Notably, plants like *Asclepias tuberosa* have garnered attention for their traditional uses in indigenous cultures and their rich phytochemical composition, which may hold promise in the management of diabetes

Asclepias tuberosa, commonly known as butterfly weed, is a perennial herbaceous plant native to North America. It has been utilized in traditional medicine for various ailments, including respiratory conditions and inflammation, owing to its diverse chemical constituents such as cardiac glycosides, flavonoids, alkaloids, and saponins.

Recent research has focused on investigating the antidiabetic potential of A. tuberosa, with studies demonstrating promising hypoglycaemic effects attributed to its ability to enhance insulin secretion, improve insulin sensitivity, and inhibit key enzymes involved in carbohydrate metabolism. Additionally, A. tuberosa extracts possess antioxidant and anti-inflammatory properties, further supporting their potential as adjunctive therapies for diabetes management. [8,9] Despite these promising findings, there remains a need for comprehensive evaluations of the pharmacognostic features, phytochemical constituents, and antidiabetic activity of A. tuberosa to elucidate its mechanisms of action and identify potential bioactive compounds. This review aims to bridge the gap between traditional knowledge and scientific evidence by providing a comprehensive analysis of the therapeutic potential of A. tuberosa in diabetes management. Through a detailed exploration of its pharmacological properties and mechanisms of action, we seek to contribute to the advancement of antidiabetic therapies and improve outcomes for individuals affected by diabetes. [10,11]

Chemical Constituents of Plants: [1,2]

Asclepias tuberosa contains various chemical constituents, including cardiac glycosides, flavonoids, alkaloids, and saponins. Cardiac glycosides are important secondary metabolites found in the plant, contributing to its medicinal properties and potential pharmacological applications. Flavonoids, another group of compounds, provide antioxidant and anti-inflammatory effects. Alkaloids and saponins are also present in A. tuberosa, displaying diverse biological activities.

Chemical Constituents of Seeds: [1,2]

The seeds of Asclepias tuberosa are rich in fatty acids, proteins, and essential minerals. Fatty acids, such as linoleic acid and oleic acid, are essential for human health and have been associated with various physiological functions. Proteins in the seeds serve as a source of nutrition and can contribute to the development and maintenance of body tissues. Additionally, essential minerals, including calcium, potassium, and magnesium, are present in the seeds, supporting proper bodily functions.

Table 1.1: Medicinal Plants that are used for Diabetes Mellitus with mechanism of action. [12,13,14,15]

Plant	Family	Plant Part Used	Active Ingredient	Mechanism of Action
Bitter melon	Cucurbitaceae	Fruit	Charantin	Increases insulin sensitivity
Fenugreek	Fabaceae	Seed	Trigonelline	Improves glucose tolerance
Ginseng	Araliaceae	Root	Ginsenosides	Enhances insulin secretion
Cinnamon	Lauraceae	Bark	Cinnamaldehyde	Increases glucose uptake in cells
Gymnema	Asclepiadaceae	Leaf	Gymnemic acids	Inhibits sugar absorption in the gut
Berberine	Berberidaceae	Bark	Berberine	Improves insulin sensitivity

Aloe vera	Asphodelaceae	Leaf	Aloesin	Stimulates insulin secretion
Blueberry	Ericaceae	Fruit	Anthocyanins	Improves insulin sensitivity
Mulberry	Moraceae	Leaf	DNJ	Inhibits carbohydrate digestion
Olive leaf	Oleaceae	Leaf	Oleuropein	Improves insulin sensitivity
Plant	**Family**	**Plant Part Used**	**Active Ingredient**	**Mechanism of Action**
Holy basil	Lamiaceae	Leaf	Eugenol	Stimulates insulin secretion
Neem	Meliaceae	Leaf	Nimbin	Improves insulin sensitivity
Okra	Malvaceae	Fruit	Polysaccharides	Inhibits carbohydrate absorption
Guava	Myrtaceae	Leaf	Quercetin	Enhances insulin production
Turmeric	Zingiberaceae	Rhizome	Curcumin	Protects pancreatic beta cells

2. Methods

A thorough literature search was conducted using prominent search engines including Google Scholar, PubMed, and Scopus. Keywords related to diabetes mellitus (DM), Centaurea, hyperglycaemia, medicinal plants, antidiabetic plants, α-glucosidase, α-amylase, high blood glucose levels, enzyme inhibition, plant-based diets, folk medicine, and treatment were utilized to ensure comprehensive coverage. All retrieved results were meticulously extracted and analysed to provide a comprehensive overview of the relevant literature.

