



**PHARMACOGNOSTICAL AND PHYTOCHEMICAL INVESTIGATION ON THE  
LEAVES OF *DOLICHOS GLADIATUS*: A COMPREHENSIVE REVIEW**

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### ABSTRACT

*Dolichos gladiatus*, a leguminous climber from the Fabaceae family, has long been recognized in traditional medicine systems across tropical regions for its therapeutic potential, particularly in treating inflammatory conditions, digestive disorders, and skin ailments. This comprehensive review synthesizes the existing body of knowledge on the pharmacognostical and phytochemical aspects of its leaves, drawing from a wide array of studies to elucidate their morphological, anatomical, chemical, and biological properties. Pharmacognostical evaluations, including macroscopic, microscopic, and physicochemical analyses, provide essential data for standardization and quality control, ensuring the authenticity and purity of herbal materials derived from this plant. Phytochemical investigations reveal a rich profile of secondary metabolites, such as flavonoids, phenolic acids, alkaloids, tannins, saponins, and terpenoids, which are responsible for the observed bioactivities. These compounds exhibit potent antioxidant, anti-inflammatory, antimicrobial, antidiabetic, hepatoprotective, and anticancer effects, as demonstrated through in vitro, in vivo, and preliminary clinical studies. The review incorporates five tables summarizing key findings on morphological features, physicochemical parameters, phytochemical constituents, extraction methods, and pharmacological activities. By compiling data from over 60 peer-reviewed sources published between 2000 and 2025, this article highlights the therapeutic promise of *D. gladiatus* leaves while identifying gaps in clinical validation and toxicological profiling. Future research should prioritize standardized extraction protocols, bioavailability enhancement, and randomized controlled trials to translate these findings into viable herbal therapeutics, potentially addressing global health challenges like antibiotic resistance and chronic metabolic diseases.

**KEYWORDS:** *Dolichos gladiatus*, Toxicological evaluation, Pharmacognostical analysis, Phytochemical constituents, Herbal drug safety, Acute and subchronic toxicity, Bioactive compounds.

### 1. INTRODUCTION

The discovery of medicinal plants has been a cornerstone of human healthcare since ancient times, with civilisations in Africa, Asia and the Americas relying on plant resources for healing. Among these, *Dolichos gladiatus*, a type of hyacinth bean (often classified under *Dolichos lablab* var. *gladiatus* or *Vigna unguiculata* subspecies *sesquipedalis* in modern classification), stands out as a versatile legume plant with ethnomedicinal value. Native to tropical and subtropical regions, this perennial vine is cultivated not only for its edible pods and seeds, but also for its leaves, which have been traditionally used in decoctions and poultices to alleviate symptoms of fevers, wounds, gastrointestinal disorders and inflammatory conditions.<sup>[1-3]</sup> In Ayurvedic and Unani systems of medicine, its leaves are known for

their cooling, astringent and diuretic properties, often used to treat dysentery, skin infections and even diabetes. Driven by limitations such as side effects and resistance to synthetic drugs, a resurgence of interest in natural products has brought pharmacological and phytochemical studies on *D. gladiatus* leaves to the forefront of herbal research. As a discipline, pharmacognosy bridges botany and pharmacology by providing tools for identification, authentication and quality assurance of plant substances, ensuring that they meet standards of safety and efficacy.<sup>[2-7]</sup> This is particularly important in an era where adulteration and variability in herbal products pose significant risks to consumers. Phytochemical investigations serve this function by isolating and characterizing bioactive compounds, uncovering the molecular basis of traditional

uses. Over the past two decades, advances in analytical techniques such as high-performance liquid chromatography (HPLC), gas chromatography-mass spectrometry (GC-MS), and nuclear magnetic resonance (NMR) have made it possible to accurately profile these components, identifying flavonoids, phenolic acids, and other metabolites that have potent biological activities. The aim of this review is to consolidate these findings, and provide a holistic perspective on the potential of leaves as a source of new therapies. The importance of such a review lies in its ability to combine traditional knowledge with modern science, potentially leading to the development of standardized herbal formulations.

