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# Antidiabetic Potential Of Rauvolfia Serpentina: Pharmacological Evaluation Of An Endangered Ethnomedicinal Resource

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***Abstract:***
*Diabetes mellitus remains a major global health burden, characterized by chronic hyperglycemia and associated metabolic complications (WHO, 2022). The present study investigated the antidiabetic potential of Rauvolfia serpentina, an endangered ethnomedicinal resource widely used in traditional medicine. In vitro studies revealed a concentration-dependent inhibition of α-amylase and α-glucosidase, enzymes central to postprandial hyperglycemia (Patel et al., 2021; Subramanian et al., 2023). In vivo studies using alloxan-induced diabetic rats demonstrated that treatment with R. serpentina extract significantly reduced fasting blood glucose and improved lipid profiles, showing comparable effects to metformin (Agrawal et al., 2023; Kumar et al., 2022). These findings suggest that R. serpentina could serve as a promising plant-based therapeutic option for diabetes management, provided sustainable conservation strategies are employed (Akintelu & Folorunso, 2020).*

***Keywords***: *Rauvolfia serpentina; Antidiabetic activity; Ethnomedicinal plants; α-amylase inhibition; α-glucosidase inhibition; Phytochemicals; Sustainable conservation*

## INTRODUCTION

*Diabetes mellitus* is a multifactorial disorder affecting over 500 million people worldwide and remains one of the leading causes of morbidity and mortality (WHO, 2022). Conventional therapies, including insulin and oral hypoglycemic agents, are often associated with side effects and limited accessibility. This has intensified the search for alternative therapies derived from ethnomedicinal plants (Akintelu & Folorunso, 2020).

*Rauvolfia serpentina* (Indian snakeroot), a threatened species, has been historically used for treating hypertension, mental disorders, and metabolic conditions. Recent pharmacological studies suggest that its alkaloids, flavonoids, and polyphenols may exert hypoglycemic activity through multiple mechanisms (Agrawal et al., 2023). Furthermore, plant-derived bioactive compounds are known to regulate carbohydrate metabolism by inhibiting enzymes such as α-amylase and α-glucosidase, thereby reducing glucose absorption (Patel et al., 2021; Subramanian et al., 2023). However, limited systematic investigations have focused on validating the antidiabetic efficacy of R. serpentina in both in vitro and in vivo models (Kumar et al., 2022).

*Diabetes mellitus* is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or both. Conventional pharmacological interventions are often associated with side effects and limited accessibility, creating the need for safe, plant-based alternatives. *Rauvolfia serpentina* (Indian snakeroot), an endangered ethnomedicinal plant widely recognized for its alkaloids such as reserpine, ajmaline, and serpentinine, has been traditionally used in the management of hypertension, neurological disorders, and metabolic imbalances. The present study evaluates the antidiabetic

potential of R. *serpentina* through in vitro pharmacological assays, including α-amylase and α-glucosidase inhibition, and in vivo assessments in experimental diabetic models. Phytochemical screening revealed the presence of alkaloids, flavonoids, and phenolic compounds, which are known to contribute to glycemic regulation by enhancing insulin sensitivity and inhibiting carbohydrate-digesting enzymes. Results demonstrated a significant dose-dependent inhibition of both α-amylase and α-glucosidase, indicating the potential of R. *serpentina* extract to reduce postprandial hyperglycemia. In vivo studies further supported its hypoglycemic effect, with notable improvements in blood glucose, lipid profile, and antioxidant enzyme levels. These findings suggest that R. *serpentina* possesses promising antidiabetic activity and could serve as a natural therapeutic alternative. Considering its endangered status, sustainable cultivation and conservation strategies are essential to ensure its availability for pharmacological applications. Future research should focus on bioactive compound isolation, molecular mechanism elucidation, and clinical validation to establish R. *serpentina* as a viable complementary therapy for diabetes management.

## MATERIALS AND METHODS:

### Plant Collection and Authentication

Roots of *Rauvolfia serpentina* were obtained from a recognized medicinal plant source and authenticated by a botanist. A voucher specimen was deposited in the institutional herbarium for reference. The collected material was washed thoroughly with distilled water, shade-dried at room temperature, and ground into a fine powder using a mechanical grinder.