3. Result:

Two very Common in-vitro models used to evaluate the antidiabetic activity.

3.1 Inhibition of Alpha-Amylase:[16, 17]

The inhibition of alpha-amylase serves as a crucial indicator of the ability of natural compounds to modulate carbohydrate digestion. By assessing the inhibitory activity of Asclepias tuberosa extracts against alpha-amylase, we can gauge their potential to delay carbohydrate breakdown and reduce postprandial glucose levels. Positive results from this assay may suggest that A. tuberosa possesses bioactive constituents capable of exerting antidiabetic effects through the regulation of carbohydrate metabolism.

3.2 Glucose Diffusion Assay:[18]

The glucose diffusion assay offers insights into the capacity of Asclepias tuberosa extracts to modulate glucose transport across cellular membranes. This assay mimics the physiological process of glucose uptake by cells, allowing us to evaluate the impact of A. tuberosa on cellular glucose uptake mechanisms. Favourable outcomes in this assay may indicate that A. tuberosa contains bioactive compounds capable of enhancing glucose uptake by target tissues, thereby improving glucose utilization, and potentially contributing to glycemic control.

Discussion:

The investigation of *Asclepias tuberosa* for its antidiabetic properties has predominantly focused on two key areas: in vitro assays targeting the inhibition of α-glucosidase and α-amylase enzymes, and in vivo studies conducted on animal models, primarily rats and mice. These approaches offer valuable insights into the potential mechanisms underlying the plant's efficacy in managing diabetes.

In vitro assays assessing the inhibition of α-glucosidase and α-amylase enzymes provide a preliminary understanding of *Asclepias tuberosa*'s ability to modulate carbohydrate metabolism. α-Glucosidase inhibitors delay the digestion and absorption of carbohydrates in the small intestine, thereby reducing postprandial blood glucose levels. Similarly, α-amylase inhibitors impede the breakdown of complex carbohydrates into simple sugars, further attenuating glucose absorption. The effectiveness of *Asclepias tuberosa* extracts or isolated compounds in inhibiting these enzymes underscores their potential as antidiabetic agents.

In contrast, in vivo studies conducted on animal models offer insights into the physiological effects of *Asclepias tuberosa* supplementation. Rodent models of diabetes, such as streptozotocin-induced diabetic rats or high-fat diet-induced diabetic mice, are commonly employed to evaluate the plant's impact on glucose homeostasis, insulin sensitivity, and other metabolic parameters. These studies provide valuable data on the plant's potential to mitigate hyperglycaemia, improve insulin signalling, and ameliorate diabetic complications.

However, despite promising findings from preclinical studies, the translation of *Asclepias tuberosa*'s antidiabetic effects into clinical practice remains limited. To date, no clinical trials have been conducted to evaluate the efficacy and safety of *Asclepias tuberosa* in human subjects with diabetes. Clinical trials are essential for corroborating preclinical findings, assessing the plant's therapeutic potential in real-world settings, and establishing evidence-based recommendations for its use in diabetes management.

Conclusion:

In conclusion, the review of *Asclepias tuberosa* as a potential agent for managing diabetes highlights several key findings and implications. Firstly, preclinical studies, including in vitro assays and animal models, have demonstrated promising antidiabetic effects of *Asclepias tuberosa*, particularly through the inhibition of α-glucosidase and α-amylase enzymes. These findings suggest that *Asclepias tuberosa* may hold potential as a natural alternative for regulating blood glucose levels and improving metabolic outcomes in diabetes.

However, despite the encouraging preclinical data, the translation of *Asclepias tuberosa*'s antidiabetic effects into clinical practice is currently limited by the lack of human studies. The absence of clinical trials prevents the validation of its efficacy, safety, and optimal dosage regimens in real-world settings. Therefore, future research efforts should prioritize conducting well-designed clinical trials to evaluate the therapeutic potential of *Asclepias tuberosa* in human subjects with diabetes.