## 2. Botanical Description and Taxonomy

*Dolichos gladiatus* belongs to the Fabaceae family, a diverse group of legumes known for their nitrogen-fixing capabilities and economic importance in agriculture and medicine. Taxonomically, it is often synonymized with *Dolichos lablab* var. *gladiatus* or placed under the genus *Vigna* due to molecular phylogenetic studies, but traditional classifications retain the *Dolichos* nomenclature for its distinct morphological traits. The plant is a vigorous, twining vine that can reach heights of 3-5 meters, with stems that are angular and sparsely pubescent. Its leaves are alternate and trifoliate, consisting of ovate to rhomboid leaflets that measure 5-15 cm in length and 3-10 cm in width, with entire margins and acuminate tips. The adaxial surface is glabrous and dark green, while the abaxial side is lighter and may exhibit fine hairs, especially along the veins. Flowers are zygomorphic, purple or white, arranged in racemes, and pods are flat, sword-like (hence "gladiatus"), containing 3-6 seeds. Geographically, *D. gladiatus* is distributed across sub-Saharan Africa, India, Southeast Asia, and parts of Latin America, thriving in warm, humid climates with well-drained soils. In ethnobotanical contexts, the leaves have been used by indigenous communities for centuries; for instance, in Indian traditional medicine, they are brewed into teas for digestive relief, while in African folklore, they are applied topically for wound healing.<sup>[1-5]</sup> This widespread use has prompted scientific scrutiny to validate these claims through systematic botanical and chemical analyses. Comparative taxonomy with related species like *Phaseolus vulgaris* or *Vigna unguiculata* reveals similarities in leaf venation and pod structure, but *D. gladiatus* is distinguished by its larger leaflets and gladiate pods. Cultivation practices influence leaf quality, with organic farming yielding higher phytochemical content compared to conventional methods exposed to pesticides. Harvesting typically occurs during the pre-flowering stage to maximize bioactive compounds, and post-harvest drying at 40-50°C preserves morphology without degrading volatiles. Understanding these botanical aspects is foundational for pharmacognostical studies, as they provide the baseline for authentication and prevent misidentification with adulterants like other *Dolichos* species.<sup>[5-7]</sup>

## 3. Pharmacognostical Investigations

Pharmacognostical studies form the bedrock of herbal drug development, offering standardized parameters to evaluate the identity, purity, and quality of plant materials like *D. gladiatus* leaves. These investigations follow protocols outlined by the World Health Organization and national pharmacopoeias, ensuring reproducibility and regulatory compliance.<sup>[9-12]</sup> Macroscopically, the leaves of *D. gladiatus* present as trifoliate structures with a smooth, leathery texture when fresh, exhibiting a vibrant green color that darkens to brownish-green upon drying. They are typically 5-15 cm long, with an odorless profile when intact but releasing a mild herbaceous aroma upon crushing, accompanied by a slightly astringent taste due to tannin content. The surface is glabrous on the upper side and slightly pubescent below, with prominent reticulate venation that aids in identification. Foreign matter, such as soil or insect residues, should not exceed 2% by weight to meet quality standards, as excessive contaminants can compromise efficacy and safety. Microscopically, transverse sections of the leaves reveal a dorsiventral arrangement, characterized by a single-layered epidermis covered by a thin cuticle, followed by palisade parenchyma cells that are elongated and densely packed with chloroplasts for photosynthesis. The spongy mesophyll is loosely arranged, facilitating gas exchange, and the midrib region shows collenchymatous support tissue surrounding vascular bundles composed of xylem and phloem. Diagnostic features include anomocytic stomata on the lower epidermis (stomatal index 18-25), multicellular covering trichomes, and abundant calcium oxalate crystals in prismatic and druse forms, which are visible under polarized light microscopy. Vein islet numbers range from 8-12 per mm<sup>2</sup>, and palisade ratio is 4-6, providing quantitative markers for authentication. These anatomical traits distinguish *D. gladiatus* from similar species like *Lablab purpureus*, where trichome density and crystal types differ. Physicochemical parameters further quantify quality; moisture content is typically 8-12% in dried leaves to prevent microbial growth, total ash value (6-10%) indicates inorganic matter, and acid-insoluble ash (1-2%) reflects siliceous impurities. Extractive values, such as water-soluble (15-20%) and alcohol-soluble (10-15%), highlight the solubility of active principles, with higher values in polar solvents suggesting abundance of polar compounds like glycosides.<sup>[1-17]</sup> Loss on drying at 105°C is below 10%, and pH of aqueous extracts ranges from 5.5-6.5, indicating mild acidity. Fluorescence analysis under UV light shows green fluorescence for powdered leaves, attributed to flavonoids, which serves as a rapid screening tool. These parameters are critical for batch-to-batch consistency, especially in herbal formulations where variability can affect therapeutic outcomes. Comparative studies with other Fabaceae leaves show that *D. gladiatus* has higher ash values, due to mineral-rich soils in its native habitats. Overall, these pharmacognostical insights ensure the leaves' suitability

for pharmaceutical use, paving the way for phytochemical exploration.<sup>[18-21]</sup>

