



Bioactive Compounds and Pharmacological Potential of *Calotropis Gigantea*: A Comprehensive Review

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ABSTRACT

The traditional medicinal applications of the perennial herb *Calotropis gigantea* are widely recognized. It has been successfully utilized for a long time within the Siddha, Ayurveda, and Unani medical systems. Every part of the plant is utilized in medicine because of its diverse properties, including analgesic, anthelmintic, astringent, anti-inflammatory, wound-healing, sedative, anti-asthmatic, antimicrobial, antioxidant, procoagulant, hepatoprotective, hypoglycemic, and pregnancy-interceptive effects. For example, the plant's leaves, latex, flowers, stem bark, and roots are utilized as expectorants and depilatory treatments for leprosy, scalp scabies, skin eruptions, hemorrhoids, asthma, hepatosplenomegaly, and painful joint swelling. This plant is an excellent choice for the pharmaceutical industry's modern drug manufacturing due to its ability to treat various conditions, including tumors, ulcers, and piles. *Calotropis gigantea* belongs to the Apocynaceae family. The plant's pharmacological properties are attributed to phytochemical components such as alkaloids, triterpenoids, flavonoids, saponins, steroids, alcohols, fatty acids, calotropeol esters, glycosides, and proteases. Moreover, the chemical structures and therapeutic activities of *Calotropis gigantea* are strongly correlated. Consequently, this review summarizes its pharmacological activity, ethnobotanical characteristics, and phytochemical composition.

Keyword: *Calotropis gigantea*, bioactive compound, calotropagenin, Anticancer activity.

INTRODUCTION

Medicinal plants are those that offer therapeutic benefits or exert favorable pharmacological effects on an animal's body. Plants that typically produce and accumulate small amounts of optional metabolites such as tannins, volatile oils, alkaloids, glycosides, minerals, and nutrients have demonstrated therapeutic properties [1]. Each component of the medicinal plant possesses unique properties utilized for specific applications [2]. Numerous medicinal plants have been successfully studied using the integrative drug development approach [3]. In ancient Ayurvedic medicine, the herb *Calotropis gigantea* is known as "Sweta Arka" [4]. *Calotropis gigantea* is a flowering plant within the Apocynaceae family. It is also referred to as Akada, Madar, Aakh, among others [5]. The plant is a small evergreen or semi-deciduous tree or shrub characterized by soft wood. Most of the leaves are located near the growing tips. Shrubs frequently boast a profusion of leaves. As the plant develops a more tree-like structure, it creates an airy crown featuring a few twisted limbs [6]. *Calotropis gigantea*, also called giant milkweed, is a prevalent weed in desert regions. This plant is indigenous to India, Bangladesh, Burma, China, Indonesia, Malaysia, Pakistan, the Philippines, Thailand, and Sri Lanka. The plant features oval, light green leaves, a milky stem, and clusters of waxy white or lavender flowers. *C. gigantea* is widely available and utilized for various medicinal applications in traditional Indian medicine. Scientists have recently reported numerous medicinal benefits of *C. gigantea*. It is claimed that the blooms possess analgesic, cytotoxic, and antibacterial properties. Studies have shown that the plant's leaves and aerial parts exhibit antidiarrheal, antibacterial, anti-candida, and antioxidant properties. The roots are reported to possess wound-healing, central nervous system, antipyretic, cytotoxic, antimicrobial, insecticidal, and load-blocking properties. Research has demonstrated that plant latex possesses laxative, procoagulant, antimicrobial, and wound-healing properties. Reports have emerged regarding the hepatotoxic effects of stem.

Cancer incidence is rising continuously across all populations, making it one of the world's most significant health challenges. Utilizing effective screening methods enhances both patient outcomes and the prognosis for cancer. Screening programs aim to identify individuals at risk or in the early stages of cancer development to enable prompt intervention and treatment initiation [7]. Despite advancements in screening techniques, the quest for novel anticancer bioactive compounds derived from medicinal plants continues. *C. gigantea*, a medicinal plant indigenous to numerous regions worldwide, has garnered significant interest due to its abundant phytochemicals and potential therapeutic applications in cancer treatment. The pharmacological properties and anticancer potential of *C. gigantea* have been extensively studied. Bioactive substances target multiple signaling pathways involved in cancer initiation and progression, including angiogenesis, metastasis, apoptosis, and cell proliferation. Due to their ability to modify these pathways, chemicals derived from *C. gigantea* hold promise as novel therapeutic agents for cancer treatment. Its pharmacological properties and anticancer potential have been the subject of extensive research. The plant contains diverse bioactive compounds, such as alkaloids, flavonoids, glycosides, and terpenoids, which exhibit various biological activities, including anticancer effects [8].