Additionally, further investigations are warranted to elucidate the underlying mechanisms of action of *Asclepias tuberosa* and identify the bioactive compounds responsible for its antidiabetic properties. By gaining a deeper understanding of the plant's pharmacological effects, researchers can optimize its therapeutic use and develop standardized formulations for clinical applications.

Overall, while *Asclepias tuberosa* shows promise as a natural remedy for diabetes management, further research, particularly clinical trials, is essential to validate its efficacy, safety, and clinical relevance. By addressing these knowledge gaps, we can advance our understanding of *Asclepias tuberosa*'s potential as an adjunctive therapy for individuals living with diabetes and contribute to the development of evidence-based approaches for diabetes management.

References:

1. Johnson, A. B., & Davis, P. T. (2018). Phytochemical analysis of Asclepias tuberosa: A comprehensive review. Journal of Ethnopharmacology, 210, 132-148.
2. Patel, S., et al. (2015). Pharmacognostic analysis of Asclepias tuberosa Linn. Journal of Applied Pharmaceutical Science, 5(2), 142-146.
3. International Diabetes Federation. (2019) World Health Organization. (2019)
4. Moerman, D. E. (1998). Native American Ethnobotany: A Database of Foods, Drugs, Dyes and Fibers of Native American Peoples, Derived from Plants. Retrieved from University of Michigan, Dearborn, Ethnobotany
5. Parekh, J., & Chanda, S. (2011). In vitro antimicrobial activity and phytochemical analysis of some Indian medicinal plants. Turkish Journal of Biology, 35(3), 251-257.

6. Johnston, K., & Shaik, A. (2020). Antidiabetic potential of Asclepias tuberosa: A systematic review and meta-analysis of preclinical studies. Journal of Ethnopharmacology, 256, 112835.
7. Goyal, R. K., Singh, J., Lal, P., & Kumar, P. (2016). Importance of pharmacognostic evaluation in standardization of herbal drugs. International Journal of Pharmaceutical Sciences Review and Research, 37(2), 21-26.
8. Kumar, V., Sagar, A., Kumar, V., & Jaiswal, S. (2018). In vitro α-glucosidase inhibition and antioxidant activity of Asclepias tuberosa L. Journal of Herbs, Spices & Medicinal Plants, 24(4), 313-322.
9. Bischoff, H. (1995). The mechanism of α-glucosidase inhibition in the management of diabetes. Clinical Investigator, 73(8), 713-725.
10. American Diabetes Association. (2021). Standards of medical care in diabetes. Diabetes Care, 44(Supplement 1), S1-S232.
11. Kumar, V., Sankar, P., & Jacob, S. (2019). Challenges in diabetes management: A comprehensive review. Indian Journal of Clinical Practice, 30(8), 731-737.
12. Ng, T. B. (2017). Pharmacological activity of saponins from plants. In M. Rahman, D. A. H. Kaisar, M. R. Rahman, M. S. Islam, & K. K. Islam (Eds.), Saponins: Properties, Applications and Health Benefits (pp. 1-16). Nova Science Publishers.
13. Patel, D. K., Prasad, S. K., Kumar, R., Hemalatha, S. (2012). An overview on antidiabetic medicinal plants having insulin mimetic property. Asian Pacific Journal of Tropical Biomedicine, 2(4), 320-330.
14. Bisht, D., & Dhasmana, D. C. (2018). Ethnomedicinal uses and pharmacological activity of Asclepiastuberosa Linn.: A review. International Journal of Green Pharmacy, 12(4), 213- 220.
15. S. S. Nair, V. Kavrekar and A. Misha, "In vitro studies on alpha amylase and alpha glucosidase inhibitory activities of selected plant extracts," European Journal of Experimental Biology, 3(1): 128-132, 2013.Glucose diffusion
16. C.I. Ovvuama, "Brewing Beer with Sorghum" Journal of The Institute of Brewing, 105(1), 1999.
17. K. R.R. Rengasamy, M. A. Aderogba, S. O. Amoo, W. A. Stirk, J. V. Staden, "Potential antiradical and alphaglucosidase inhibitors from Ecklonia maxima (Osbeck) Papenfuss," Food Chemistry 141, 1412–1415, 2013.