अवधारणा {AWADHARANA}
{A Peer-Reviewed Multidisciplinary, Open Access & NepJOL Indexed Journal}
Volume 9, 2025 {Print ISSN: 2505-080x}
Email: loktantrik066@gmail.com
URL: https://nepjol.info/index.php/awadharana

Publisher
Creative Democrat Academy

Ethnobotanical Uses, Phytochemical Insights, and Therapeutic Potential of *Calotropis* Species in Nepal

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Article History:
Received 22 July 2025, Reviewed 23 August 2025, Accepted 12 October 2025

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DOI : https://doi.org/10.3126/awadharana.v9i1.86206

Abstract

Calotropis procera and *Calotropis gigantea* are prominent medicinal plants distributed across the lowlands (below 1000 m elevation) in Nepal and wider in South Asia. They hold long-standing ethnomedicinal value, particularly in the treatment of skin infections, digestive disorders, respiratory conditions, pain, and wound healing. This review synthesizes published ethnobotanical records, phytochemical studies, and traditional knowledge to provide an overview of their medicinal importance in Nepal. Reported bioactive compounds, including glycosides, flavonoids, alkaloids, phenolics, and terpenoids, are associated with anti-inflammatory, antimicrobial, analgesic, and regenerative properties. The latex, while therapeutically significant, also contains toxic principles that necessitate caution and standardized dosage. Overall, the evidence highlights both the therapeutic promise and the potential risks of *Calotropis* species, underscoring the need for further pharmacological validation and safety-focused research in the Nepalese context.

Keywords: Ethnomedicine, Phytochemistry, Pharmacology, Toxicity, Bioactivity

Introduction

Medicinal plants are among the most enduring pillars of healthcare systems worldwide. The World Health Organization (WHO, 2013) estimates that nearly 80% of the global population relies on herbal remedies as a primary source of treatment. In Nepal, where geographical barriers and limited infrastructure often restrict access to modern medical services, traditional plant-based medicine remains essential. The country's remarkable biodiversity and rich cultural traditions have fostered a long-standing heritage of ethnobotanical knowledge that continues to support rural and indigenous communities (Kunwar et al., 2010).

Within this ethnomedicinal context, the genus *Calotropis* locally known as "Aank" or "Madar" holds a distinctive place due to its therapeutic, cultural, and religious significance. Belonging to the family Apocynaceae, *Calotropis* in Nepal is represented primarily by two species: *Calotropis procera* and *Calotropis gigantea*. These hardy, drought-tolerant shrubs are commonly found in the Terai and inner Terai regions, where they establish themselves in open, sunlight, well-drained soils. They frequently colonize marginal or disturbed habitats, including roadside areas, abandoned fields, sandy riverbanks, and other degraded landscapes (Phytomed Nepal, n.d.; Joshi, 2000). *C. procera* typically occurs in drier, arid zones, whereas *C. gigantea* favors slightly more humid lowlands and is culturally significant, as its flowers are traditionally used in Hindu rituals (Kirtikar & Basu, 1987). Both species demonstrate remarkable ecological resilience, tolerating drought, saline soils, and heavy grazing, which enables them to thrive in areas where many plants cannot. However, their aggressive proliferation has led some local farmers to regard them as invasive weeds (Khan et al., 2022).

Figure 1 *Calotropis* Species

Morphologically, *Calotropis* species are perennial shrubs or small trees, generally attaining heights of 2–4 m. The leaves are oppositely arranged, sessile, thick, broadly ovate, and covered with fine hairs, giving a velvety texture. Inflorescences occur in clusters, with flowers ranging from white to lilac and often displaying purple streaks. Fruits develop as large, inflated follicles that split upon maturity, releasing numerous seeds attached to silky hairs that aid wind dispersal (Planet Ayurveda, 2019). Specifically, *C. procera* tends to be a shorter shrub (1–2 m), with broad, fleshy, heart-shaped leaves, white to pale lilac flowers, and highly caustic latex that requires careful handling (Adhikari, 2055 BS). *C.*

gigantea is usually taller and more erect, bears larger leaves, and produces pale violet flowers that are culturally significant and frequently offered in religious ceremonies.

Ethnobotanical studies reveal that different plant parts—including latex, leaves, flowers, roots, and stems have been traditionally employed to manage a wide spectrum of health conditions such as skin infections, digestive and respiratory disorders, rheumatism, pain, and inflammatory diseases (Acharya & Pokhrel, 2006; Pandey et al., 2013). The latex, while therapeutically valuable, also contains toxic constituents, illustrating the dual nature of Calotropis as both a medicinal and potentially hazardous plant (Mukherjee et al., 2020). Phytochemical analyses have identified several bioactive compounds, including cardenolides, glycosides, flavonoids, alkaloids, phenolics, and terpenoids, which are associated with antimicrobial, anti-inflammatory, analgesic, wound-healing, and cytotoxic properties (Singh & Kumar, 2013). These findings provide scientific support for traditional practices, yet they also highlight significant research gaps. In Nepal, systematic pharmacological validation, toxicological assessment, dosage standardization, and conservation-oriented management remain limited.