**Table 1: Macroscopic and Microscopic Features of *D. gladiatus* Leaves.**<sup>[2-5]</sup>

Parameter	Description/Details
Color (Fresh)	Bright green
Color (Dried)	Dark green to brown
Shape/Size	Trifoliolate, ovate leaflets (5-15 cm)
Odor/Taste	Herbal odor; slightly bitter
Epidermis	Glabrous with multicellular trichomes
Stomatal Type/Index	Anomocytic; 18-25
Crystals	Calcium oxalate prisms and druses
Vein Islet Number	8-12

Phytochemical investigations delve deeper into the chemical composition, revealing the molecular basis for the leaves' medicinal properties. Preliminary screening employs qualitative tests to detect major classes of compounds: alkaloids yield a reddish-brown precipitate with Drage Dorff's reagent, flavonoids produce a pink color in the Shinoda test, tannins form a blue-green complex with ferric chloride, saponins create stable foam, and steroids show a red ring in the Salkowski test. These tests confirm the presence of carbohydrates, proteins, glycosides, and fixed oils as well, providing a broad phytochemical fingerprint. Quantitative analysis, using spectrophotometric methods, estimates total phenolic content at 50-150 mg gallic acid equivalent (GAE)/g dry weight, flavonoid content at 20-80 mg quercetin equivalent (QE)/g, and alkaloid yield at 1-5%, with variations influenced by factors like plant age, season, and extraction solvent. For instance, leaves collected during the rainy season exhibit higher phenolic levels due to increased metabolic activity.<sup>[12-17]</sup> Isolated compounds include flavonoids like quercetin and kaempferol, which are glycosylated for enhanced solubility; phenolic acids such as gallic and ferulic acids, known for their radical-scavenging abilities; alkaloids of the indole type; condensed tannins; triterpenoid saponins; steroids like  $\beta$ -sitosterol; and terpenoids

including oleanolic acid. Volatile compounds, identified via GC-MS, encompass eugenol, linalool, and  $\beta$ -caryophyllene, contributing to aromatic and antimicrobial properties. Extraction methods significantly affect yield and purity; Soxhlet extraction with methanol achieves the highest phenolic recovery (up to 150 mg GAE/g), while ultrasonic-assisted extraction with water is eco-friendly and yields 8-15% for polar compounds. Supercritical CO<sub>2</sub> extraction isolates non-polar volatiles with minimal solvent residue, and microwave-assisted methods accelerate the process, reducing time by 70% compared to conventional maceration.<sup>[15,16]</sup> Analytical techniques like HPLC with UV detection at 280 nm quantifies flavonoids, NMR elucidates structures (e.g., confirming quercetin-3-O-rutinoside), and LC-MS provides molecular ion peaks for identification. These methods have revealed seasonal and geographical variations, with African accessions showing higher saponin content than Asian ones, possibly due to soil differences. The constructive interaction among these phytoconstituents—flavonoids enhancing antioxidant effects, tannins providing astringency for wound healing—underpins the leaves' therapeutic versatility, making them a candidate for standardized extracts in nutraceuticals.<sup>[18-22]</sup>

**Table 2: Major Phytochemical Constituents in *D. gladiatus* Leaves.**<sup>[22-26]</sup>

Class of Compound	Specific Examples	Quantity (mg/g)
Flavonoids	Quercetin, Kaempferol	20-80
Phenolic Acids	Gallic, Ferulic	10-50
Alkaloids	Indole-type alkaloids	1-5
Tannins	Condensed tannins	5-15
Saponins	Triterpenoid saponins	2-10
Steroids	$\beta$ -Sitosterol	0.5-2
Triterpenoids	Oleanolic acid	1-3
Volatiles	Eugenol, Linalool	Trace

The pharmacological activities of *D. gladiatus* leaves are directly linked to their phytochemical profile, with numerous studies validating traditional claims through modern bioassays. Antioxidant activity is one of the most studied properties, where flavonoids and phenolics act as free radical scavengers, inhibiting lipid peroxidation and DNA damage. In vitro assays like DPPH (2,2-diphenyl-

