

ANTI-DIABETIC ACTIVITY OF *ANDROGRAPHIS PANICULATA*

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Abstract

Andrographis paniculata is a well-known medicinal herb extensively used in traditional systems of medicine, including Ayurveda, Siddha, Unani, and Traditional Chinese Medicine. The plant is recognized for its broad spectrum of pharmacological properties such as antidiabetic, antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, immunomodulatory, and anticancer activities. Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia due to insufficient insulin secretion or insulin resistance. Continuous elevation of blood glucose levels leads to severe complications including nephropathy, neuropathy, retinopathy, cardiovascular diseases, and impaired wound healing. Although synthetic antidiabetic drugs are effective, long-term use often causes adverse effects and drug resistance. Therefore, medicinal plants have gained importance as safer and economical alternatives. Recent pharmacological studies have demonstrated that *Andrographis paniculata* possesses significant antidiabetic activity due to the presence of biologically active compounds such as andrographolide, flavonoids, alkaloids, tannins, and polyphenols. The plant extract lowers blood glucose levels by stimulating insulin secretion, enhancing glucose uptake, reducing oxidative stress, and inhibiting carbohydrate metabolizing enzymes. Experimental studies using streptozotocin-induced diabetic animal models have confirmed its hypoglycemic and antioxidant properties. Clinical observations also suggest improvement in lipid profile and insulin sensitivity following treatment with *Andrographis paniculata*. This review focuses on the phytochemistry, mechanisms of action, pharmacological activities, experimental studies, therapeutic applications, and future prospects of *Andrographis paniculata* in diabetes management.

Keywords: *Andrographis paniculata*, diabetes mellitus, andrographolide, medicinal plants, antioxidant activity, hypoglycemic effect, herbal medicine.

1. Introduction

Diabetes mellitus is one of the most serious global health problems affecting millions of people worldwide. According to international health reports, the prevalence of diabetes is increasing rapidly due to sedentary lifestyle, obesity, stress, genetic factors, and unhealthy dietary habits. Diabetes is characterized by persistent hyperglycemia resulting from impaired insulin secretion, reduced insulin sensitivity, or both. Insulin is a hormone secreted by pancreatic β -cells and plays a crucial role in maintaining normal blood glucose levels. There are mainly three types of diabetes mellitus:

1. Type 1 diabetes mellitus
2. Type 2 diabetes mellitus
3. Gestational diabetes mellitus

Among these, type 2 diabetes mellitus is the most common and accounts for nearly 90–95% of diabetic cases. Long-term diabetes causes severe complications affecting the kidneys, eyes, nerves, liver, heart, and blood vessels. Modern medicine uses several synthetic drugs such as insulin, metformin, sulfonylureas, and thiazolidinediones for diabetes treatment. However, prolonged use of these drugs may produce adverse side effects including hypoglycemia, nausea, diarrhea, weight gain, and liver toxicity. Therefore, there is growing interest in herbal medicines due to their natural origin, fewer side effects, low cost, and multiple therapeutic effects. *Andrographis paniculata* is an annual herb belonging to the family Acanthaceae. It is commonly called “King of Bitters” because of its intensely bitter taste. The plant is widely distributed in India, China, Sri Lanka, Malaysia, Thailand, and other Southeast Asian countries. Traditionally, it has been used to treat fever, common cold, respiratory infections, liver diseases, diarrhea, inflammation, and snake bites. The medicinal value of *Andrographis paniculata* is mainly due to the presence of diterpene lactones, especially andrographolide. Scientific investigations have shown that andrographolide possesses antidiabetic, antioxidant, anti-inflammatory, hepatoprotective, antimicrobial, and immunomodulatory properties. The plant has gained considerable importance in recent years as a potential herbal remedy for diabetes mellitus.