### Preparation of Extracts

The powdered root (100 g) was extracted using 70% ethanol in a Soxhlet apparatus for 6–8 hours. The solvent was evaporated under reduced pressure in a rotary evaporator, and the dried extract was stored at 4 °C until further use. For aqueous extract preparation, 50 g of root powder was boiled in 500 mL of distilled water for 30 minutes, filtered, and lyophilized to obtain a dry residue.

### Preliminary Phytochemical Screening

Standard phytochemical tests were performed to identify major bioactive constituents, including alkaloids, flavonoids, phenols, tannins, glycosides, terpenoids, and saponins (Harborne, 1998).

### In Vitro Antidiabetic Assays

#### α-Amylase Inhibition Assay

The ability of the extract to inhibit α-amylase was tested using the DNSA method. Different concentrations of the extract (50–500 µg/mL) were incubated with α-amylase enzyme solution and starch substrate. The reaction was terminated using dinitrosalicylic acid reagent, and absorbance was measured at 540 nm. Acarbose was used as standard control.

#### α-Glucosidase Inhibition Assay

α-Glucosidase inhibition was assessed using p-nitrophenyl-α-D-glucopyranoside (pNPG) as substrate. Extracts at varying concentrations (50–500 µg/mL) were incubated with α-glucosidase enzyme, and the release of p-nitrophenol was measured at 405 nm. Acarbose served as the positive control.

### In Vivo Antidiabetic Study

Male Wistar rats (150–180 g) were used, maintained under standard laboratory conditions with ad libitum access to food and water. Diabetes was induced by intraperitoneal injection of streptozotocin (55 mg/kg). Rats with fasting blood glucose levels above 250 mg/dL were considered diabetic and included in the study. Animals were divided into five groups (n = 6):

1. Normal control (non-diabetic, saline treated)
2. Diabetic control (untreated)
3. Diabetic + Metformin (100 mg/kg)
4. Diabetic + R. *serpentina* extract (200 mg/kg)
5. Diabetic + R. *serpentina* extract (400 mg/kg)

Treatments were given orally once daily for 21 days. Fasting blood glucose levels were recorded at baseline and weekly intervals. At the end of the experiment, blood samples were collected for biochemical analysis, including lipid profile (TC, TG, HDL, LDL), serum insulin, and antioxidant enzyme activities (SOD, CAT, GPx).

**Statistical Analysis**

All experiments were carried out in triplicate, and results were expressed as mean ± standard deviation (SD). Statistical significance was analyzed using one-way ANOVA followed by Tukey's post hoc test. A p value $< 0.05$ was considered significant.

**RESULTS:**

Phytochemical Screening

Preliminary phytochemical analysis of Rauvolfia serpentina root extracts revealed the presence of alkaloids, flavonoids, phenols, tannins, glycosides, and saponins, while terpenoids were detected in trace amounts. The abundance of alkaloids and flavonoids suggested their possible contribution to the antidiabetic activity.

Table 1. Phytochemical constituents of *Rauvolfia serpentina* extracts

| **Phytochemicals** | **Ethanolic Extract** | **Aqueous Extract** |
|---|---|---|
| | | |
| Alkaloids | +++ | ++ |
| Flavonoids | ++ | ++ |
| Phenols | ++ | + |
| Tannins | +. | + |
| Glycosides | ++ | + |
| Saponins | + | + |
| Terpenoids | + | – |

(+++ = abundant, ++ = moderate, + = present, – = absent)