1-picrylhydrazyl) and ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) show IC<sub>50</sub> values of 20-50  $\mu$ g/mL for methanolic extracts, comparable to ascorbic acid standards.<sup>[26-31]</sup> This activity is crucial for preventing oxidative stress-related conditions such as atherosclerosis and aging. Anti-inflammatory effects are mediated by inhibition of pro-inflammatory enzymes like

cyclooxygenase-2 (COX-2) and lipoxygenase (LOX), with leaf extracts reducing paw edema in carrageenan-induced rat models by 30-50% at doses of 200-400 mg/kg. Tannins and phenolic acids contribute to this by downregulating cytokines like TNF- $\alpha$  and IL-6, suggesting potential in arthritis management.<sup>[29-31]</sup> Antimicrobial properties are evident against both Gram-positive (*Staphylococcus aureus*) and Gram-negative (*Escherichia coli*) bacteria, with ethanol extracts producing inhibition zones of 15-22 mm in agar diffusion tests, attributed to alkaloids and saponins disrupting cell membranes. Antifungal activity against *Candida albicans* is also noted, with MIC values of 50-100  $\mu\text{g/mL}$ , supporting its use in topical infections. For antidiabetic potential,  $\alpha$ -glucosidase and  $\alpha$ -amylase inhibition assays yield IC50 values of 30-60  $\mu\text{g/mL}$ , while in vivo studies in streptozotocin-induced diabetic rats demonstrate a 25-40% reduction in blood glucose levels after 14 days of treatment, due to flavonoids

enhancing insulin sensitivity.<sup>[27-33]</sup> Hepatoprotective effects are observed in carbon tetrachloride (CCl<sub>4</sub>)-induced liver toxicity models, where lower serum enzymes (ALT, AST) by 40-60% and restore glutathione levels, protecting hepatocytes from oxidative damage. Wound-healing properties are supported by accelerated collagen synthesis and epithelialization in excision wound models, with extracts promoting 70-80% wound closure within 10 days. Anticancer activity is promising, with cytotoxicity against HeLa and MCF-7 cell lines at 40-60% inhibition (100  $\mu\text{g/mL}$ ), involving apoptosis induction via caspase activation. Other activities include analgesic effects (tail-flick test showing 50% pain reduction) and immunomodulatory potential (enhanced phagocytic index in macrophages). These findings align with ethnomedicinal uses but require dose-response optimization and mechanistic elucidation using advanced tools like molecular docking.<sup>[34-38]</sup>

**Table 3: Extraction Methods and Yields for Phytochemicals.**<sup>[32-36]</sup>

Extraction Method	Solvent	Yield (%)	Key Compounds Extracted
Soxhlet	Methanol	15-25	Flavonoids, Phenolics
Maceration	Ethanol	10-20	Alkaloids, Tannins
Ultrasonic	Water	8-15	Saponins, Glycosides
Supercritical CO <sub>2</sub>	CO <sub>2</sub>	5-10	Volatiles, Steroids
Microwave-Assisted	Methanol	12-22	Triterpenoids

### Toxicological Evaluation of *Dolichos gladiatus* Leaves: Safety Profile for Therapeutic Applications

Toxicological assessments are critical for validating the safety of herbal materials like *Dolichos gladiatus* leaves, which contain bioactive compounds such as tannins and alkaloids that exhibit dose-dependent effects. This report synthesizes findings from acute, subacute, subchronic, genotoxicity, and reproductive toxicity studies, highlighting the plant's generally low toxicity profile.<sup>[37]</sup> Key recommendations include caution for high doses, vulnerable populations, and the need for further chronic studies and interaction analyses. Data are drawn from established guidelines and peer-reviewed research, ensuring evidence-based insights.

#### Introduction to Toxicological Importance

Toxicological evaluations are indispensable for confirming the safety of plant-based therapeutics, particularly when compounds like tannins and alkaloids may exert beneficial effects at low doses but potential risks at higher levels. For *D. gladiatus* leaves, these studies provide assurance for their traditional uses in managing inflammation, digestion, and other conditions, while identifying thresholds for safe consumption.<sup>[38]</sup>

#### Acute Toxicity Profile

Acute toxicity testing, aligned with OECD Guideline 423, demonstrates no mortality or observable behavioral changes in mice administered oral doses up to 2000 mg/kg. The median lethal dose (LD<sub>50</sub>) is estimated to exceed 5000 mg/kg, categorizing the extract as

practically non-toxic according to standard classifications. No gross pathological alterations were noted in vital organs post-administration, supporting initial safety for short-term use.<sup>[39-41]</sup>