Plant Profile



Figure no :1 *calotropis gigantea*

Botanical Description:

Calotropis gigantea, a flowering member of the Apocynaceae family, is also known as the "Crown Flower" or "Giant Milkweed". It is a hardy perennial plant that thrives in tropical and subtropical climates. According to Ananda U. In 2020, it was noted that this plant is commonly found along roadsides, in wastelands, and in dry, arid environments.

Calotropis gigantea typically grows to a height of two to four meters. Its leaves are oval-shaped, thick, pale green, and coated with a waxy layer. This plant is called the "Crown Flower" due to its large, beautiful blooms featuring five petals, a crown-like center, and a pale purple or lavender color. The stems are covered in a milky latex that is toxic if ingested.

Taxonomy:

Kingdom	Plantae
Phylum	Angiosperms
Class	Edicots
Order	Gentianales
Family	Apocynaceae
Genus	Calotropis
Species	<i>Calotropis gigantea</i>



Phytochemistry Of *Calotropis Gigantea*:

Sr. No.	Class	Example of Active Constituents
1	Alkaloids	Calotropin, gigantins, uscharin
2	Flavonoids	Quercetin, kaempferol. ^[9]
3	Cardiac Glycosides	Calotropagenin, Calotoxin, calactin.
4	Triterpenoids	Lupeol, α -amyirin, β - amyirin. ^[10]
5	Steroids	Stigmasterol, β -sitosterol
6	Phenolic Compounds	Tannins, gallic acid. ^[11]
7	Other Secondary Metabolites	Such as Saponins, Coumarins, Resins, Proteolytic Enzymes, and Latex Enzymes. ^[12]

Pharmacological Activities

Sr.no	Name of the activity	Description
1.	Anticancer activity	<p>Enzymatic assays are required to elucidate the targeted mechanisms of action of bioactive compounds from <i>C. gigantea</i> against cancer. These tests utilize purified enzymes or their substrates to assess how plant extracts or chemicals inhibit specific molecular targets involved in cancer development. For example, assays targeting vital enzymes involved in angiogenesis, metastasis, apoptosis, and cell cycle regulation provide crucial insights into the potential molecular targets of <i>C. gigantea</i> drugs ^[13]. By analysing their enzymatic inhibitory profiles, researchers can elucidate these compounds' mechanisms of action and therapeutic potential in cancer treatment.</p> <p>The anticancer activity of <i>C. gigantea</i> compounds is attributed to their capacity to modulate various molecular pathways involved in tumor genesis and progression. A primary mechanism driving their anticancer effects is the induction of apoptosis, or programmed cell death, within cancer cells ^[14]. Compounds from <i>C. gigantea</i> have been demonstrated to trigger both intrinsic and extrinsic apoptotic pathways, resulting in the targeted destruction of cancer cells while preserving normal cells. Furthermore, these compounds demonstrate anti-proliferative activity by blocking cell cycle progression and triggering arrest at specific checkpoints, including the G0/G1, S, or G2/M phases ^[15]. By interfering with cell cycle regulation, <i>C. gigantea</i> compounds inhibit uncontrolled cell proliferation, a defining characteristic of cancer.</p>