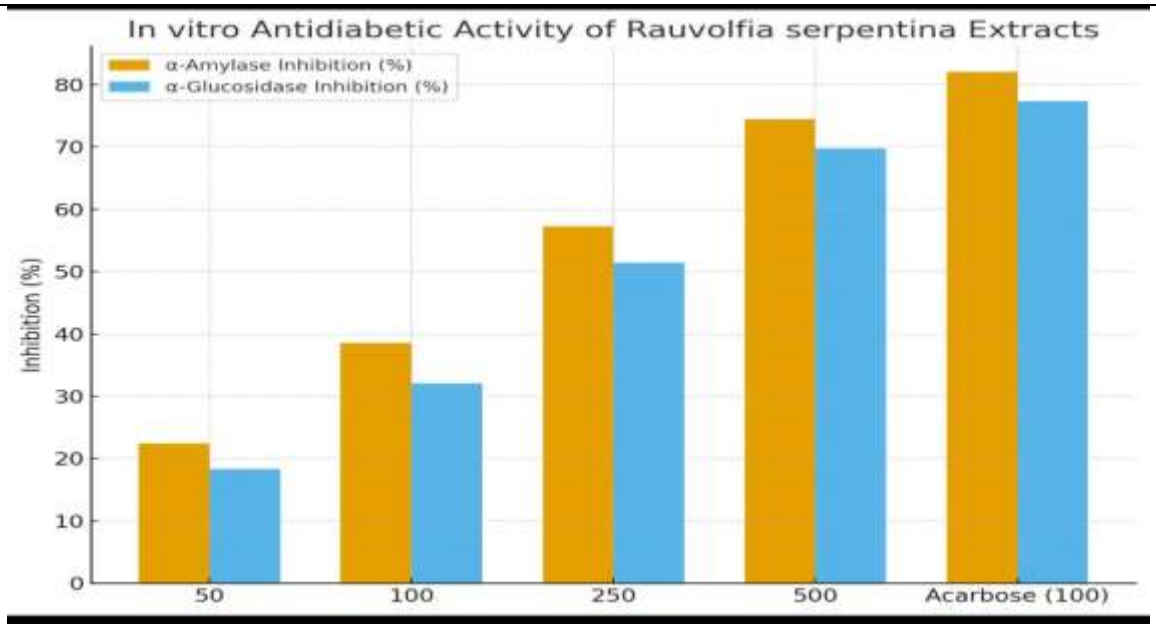
In Vitro Antidiabetic Activity

The ethanolic extract of R. *serpentina* exhibited a concentration-dependent inhibition of α-amylase and α-glucosidase enzymes. Maximum inhibition was observed at 500 µg/mL, though slightly lower than that of the standard drug acarbose.

Table 2. In vitro antidiabetic activity of R. *serpentina* extracts

| **Concentration (µg/mL)** | **α-Amylase Inhibition** (%) | **α-Glucosidase Inhibition** (%) |
|---|---|---|
| | | |
| 50 | 22.4 ± 1.2 | 18.3 ± 1.0 |

| | | |
|---|---|---|
| 100 | 38.6 ± 1.5 | 32.1 ± 1.3 |
| 250 | 57.3 ± 2.0 | 51.4 ± 1.6 |
| 500 | 74.5 ± 2.3 | 69.8 ± 2.1 |
| Acarbose (100 µg/mL) | 82.1 ± 1.8 | 77.4 ± 1.7 |