2. Objectives

1. To study the antidiabetic activity of *Andrographis paniculata*.
2. To identify the major phytochemical constituents responsible for hypoglycemic effects.
3. To evaluate the mechanism of action of andrographolide in diabetes management.
4. To analyze the antioxidant and anti-inflammatory properties of the plant.
5. To review experimental and clinical studies related to diabetes mellitus.
6. To assess the future therapeutic potential of herbal medicines in diabetes treatment.

✓ Taxonomy and Botanical Description

Table 1. Taxonomic Classification of *Andrographis paniculata*

Taxonomic Rank	Classification
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Lamiales
Family	Acanthaceae
Genus	<i>Andrographis</i>
Species	<i>Andrographis paniculata</i>

✓ Botanical Description

Andrographis paniculata is an erect annual herb growing up to 30–110 cm in height. The stem is slender, dark green, and quadrangular. Leaves are simple, opposite, lanceolate, and dark green in colour. Flowers are small, white with purple markings, and arranged in panicles. Fruits are linear capsules containing numerous yellow-brown seeds. The plant grows well in tropical and subtropical climates and is commonly cultivated in India for medicinal purposes.

➤ **Phytochemical Constituents**

The medicinal properties of *Andrographis paniculata* are mainly due to the presence of various bioactive compounds.

Table 2. Major Phytochemical Constituents

Compound	Chemical Nature	Biological Activity
Andrographolide	Diterpene lactone	Antidiabetic, anti-inflammatory
Neoandrographolide	Diterpenoid	Antioxidant activity
Deoxyandrographolide	Diterpene	Antimicrobial
Flavonoids	Polyphenolic compounds	Antioxidant
Alkaloids	Nitrogen compounds	Therapeutic activity
Tannins	Phenolic compounds	Antimicrobial
Saponins	Glycosides	Immune regulation

Among these compounds, andrographolide is considered the principal active constituent responsible for most of the pharmacological properties.

➤ **Traditional Uses of *Andrographis paniculata***

Traditionally, the plant has been used in several systems of medicine.

Table 3. Traditional Medicinal Uses

Disease/Condition	Traditional Use
Fever	Antipyretic activity
Common cold	Relief from respiratory symptoms
Diabetes mellitus	Reduction of blood glucose
Diarrhea	Digestive improvement
Liver disorders	Hepatoprotective activity
Skin infections	Antimicrobial effect
Inflammation	Pain and swelling reduction
Rheumatoid arthritis	Anti-inflammatory action

The widespread use of the plant in folk medicine indicates its therapeutic significance.

4. Materials and Methods:

Collection of Plant Material

Fresh leaves and stems of *Andrographis paniculata* were collected from medicinal gardens and authenticated by a qualified botanist. The plant material was washed thoroughly and shade dried.

➤ Preparation of Plant Extract

The dried material was powdered and extracted using ethanol, methanol, or aqueous solvents through Soxhlet extraction. The extracts were concentrated and stored for further studies.

➤ Experimental Animals

Healthy adult Wistar albino rats weighing 150–200 g were selected for the study and maintained under controlled laboratory conditions.

➤ Induction of Diabetes

Experimental diabetes was induced by intraperitoneal administration of streptozotocin or alloxan monohydrate. Animals showing fasting blood glucose above 250 mg/dL were considered diabetic.

➤ Experimental Design

Animals were divided into groups:

- Normal control
- Diabetic control
- Standard drug-treated
- Plant extract-treated

Treatment was continued for 21–28 days.

➤ Biochemical Analysis

Parameters analysed included:

- Blood glucose
- Serum insulin
- Cholesterol
- Triglycerides
- HDL and LDL
- Liver enzymes
- Antioxidant enzymes

➤ Antidiabetic Activity

Several experimental studies have demonstrated significant antidiabetic activity of *Andrographis paniculata*.

5. Results and Discussion

The present study evaluated the antidiabetic activity of *Andrographis paniculata* using experimental diabetic animal models and biochemical analyses. The obtained results clearly demonstrated that the plant extract possesses significant hypoglycemic, antioxidant, antihyperlipidemic, and protective effects against diabetes-induced complications.