#### Subacute and Subchronic Toxicity

Subacute (28-day) and subchronic (90-day) studies in rats at doses ranging from 100-500 mg/kg reveal no significant impacts on body weight, hematological parameters (e.g., red blood cells, white blood cells, hemoglobin), or biochemical markers (e.g., liver enzymes, creatinine, urea). Histopathological analyses of organs including the liver, kidney, and heart confirm normal cellular architecture without signs of necrosis or inflammation. These findings indicate minimal systemic toxicity over extended periods at therapeutic levels.<sup>[38]</sup>

#### Observations at High Doses

At elevated doses exceeding 1000 mg/kg, mild gastrointestinal irritation, such as diarrhea, may occur, attributable to the astringent properties of tannins. This effect is transient and resolves without intervention, but it underscores the importance of dose moderation.<sup>[42,43]</sup>

#### Genotoxicity and Reproductive Safety

Genotoxicity evaluations, including the Ames test and micronucleus assay, show no mutagenic activity, indicating minimal risk of DNA damage. Reproductive toxicity assessments in rodents reveal no adverse impacts on fertility, gestation, or fetal development, further affirming safety for general use.<sup>[42-44]</sup>

### Comparative Toxicity Insights

When compared to related plants like *Phaseolus vulgaris*, *D. gladiatus* exhibits a similar safety profile but with lower alkaloid content, which reduces potential neurotoxic risks. This comparative advantage highlights its suitability for herbal applications.<sup>[38]</sup>

### Limitations and Recommendations

Despite reassuring data, long-term chronic toxicity studies are limited, and potential interactions with pharmaceuticals (e.g., antidiabetic agents) require further exploration. Adulteration with toxic Fabaceae species poses a risk, necessitating rigorous pharmacogenetic verification. Overall, the leaves are safe for short-term therapeutic use, but caution is advised for pregnant individuals and those with gastrointestinal sensitivities. Human safety trials are recommended to bolster clinical applications.<sup>[48-52]</sup>

### Toxicological evaluations

Toxicological evaluations are essential to establish the safety of *D. gladiatus* leaves for therapeutic use, given the presence of potentially bioactive but dose-dependent compounds like tannins and alkaloids. Acute toxicity studies, conducted per OECD guideline 423, indicate no mortality or behavioral changes in mice at oral doses up to 2000 mg/kg, with the LD50 estimated above 5000 mg/kg, classifying the extract as practically non-toxic.

Subacute toxicity (28 days) and subchronic studies (90 days) in rats at doses of 100-500 mg/kg reveal no significant alterations in body weight, hematological parameters (RBC, WBC, hemoglobin), or biochemical markers (liver enzymes, creatinine, urea).<sup>[53-55]</sup> Histopathological examination of vital organs like the liver, kidney, and heart shows normal architecture, with no signs of necrosis or inflammation. However, high doses (>1000 mg/kg) may cause mild gastrointestinal irritation, manifested as diarrhea, likely due to tannin-induced astringency.<sup>[56]</sup> Genotoxicity assays, such as the Ames test and micronucleus assay, confirm no mutagenic potential, while reproductive toxicity studies in rodents indicate no adverse effects on fertility or fetal development. Comparative toxicity with related plants like *Phaseolus vulgaris* shows similar safety profiles, but *D. gladiatus* has lower alkaloid content, reducing the risk of neurotoxicity. Despite these reassuring findings, long-term chronic toxicity data are limited, and interactions with pharmaceuticals (e.g., antidiabetic drugs) warrant investigation.<sup>[57]</sup> Adulteration risks, such as substitution with toxic Fabaceae species, emphasize the need for pharmacognostical authentication. Overall, the leaves appear safe for short-term use at therapeutic doses, but pregnant women and individuals with gastrointestinal sensitivities should exercise caution, and further human safety trials are recommended to support clinical applications.<sup>[58]</sup>

**Table 4: Pharmacological Activities of *D. gladiatus* Leaf Extracts.**<sup>[59,60]</sup>

Activity	Model/Method	Key Findings (IC50 or % Inhibition)
Antioxidant	DPPH Assay	IC50: 20-50 µg/mL
Anti-inflammatory	Carrageenan-Induced Edema	30-50% Reduction
Antimicrobial	Agar Well Diffusion	Zone: 15-22 mm (Gram +/-)
Antidiabetic	α-Glucosidase Inhibition	IC50: 30-60 µg/mL
Hepatoprotective	CCl4-Induced Toxicity	ALT/AST Reduction: 40-60%
Anticancer	MTT Assay (HeLa Cells)	Cytotoxicity: 40-60%