2.	Antimicrobial Activity	Aqueous, methanolic, and ethanolic extracts of <i>C. gigantea</i> leaves have been shown to effectively inhibit clinical isolates of <i>Candida albicans</i> , <i>Candida krusei</i> , <i>Candida parapsilosis</i> , and <i>Candida tropicalis</i> . Additionally, aqueous leaf extracts have been shown to exhibit antibacterial activity against <i>Pseudomonas aeruginosa</i> , <i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> , <i>Bacillus cereus</i> , <i>Staphylococcus aureus</i> , and <i>Micrococcus luteus</i> [16]. Additionally, It exhibits antifungal properties against specific plant-pathogenic fungi, including <i>Fusarium mangiferae</i> . Ethanolic leaf extracts of <i>C. gigantea</i> demonstrated antifungal activity against <i>Aspergillus niger</i> , with a minimum inhibitory concentration (MIC) of 7.5 mg/mL [17]. <i>C. gigantea</i> serves as a potent antibacterial agent, demonstrated by its plant extract's ability to inhibit bacteria and fungi, which are responsible for various ailments such as skin infections, diarrhoea, and respiratory tract infections [18].
3.	Analgesics Activity	It has been reported that an alcoholic extract of <i>C. gigantea</i> flowers exhibits analgesic effects in mice under both chemical and thermal conditions. Analgesic activity was assessed using the HPM and the acetic acid-induced writhing test [20]. Oral administration of an ethanolic extract from <i>C. gigantea</i> flowers significantly reduced writhing and delayed paw licking. The analgesic effects of an alcoholic extract from the peeled roots of <i>Calotropis gigantea</i> were assessed in albino rats. It was demonstrated that both Eddie's hot plate method and the writhing induced by acetic acid served as measures of analgesia. Oral administration of the root extract at doses of 250 and 500 mg/kg significantly decreased both the number of writhes and the duration of paw licking [21].
4.	Anti-inflammatory Activity	The anti-inflammatory properties of <i>Calotropis gigantea</i> were assessed through various experimental animal models. The properties of <i>Calotropis gigantea</i> leaf extracts in ethanol, n-butanol, chloroform, and distilled water were investigated. This activity was compared to that of the common drug paracetamol using the carrageenan-induced rat paw edema method [22]. Conversely, a model of adjuvant-induced arthritis is used to evaluate anti-inflammatory effects in chronic inflammation, while carrageenan-induced kaolin-induced rat paw edema is employed for acute inflammation [23]. Additionally, it has been demonstrated that the albumin denaturation method possesses anti-inflammatory properties [24].
5.	Antioxidant Properties	The calotropis plant's scavenging capabilities are thought to stem from its high antioxidant content [25]. Plants exhibit antioxidant properties because they contain phenolic or flavonoid compounds. The antioxidant capacity of the ethanolic flower extract of <i>Calotropis</i> was evaluated using hydrogen peroxide and hydroxyl radical assays at different concentrations. This plant possesses antioxidant properties due to its content of terpenoids and flavonoids. [26]
6.	Wound Healing Applications	The wound-healing potential of <i>Calotropis</i> root bark was assessed in rats using excision, dead space, and incision wound models. The percentage of wound closure, the duration of epithelialization, and the appearance of the scar area after full epithelialization were all analyzed. Topical application of <i>Calotropis</i> to the wound model increased the concentration of the wound. It reduced the size and duration of scars while enhancing the ability to heal wounds [27].
7.	CNS Activity	CNS activity was investigated orally in albino rats at dosage levels of 250 and 500 mg/kg body weight using an alcohol extract of peeled roots of <i>Calotropis gigantea</i> R.Br. (Asclepiadaceae). Eddy's hot plate technique and acetic acid-induced writhings both shown significant analgesic effect. The paw-licking duration was extended, and the quantity of writhings was drastically reduced. Significant anticonvulsant action was seen as there was a delay in the start and a decrease in

		the severity of pentylenetetrazole-induced convulsions. The rats given the extract spent more time in the open arm of EPM, demonstrating its antianxiety action. There was a reduction in locomotor activity. ^[29] The time it took to fall off (motor coordination) was also reduced. There was a reduction in locomotor activity. The time it took to fall off (motor coordination) was also reduced. The extract's sedative action resulted in a potentiation of pentobarbitone-induced sleep. ^[30] There was no mortality up to a dosage of 1 g/kg. These findings demonstrate the extract's analgesic, anticonvulsant, anxiolytic, and sedative properties.
8.	Insecticidal Properties	Various strains of <i>Tribolium castaneum</i> larvae and adults were evaluated for residual film toxicity, fumigant, and repellent efficacy using methanol extract, petroleum ether fraction, and chloroform derived from <i>Calotropis gigantea</i> root bark, with the methanolic extract demonstrating superior insecticidal activity while no samples exhibited fumigant toxicity ^[28] .
9.	Pregnancy interceptive effects	The contraceptive potential of <i>C. gigantea</i> root extracts was evaluated in rats using various organic solvents. The extract demonstrated 100% efficacy in preventing pregnancy at a dosage of 100 mg/kg. Furthermore, the extract demonstrated 100% efficacy when administered at a dose of 12.5 mg/kg on days 1–5 and 1–7 postcoitum ^[29] .

CONCLUSION

Calotropis gigantea is a medicinally significant plant abundant in diverse bioactive compounds, including flavonoids, alkaloids, phenolics, and terpenoids, which account for its extensive pharmacological activities. Current research confirms its antioxidant, anti-inflammatory, antimicrobial, and anticancer properties, thereby validating its traditional medicinal applications. Nevertheless, additional research is needed to address standardization, safety assessment, and clinical validation. Overall, *Calotropis gigantea* shows great promise as a natural source for future therapeutic agents, with this research's novelty stemming from its integrated pharmacognostic and pharmacological approach that provides new insights into the plant's bioactive potential and microscopic identification. This establishes a foundation for their standardized application in herbal medicine.

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