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UNLOCKING THE THERAPEUTIC POTENTIAL OF *SARPAGANDHA* (*RAUWOLFIA SERPENTINA*): A COMPREHENSIVE ANALYSIS OF ROOT PROPERTIES

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ABSTRACT

Sarpagandha (*Rauvolfia serpentina*), a critical component of traditional medicine, is well- known for its therapeutic efficacy in managing hypertension, mental illness, and neurological disorders. This study presents a comprehensive analysis of *Sarpagandha* root, focusing on its taxonomic identity, morphology, microscopic anatomy, phytochemical composition, extraction methods, and quality control standards. Comparative analysis with *Rauvolfia tetraphylla*—a commonly used substitute—reveals significant similarities in alkaloidal content, particularly reserpine and ajmalicine. Results confirm the plant's pharmacological significance, highlight the superior efficiency of hydro-alcoholic extraction, and establish TLC fingerprinting as a reliable tool for authentication. Conservation of *R. serpentina*, now endangered, remains an urgent priority alongside the development of sustainable alternatives.

1. INTRODUCTION

Medicinal plants have long served as the backbone of healthcare systems across the globe, with India's Ayurveda system offering particularly rich insight into botanical therapies. One of the most potent plants in this tradition is *Sarpagandha* (*Rauvolfia serpentina*), a member of the Apocynaceae family, used traditionally for the treatment of hypertension, schizophrenia, and snakebite envenomation (Chopra et al., 1956; WHO, 2002).

The pharmacological efficacy of *R. serpentina* arises primarily from its root, rich in indole alkaloids like reserpine, ajmaline, and serpentine (Seth & Sharma, 2004). Despite its historical use and proven benefits, the species faces ecological challenges and has been classified as endangered in many regions (Nayar & Sastry, 1987). This has led to increased use of *Rauvolfia tetraphylla*, or Vanasarpagandha, a close relative with comparable therapeutic properties but differing in morphology and regional availability.

Given the importance of both pharmacological efficacy and botanical authenticity, this study aims to conduct an advanced analysis of *Sarpagandha* root, evaluating its identification markers, extraction efficiency, phytochemical profile, and comparative potential with *R. tetraphylla*.

2. MATERIALS AND METHODS

2.1 Botanical Identification

Authenticated samples of *R. serpentina* and *R. tetraphylla* were sourced from certified herbal nurseries in India. Identification was confirmed using floristic keys and cross-referenced with herbarium specimens deposited at the Botanical Survey of India.

2.2 Morphological and Microscopic Analysis

Morphological characteristics (root length, diameter, color, bark texture) were recorded. For microscopic analysis, transverse sections were stained with safranin and fast green, and examined under light microscopy to identify key tissues such as cork, secondary cortex, xylem, and calcium oxalate crystals (Kokate et al., 2004).

2.3 Extraction Techniques

Two extraction methods were used:

- **Hydro-alcoholic Reflux Extraction**: 50:50 ethanol-water solvent heated to 80–85°C for 6 hours.
- **Aqueous Maceration**: Powdered roots soaked in distilled water for 24 hours at room temperature.

Rotary evaporation at 40–50°C was used for concentration. Final yields were calculated using:

$$\text{Extraction Yield (\%)} = (\text{Weight of dried extract} \times 100) / \text{Weight of raw material}$$

2.4 Physicochemical and Phytochemical Testing

Parameters like loss on drying, total ash, acid-insoluble ash, and pH of 10% aqueous extract were measured as per WHO guidelines (WHO, 1998). Phytochemical screening included:

- **Alkaloids**: Dragendorff's, Mayer's, Hager's, and Wagner's tests
- **Tannins**: Ferric chloride and lead acetate tests
- **Steroids**: Liebermann–Burchard test
- **Carbohydrates**: Molisch's and Fehling's tests

2.5 TLC Fingerprinting

TLC was carried out on Silica gel 60 F254 plates using Toluene:Ethyl acetate:Diethylamine (7:2:1) as mobile phase. Visualization was performed under UV (254 nm) and with Dragendorff's reagent. Rf values of reserpine and ajmalicine were recorded and compared with standard references.

3. RESULTS

3.1 Morphological and Microscopic Features

R. serpentina roots were subcylindrical, 5–15 cm long and 0.5–2 cm thick, with a twisted, tortuous appearance and grayish-brown bark. Microscopy revealed a stratified cork, isodiametric parenchyma, uniseriate medullary rays, and prominent prismatic calcium oxalate crystals, aiding species authentication (Kokate et al., 2004).

3.2 Extraction Efficiency

Extraction Type	Solvent	Yield (% w/w)
Hydro-alcoholic	50:50 EtOH:Water	0.125
Aqueous	Water	0.061
Acidified Alcoholic	EtOH + 1% HCl	0.189 (↑50%)

Hydro-alcoholic extraction showed significantly higher alkaloid yield than water extraction. Acidified ethanol improved yield further by enhancing alkaloid solubility (Ghosal et al., 1971).

3.3 Physicochemical Properties

Parameter	R. serpentina	R. tetraphylla
Loss on drying	6.31–6.87%	~6.10%
Total ash	3.14–3.49%	0.80%
Acid-insoluble ash	0.17%	—
pH (10% aqueous solution)	5.55-6.01	—
Water-soluble extractive	5.52%	10.93%
Alcohol-soluble extractive		4.34%

3.4 Phytochemical Screening

Both species tested positive for:

- **Alkaloids** (confirmed via Dragendorff's and Mayer's)
- **Tannins**
- **Steroids**
- **Reducing sugars**

However, R. serpentina roots showed stronger alkaloid reactions, consistent with their traditional use and pharmaceutical preference.

3.5 TLC Fingerprinting

The Rf value for reserpine was 0.69. Dragendorff's spray produced distinctive orange spots on both species' plates, confirming alkaloid presence. Fluorescence under UV further verified compound profiles.

4. DISCUSSION

This study affirms the phytochemical and pharmacological richness of *R. serpentina*, particularly its root, which is rich in reserpine—a key antihypertensive compound that revolutionized psychopharmacology in the 20th century (Vakil, 1949).

Microscopic features like cork layering, calcium oxalate crystals, and medullary rays provide reliable anatomical markers for authentication. Comparative analysis with *R. tetraphylla* highlights their chemical similarities, validating its use as a substitute, especially in the context of conservation challenges (Bhutani & Gohil, 2009).

Hydro-alcoholic and acidified ethanol extractions outperform aqueous methods in extracting active alkaloids, supporting their use in standardized pharmaceutical production. TLC fingerprinting proves to be a cost-effective and dependable tool for routine quality control, especially for ensuring the presence of key alkaloids like reserpine and ajmalicine (Chattopadhyay & Bhattacharya, 2004).

Despite their interchangeability in some cases, the endangered status of *R. serpentina* underscores the need for cultivation, propagation, and sustainable harvesting policies, combined with chemical standardization to prevent therapeutic variability in herbal formulations (Nayar & Sastry, 1987; WHO, 2002).

5. CONCLUSION

The root of *Rauvolfia serpentina* remains one of the most pharmacologically potent plant parts in traditional and modern medicine. Its complex alkaloidal composition—led by reserpine—explains its diverse therapeutic applications, particularly in the management of hypertension and mental disorders. Through rigorous macroscopic, microscopic, and phytochemical analyses, this study reaffirms the plant's medicinal value and the importance of quality control through TLC fingerprinting.

Substitution with *R. tetraphylla* offers a practical solution for conservation but demands strict pharmacological equivalence testing. Future directions should include DNA barcoding, clinical validation of substitutes, and cultivation strategies for preserving this critical botanical resource.

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