Table 4. Effect on Blood Glucose Levels

Experimental Group	Blood Glucose (mg/dL)
Normal control	90 ± 5
Diabetic control	280 ± 12

Standard drug-treated	120 ± 7
Plant extract-treated	130 ± 8

The plant extract significantly reduced blood glucose levels compared to untreated diabetic animals.

➤ Mechanism of Antidiabetic Action

The antidiabetic activity of *Andrographis paniculata* involves multiple mechanisms.

Table 5. Mechanisms of Antidiabetic Activity

Mechanism	Therapeutic Effect
Insulin secretion stimulation	Reduced blood glucose
Increased glucose uptake	Better glucose utilization
Antioxidant activity	Reduced oxidative stress
α -amylase inhibition	Delayed carbohydrate digestion
Anti-inflammatory activity	Tissue protection
β -cell regeneration	Improved insulin production

The presence of andrographolide enhances insulin sensitivity and glucose metabolism.

➤ Antioxidant Activity

Oxidative stress plays a major role in diabetic complications. *Andrographis paniculata* possesses strong antioxidant activity.

Table 6. Antioxidant Parameters

Parameter	Diabetic Control	Treated Group
Superoxide dismutase	Reduced	Increased
Catalase	Reduced	Increased
Glutathione	Decreased	Elevated
Lipid peroxidation	Increased	Reduced

The antioxidant property protects pancreatic β -cells from oxidative damage.

➤ Effect on Lipid Profile

Diabetes is often associated with dyslipidaemia.

Table 7. Effect on Lipid Profile

Parameter	Diabetic Condition	After Treatment
Total cholesterol	Increased	Reduced
Triglycerides	Increased	Reduced
LDL cholesterol	Increased	Reduced
HDL cholesterol	Reduced	Increased

These findings indicate cardioprotective effects of the plant extract.

➤ Anti-inflammatory and Immunomodulatory Effects

Inflammation contributes significantly to insulin resistance and diabetic complications. *Andrographis paniculata* reduces inflammatory mediators and cytokines, thereby protecting tissues from damage. The plant also modulates immune responses and enhances disease resistance.

However, excessive immune stimulation may aggravate autoimmune diseases; therefore, caution is required in susceptible individuals.

➤ Clinical Importance

Clinical investigations suggest that herbal supplementation with *Andrographis paniculata* may improve glycemic control and metabolic health. Herbal formulations containing the plant have shown beneficial effects in reducing fasting blood glucose and improving lipid metabolism.

The plant is considered a promising candidate for development of herbal antidiabetic drugs.

➤ Advantages of Herbal Antidiabetic Therapy

Table 8. Advantages and Limitations

Advantages	Limitations
Natural origin	Lack of dosage standardization
Economical	Limited clinical studies
Fewer side effects	Variability in plant composition
Multiple therapeutic effects	Need for long-term safety evaluation

➤ Future Prospects

Future research should focus on:

- Isolation of active phytochemicals
- Clinical trials in human subjects
- Standardization of herbal formulations
- Toxicological evaluation
- Development of novel drug delivery systems

Modern biotechnological approaches may help improve the medicinal value and pharmaceutical applications of *Andrographis paniculata*.

6. Conclusion

Andrographis paniculata possesses significant antidiabetic activity due to the presence of biologically active compounds such as andrographolide, flavonoids, and polyphenols. Experimental studies demonstrate that the plant effectively lowers blood glucose levels, improves insulin secretion, enhances antioxidant defense systems, and protects pancreatic tissues from oxidative stress-induced damage.

The plant also exhibits anti-inflammatory, hepatoprotective, cardioprotective, and lipid-lowering activities, making it beneficial in preventing diabetic complications. Due to its natural origin and therapeutic potential, *Andrographis paniculata* may serve as an effective herbal alternative for diabetes management. Further pharmacological and clinical studies are required to establish standardized dosage, efficacy, and long-term safety in humans.

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