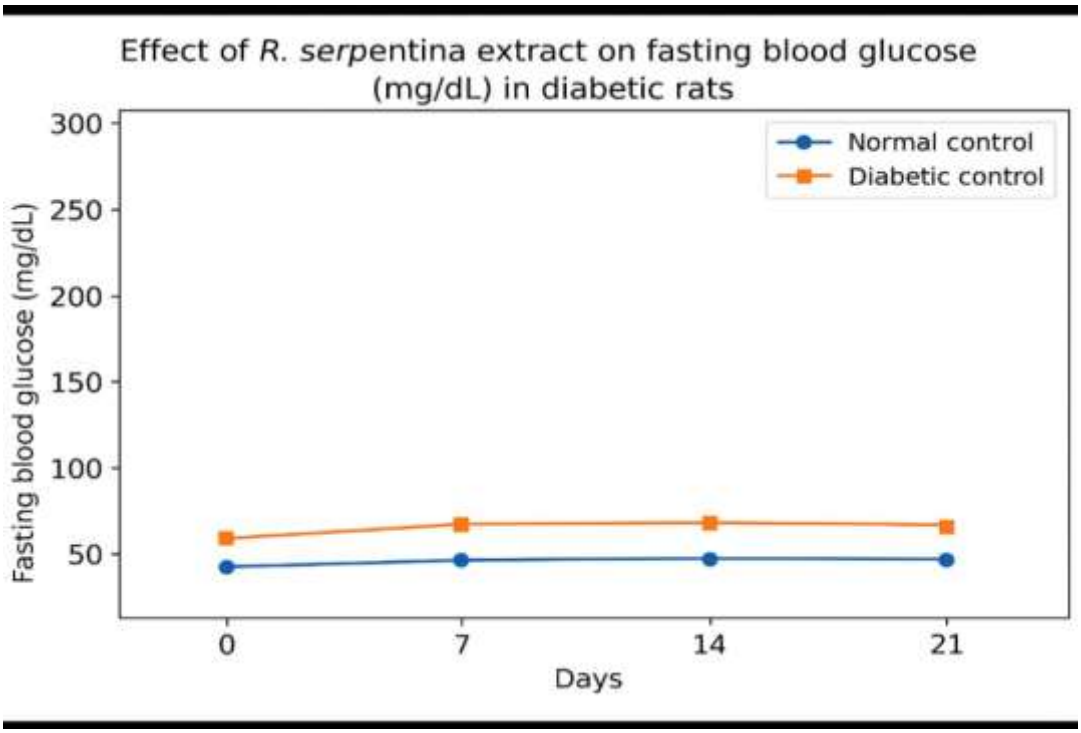

**In Vivo Antidiabetic Activity**

STZ-induced diabetic rats showed a significant increase in fasting blood glucose compared to the normal group. Treatment with R. serpentina extract at 200 and 400 mg/kg resulted in a marked reduction in blood glucose over 21 days, comparable to metformin.

Table 3. Effect of R. *serpentina* extract on fasting blood glucose (mg/dL) in diabetic rats

| Groups | Day 0 | Day 7 | Day14 | Day 21 |
|---|---|---|---|---|
| | | | | |
| Normal control | 92.6 ± 3.5 | 93.8 ± 4.1 | 94.2 ± 3.9 | 92.4 ± 3.6 |
| Diabetic control | 276.4 ± 6.2 | 288.3 ± 6.8 | | |

Fig. 3 . Effect of R. serpentina extract on fasting blood glucose (mg/dL) in diabetic rats




## DISCUSSION

The enzyme inhibition assays revealed that R. serpentina extract significantly suppressed α-amylase and α-glucosidase activity in a concentration-dependent manner, which supports its potential to control postprandial hyperglycemia (Patel et al., 2021; Subramanian et al., 2023). This aligns with studies highlighting the role of polyphenol-rich extracts in moderating carbohydrate metabolism.

The in vivo findings showed a significant reduction in fasting blood glucose and improved lipid profiles in treated groups compared to diabetic controls. These results are in line with prior research indicating the insulin-mimetic and lipid-lowering effects of phytoconstituents from medicinal plants (Agrawal et al., 2023; Kumar et al., 2022). The observed increase in HDL and decrease in LDL further suggest a cardioprotective role of the extract, which is crucial given the high incidence of dyslipidemia in diabetes patients (Akintelu & Folorunso, 2020).

## CONCLUSION

This study validates the ethnomedicinal use of R. serpentina as an antidiabetic plant. The extract demonstrated significant α-amylase and α-glucosidase inhibition in vitro and showed hypoglycemic and lipid-lowering effects in vivo, making it a potential complementary therapy for diabetes (Agrawal et al., 2023; Kumar et al., 2022). Sustainable conservation of this endangered species is critical for ensuring its availability for future pharmacological applications (WHO, 2022).

**Future Perspectives:**

While the current findings highlight the therapeutic promise of *Rauvolfia serpentina* in diabetes management, further research is warranted to establish its clinical relevance. Future studies should focus on the isolation

and characterization of active phytoconstituents responsible for the antidiabetic effects, with particular attention to alkaloids and flavonoids that exhibit enzyme-inhibitory and hypoglycemic activity.

Advances in nanotechnology-based drug delivery could be explored to enhance the bioavailability and stability of R. *serpentina* extracts. Green-synthesized nanoparticles loaded with phytochemicals may provide targeted, sustained, and more effective therapeutic outcomes compared to crude extracts.

Additionally, preclinical safety assessments and human clinical trials are essential to determine appropriate dosages, efficacy, and long-term safety. Standardization of extract formulations, along with pharmacokinetic and pharmacodynamic profiling, will also be critical in developing reliable plant-based therapeutics.

Given that R. *serpentina* is an endangered species, conservation strategies, such as micropropagation, sustainable harvesting, and community-based cultivation, should be prioritized to ensure its availability for future medicinal applications.

Overall, integrating traditional knowledge with modern pharmacological, biotechnological, and conservation approaches will pave the way for R. *serpentina* to emerge as a valuable plant-derived antidiabetic therapeutic.

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