Given this context, the present review aims to synthesize knowledge on the ethnobotanical applications, phytochemical composition, and medicinal relevance of *Calotropis* species in Nepal. The specific objectives are:

1. To document the traditional ethnobotanical uses of *Calotropis procera* and *Calotropis gigantea* in Nepal.
2. To summarize reported phytochemical constituents from different plant parts.
3. To evaluate their therapeutic properties in relation to traditional and modern applications.
4. To identify existing knowledge gaps and emphasize the need for pharmacological validation, toxicity assessment, and conservation strategies.

Materials and Methods

This study is a literature-based review aimed at synthesizing existing information on the ethnobotanical uses, phytochemical composition, and medicinal properties of *Calotropis* species in Nepal. No new field surveys or laboratory experiments were conducted; instead, data were collated from published studies, ethnobotanical books, Ayurvedic texts, and documented traditional knowledge reported in prior literature.

Literature Search and Selection

A systematic search of online databases (Google Scholar, PubMed, Scopus) and printed references was conducted using keywords such as "*Calotropis*," "ethnobotany," "medicinal uses," "phytochemistry," and "pharmacological activity." Sources were selected based on relevance to Nepalese ethnomedicine, phytochemical composition, or pharmacological evaluation. Reports describing traditional usage by local healers,

communities, or Ayurvedic practitioners were included to capture indigenous knowledge, as documented in prior studies (Acharya & Pokhrel, 2006; Pandey et al., 2013; Joshi, 2000).

Data Extraction and Synthesis

Information on the following aspects was extracted from the selected literature:

Ethnobotanical Uses

Traditional applications of different plant parts (latex, leaves, flowers, roots, and bark), preparation methods, and therapeutic purposes.

Phytochemical Composition

Bioactive compounds identified in prior laboratory analyses, including cardiac glycosides, flavonoids, phenolics, alkaloids, terpenoids, and proteolytic enzymes.

Pharmacological Activities

Documented biological effects, including anti-inflammatory, analgesic, antimicrobial, wound-healing, and cytotoxic properties.

Dosage and Safety

Information on reported dosage practices and toxicological considerations, as documented in traditional knowledge sources.

Information on Traditional Knowledge

The review incorporates ethnobotanical knowledge reported in literature, reflecting practices of local healers, Baidhyas, and indigenous communities. While no new interviews or field verification were performed, the documentation draws upon credible sources that have previously reported indigenous uses of *Calotropis* in Nepal. This approach ensures that both cultural insights and scientific data are represented while maintaining the reliability of the study.

Results

This review research demonstrated that *Calotropis* species, notably *C. procera* and *C. gigantea*, hold a prominent place in traditional healthcare practices across Nepal. They are widely recognized for their therapeutic versatility, with different parts of the plant latex, leaves, flowers, roots, and bark employed in the treatment of various ailments. These practices, documented in ethnobotanical sources and traditional knowledge accounts, highlight both the medicinal potential and the caution required in their use.

Ethnobotanical Uses

The milky latex of *Calotropis* is one of its most notable components. Traditionally, it has been applied externally to manage dermatological conditions such as eczema, ringworm, boils, and hemorrhoids. In controlled micro-doses, it has also been used to treat gastric ulcers. Due to its caustic and toxic nature, the latex must be handled with care, as improper application may lead to severe irritation or poisoning.

The leaves of *Calotropis* are generally broad, fleshy, and velvety, and are commonly employed as heated poultices. These are applied to relieve localized pain, joint inflammation, rheumatism, insect bites, and, in some cases, snakebites. The use of leaves in this way reflects their perceived anti-inflammatory and antitoxic properties, as well as a simple yet effective form of indigenous physiotherapy.

Flowers, although primarily considered sacred and used in religious offerings, are also consumed in the form of decoctions to aid digestion, relieve flatulence, and manage respiratory conditions such as asthma. The dual cultural and therapeutic role of the flowers illustrates the integration of medicinal and social practices within Nepalese communities.

Roots and bark are incorporated into various traditional formulations. Decoctions of these parts are reported to reduce fever, treat dysentery, soothe gastric ulcers, and act as anti-helminthic remedies, supporting gastrointestinal health and overall well-being.

Dosage practices, as described in traditional accounts, are carefully calibrated to balance therapeutic benefits with safety. Powdered plant parts are usually taken orally in small amounts, while latex is used sparingly for external applications. Fresh leaf juice may occasionally be instilled in the ear for earache relief, and heated leaves are applied directly to swollen joints or inflamed areas to alleviate discomfort. These practices reflect the indigenous understanding of both efficacy and toxicity.

Phytochemical Constituents and Pharmacological Significance

A review on phytochemical literature reveals that *Calotropis* species contain a diverse array of bioactive compounds, which provide a scientific basis for their traditional uses. Cardiac glycosides such as calotropin, usharin, and calactin contribute to the therapeutic effects of the plant, particularly on inflammatory and cardiovascular systems, while simultaneously accounting for potential toxicity. Flavonoids and phenolic compounds impart antioxidant properties, reducing oxidative stress and promoting tissue repair. Alkaloids and terpenoids exhibit antimicrobial, anti-inflammatory, and analgesic activities, supporting traditional applications in infection control, pain relief, and wound management. Proteolytic enzymes present in latex, similar to papain, facilitate protein degradation, accelerate wound healing, reduce swelling, and assist in clearing necrotic tissue.