In discussing the implications of these findings, it is evident that the pharmacognostical and phytochemical attributes of *D. gladiatus* leaves position them as a valuable resource in natural product research. The macroscopic and microscopic features provide robust markers for identification, reducing the likelihood of adulteration in commercial herbal products, which is a persistent issue in the global market. For instance, the presence of specific calcium oxalate crystals and stomatal patterns distinguishes these leaves from similar-looking adulterants like those from *Vigna* species, ensuring purity in formulations. Physicochemical parameters, such as low acid-insoluble ash, indicate minimal siliceous contaminants, aligning with international standards like those in the United States Pharmacopeia (USP) or British Pharmacopoeia. Phytochemically, the synergy between flavonoids (e.g., quercetin) and phenolic acids (e.g., gallic acid) explains the multifaceted bioactivities, with antioxidant effects potentially mitigating oxidative stress in chronic conditions like diabetes and cardiovascular diseases.<sup>[55-60]</sup> Comparative analyses with other Fabaceae leaves, such

as those from *Mucuna pruriens* or *Cassia tora*, reveal that *D. gladiatus* has a higher concentration of saponins, which may enhance its antimicrobial efficacy but also necessitate caution in dosage to avoid hemolytic effects. Extraction methods play a pivotal role; green techniques like ultrasound-assisted extraction not only yield higher phenolics (up to 20% more than conventional methods) but also align with sustainable practices, reducing solvent waste and energy consumption.<sup>[61]</sup> Analytical advancements, such as high-resolution mass spectrometry, have enabled the discovery of novel glycosides in recent studies, expanding the known chemical diversity. Pharmacologically, the leaves' activities support their traditional uses, with in vivo models demonstrating efficacy comparable to standard drugs like ibuprofen for inflammation or acarbose for diabetes management. However, the lack of human clinical trials remains a critical gap; while preclinical data are promising, translational research is needed to determine optimal dosages, bioavailability, and long-term efficacy.<sup>[62]</sup> Toxicological profiles are reassuring, but inter-individual variability (e.g., in CYP450

metabolism) could affect safety in diverse populations.<sup>[63]</sup> Future directions should include nanoencapsulation to improve bioavailability of hydrophobic compounds like  $\beta$ -sitosterol, integration with omics technologies for metabolomic profiling, and randomized controlled trials in conditions like type 2 diabetes or chronic wounds. Collaborative efforts between academia, industry, and regulatory bodies could facilitate the development of standardized extracts or

supplements, potentially positioning *D. gladiatus* as a key player in the growing herbal medicine market valued at over \$200 billion globally.<sup>[63]</sup> In conclusion, this review not only consolidates existing knowledge but also highlights the untapped potential of *D. gladiatus* leaves, advocating for accelerated research to bridge the gap between traditional wisdom and evidence-based therapeutics.

**Table 5: Comparative Phytochemical Yields Across Extraction Solvents.**<sup>[64-68]</sup>

Solvent	Total Phenolics (mg GAE/g)	Total Flavonoids (mg QE/g)	Alkaloids (%)
Methanol	120-150	50-80	3-5
Ethanol	80-120	30-60	2-4
Water	50-80	20-40	1-2
Chloroform	20-50	10-20	0.5-1
Hexane	10-30	5-15	Trace

## CONCLUSION

In synthesizing the pharmacognostical and phytochemical data on *Dolichos gladiatus* leaves, this review illuminates their significant potential as a natural therapeutic agent, rooted in a rich array of bioactive compounds that confer antioxidant, anti-inflammatory, antimicrobial, and antidiabetic properties. The detailed morphological and anatomical descriptions provide a foundation for authentication, while physicochemical parameters ensure quality control in an industry plagued by variability. Phytochemical profiling, enhanced by modern extraction and analytical techniques, reveals a synergistic blend of flavonoids, phenolics, and other metabolites that validate traditional uses and open avenues for novel applications in chronic disease management. Pharmacological studies, though predominantly preclinical, demonstrate promising efficacy with low toxicity, suggesting safety for short-term use. However, the absence of robust clinical trials and comprehensive long-term safety data represents a critical limitation, necessitating further investment in human studies and bioavailability research. By addressing these gaps, *D. gladiatus* leaves could emerge as a cornerstone in sustainable herbal medicine, contributing to global health solutions amid rising demands for natural alternatives. Ultimately, this plant exemplifies the bridge between ethnobotany and modern pharmacology, warranting interdisciplinary efforts to fully harness its benefits.

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