Integration of Traditional Knowledge and Literature Data

By combining ethnobotanical knowledge documented in previous studies with phytochemical information from the literature, a comprehensive understanding emerges. *Calotropis* species are validated as therapeutic plants with analgesic, antimicrobial, anti-inflammatory, and wound-healing properties. At the same time, the inherent toxicity of certain plant components, particularly latex, emphasizes the importance of careful handling, accurate dosage, and preparation.

Overall, the synthesized findings indicate that *Calotropis* represents a highly valuable medicinal resource within Nepalese traditional healthcare systems. Its long-standing use is supported by bioactive compounds identified in literature, illustrating a convergence between traditional knowledge and scientific understanding. However, the dual nature of its medicinal and toxic properties underscores the need for standardized usage guidelines, further pharmacological studies, and safety evaluations to ensure both efficacy and protection from adverse effects.

Discussion

Calotropis species pays a significant contribution within Nepalese ethnomedicine, where they function as an important therapeutic resource for rural and indigenous communities.

Ethnomedicinal Significance in Nepal

Calotropis procera and *C. gigantea* have been integral part to traditional healthcare practices in Nepal. Ethnobotanical studies have documented their use in treating a variety of ailments, including dermatological conditions, gastrointestinal disorders, and respiratory issues. For instance, the latex of *C. gigantea* is applied to manage skin diseases, while the root bark of *C. procera* is utilized for its antidiarrheal properties (Baral and Kurmi, 2006).

Phytochemical Profile and Pharmacological Activities

Phytochemical analyses have revealed that both *C. procera* and *C. gigantea* contain a diverse array of bioactive compounds. These include cardiac glycosides, flavonoids, terpenoids, alkaloids, saponins, and phenolic compounds. Presence of these compounds supports the traditional uses of these plants in treating inflammation, microbial infections, digestive issues, and wounds. For example, flavonoids and terpenoids exhibit anti-inflammatory and antioxidant activities, while cardiac glycosides contribute to their therapeutic effects on the cardiovascular system (Jamal et al. 2025).

Toxicity Concerns and Safety Measures

Despite their medicinal benefits, the latex of *Calotropis* species contains toxic compounds, including alkaloids and resins, which can cause adverse effects if misused. Accidental ocular exposure to the latex has led to severe corneal toxicity and vision impairment. Such incidents highlight the necessity for cautious handling and application of

these plants. Traditional knowledge emphasizes the importance of proper dosage and preparation methods to mitigate potential risks (Huda et al. 2019).

Cross-Regional Ethnomedicinal Practices

The use of *Calotropis* species extends beyond Nepal, with similar applications reported in neighboring countries like India and Pakistan, as well as in various African nations. In these regions, *Calotropis* is employed for treating skin disorders, febrile conditions, and rheumatism. This cross-regional utilization suggests a shared ethnomedicinal heritage and underscores the universal recognition of the plant's therapeutic potential (Wadhwani et. al., 2021).

Research Gaps and Need for Scientific Validation

While traditional knowledge provides valuable insights into the medicinal uses of *Calotropis*, there is a paucity of rigorous scientific studies to validate these claims. Most existing data are derived from ethnobotanical surveys or preliminary in vitro experiments. Comprehensive clinical trials, standardized dosage formulations, and detailed toxicity assessments are essential to establish the safety and efficacy of these plants in modern medicine.

Conservation Issues and Sustainable Practices

Increasing demand for *Calotropis* species has raised concerns about overharvesting and the sustainability of wild populations. In Nepal, where these plants are predominantly collected from the wild, there is a risk of depleting natural stands, especially in degraded landscapes where *Calotropis* thrives. To ensure the long-term availability of these plants, it is crucial to implement sustainable harvesting practices, promote cultivation, and integrate conservation efforts with community livelihoods.

Cultural and Spiritual Importance

Beyond their medicinal uses, *Calotropis* species hold significant cultural and spiritual value in Nepal. The flowers of *C. gigantea* are considered sacred offerings to Lord Shiva and are used in religious ceremonies. This cultural reverence contributes to the conservation of these plants, as communities often protect species that hold spiritual significance.

Conclusion

Calotropis species are invaluable medicinal plants in Nepal, combining ethnomedicinal relevance, bioactive phytochemicals, and cultural significance. Their therapeutic applications are supported by compounds such as cardiac glycosides, flavonoids, terpenoids, and proteolytic enzymes, while their toxic latex put extra emphasis on the need for careful handling. Cross-regional use confirms a shared empirical foundation, yet gaps remain in standardized dosage, clinical validation, and toxicity assessment. Sustainable harvesting, cultivation, and conservation are crucial for preserving these species. Future multidisciplinary

research will be essential to translate traditional knowledge into safe, effective, and sustainable modern healthcare applications.

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