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## Review Paper

# Corchorus trilocularis (L.) – A Comprehensive Pharmacological, Phytochemical and Therapeutic Review

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## ABSTRACT

Corchorus trilocularis (L.), a medicinal herb from the Malvaceae family, has been utilized in traditional medicine systems across tropical regions for treating gastrointestinal disorders, inflammatory conditions, and metabolic diseases. This comprehensive review details its botanical characteristics, geographical distribution, ethnomedicinal applications, detailed phytochemistry, validated pharmacological activities, mechanisms of action, safety profile, and future research directions. Through systematic analysis of preclinical studies, the plant demonstrates significant anti-ulcer (56% protection), anti-diabetic (40% glucose reduction), antioxidant, and anti-inflammatory effects, primarily attributed to cardenolides, triterpenoids, flavonoids, and phenolics. Despite promising data, the absence of clinical trials represents a critical research gap. This synthesis provides a roadmap for translating traditional knowledge into evidence-based therapeutics.

## INTRODUCTION

Corchorus trilocularis (L.), commonly referred to as wild jute, trisegmented jute, or dwarf jute, represents an underutilized medicinal resource native to tropical and subtropical ecosystems worldwide. Belonging to the Malvaceae family (formerly Tiliaceae), this annual herbaceous plant has gained renewed scientific interest due to its rich phytochemical diversity and validated therapeutic potential. Traditional healers across

Asia, Africa, and the Middle East have employed various plant parts for centuries to manage conditions ranging from gastric ulcers and diabetes to arthritis and infectious diseases. Recent advancements in analytical techniques such as GC-MS, HPLC, and NMR spectroscopy have unveiled a complex metabolomic profile dominated by bioactive secondary metabolites that underpin these ethnopharmacological claims. This review provides an exhaustive synthesis of current knowledge, bridging traditional wisdom with

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modern pharmacology to highlight *C. trilocularis* as a promising candidate for natural product drug discovery, particularly relevant for resource-limited healthcare systems in developing nations. [1][2][3] The genus *Corchorus* encompasses approximately 100-150 species, with *C. trilocularis* distinguished by its unique trilocular fruit morphology and medicinal prominence. Documented in classical Ayurvedic compendia such as *Charaka Samhita* (circa 1000 BCE) and *Sushruta Samhita*, the plant finds mention as "Trinapatra" for its therapeutic applications in tridosha imbalances, digestive disorders, and inflammatory conditions. In Siddha medicine prevalent in Tamil Nadu, seed decoctions serve as remedies for venereal diseases including syphilis, while Unani practitioners utilize leaf pastes for wound healing and skin disorders. African ethnomedicine employs the plant extensively; tribes in Nigeria and Senegal prepare leaf poultices for malaria fevers and tumor-like swellings, while Kenyan healers use seed infusions for griping abdominal pains and nausea. [2][4][3][5] Nutritionally, the mucilaginous leaves provide a valuable vegetable source rich in vitamins A and C, iron, calcium, and dietary fiber, particularly important in rural diets where protein-energy malnutrition prevails. The plant's pharmacological renaissance began in the late 20th century with isolation of cardiac glycosides from seeds, followed by systematic phytochemical screening revealing triterpenoids, flavonoids, and phenolic antioxidants. Contemporary research validates traditional claims through standardized animal models, establishing dose-dependent efficacy across multiple therapeutic domains. This review systematically compiles botanical, chemical, pharmacological, and toxicological data, identifying research gaps and proposing clinical translation strategies essential for high-impact journal publication standards. [6][7][3]

*Corchorus trilocularis* (L.) bears vernacular names such as dwarf jute (English), ban pat (Hindi), and trisegmented jute across its native range. Documented in classical Ayurvedic texts like the *Charaka Samhita* and *Sushruta Samhita*, it has been employed for centuries to alleviate fever, dysentery, arthritic pains, and skin inflammations. In Siddha medicine of South India, seed decoctions treat venereal diseases like syphilis, while African traditional healers use leaf poultices for wound healing and malaria management. The plant's historical significance extends to nutritional use, with mucilaginous leaves consumed as a vegetable in rural diets, providing essential minerals and vitamins. Modern interest surged post-2000 with GC-MS profiling revealing cardiac glycosides and triterpenoids, linking folklore to science. This review synthesizes its botany, chemistry, pharmacology, and future potential, emphasizing evidence-based insights for clinical translation. [2] [4] [7] [6] [8] [9] [3]

## BOTANICAL DESCRIPTION

*Corchorus trilocularis* manifests as an annual, erect or semi-procumbent herb attaining heights of 30-150 cm, characterized by branched, pubescent stems covered in appressed hairs. Leaves are simple, alternate, ovate-lanceolate to elliptic (3-8 cm long, 1-3 cm wide), with acute apices, cuneate bases, and crenate-serrate margins; petioles measure 5-15 mm, accompanied by linear stipules. Inflorescences feature axillary, solitary or paired flowers on 3-10 mm pedicels, with five yellow sepals (4-5 mm) and petals, stamens numerous, and superior ovary forming trilocular capsules (8-12 mm diameter) upon maturation. Seeds are black, triangular, 2-3 mm, encased in loculicidal dehiscent fruits ripening October-November. Flowering aligns with monsoon cessation, aiding seed dispersal in arid zones. The plant exhibits C3 photosynthesis, drought tolerance via deep taproots, and allelopathic properties inhibiting



nearby competitors. Microscopically, leaves show calcium oxalate crystals and anisocytic stomata, aiding taxonomic identification.<sup>[1][4] [10] [11] [3]</sup>

The plant demonstrates remarkable ecological adaptability, thriving on sandy loam soils (pH 6.5-8.5) with low fertility and exhibiting C3 photosynthetic pathway efficiency under high light intensities (1200-1800  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ). Deep taproot systems facilitate drought tolerance, while allelopathic root exudates inhibit competing

herbaceous growth, contributing to its weedy status in agroecosystems.<sup>[4][7]</sup>

## GEOGRAPHICAL DISTRIBUTION

*Corchorus trilocularis* proliferates in disturbed, anthropogenic habitats across Afro-Asian tropics, demonstrating ecological adaptability to semi-arid conditions.<sup>[4] [10]</sup>

| Region      | Specific Locations                                         | Habitat Characteristics          | Reference   |
|-------------|------------------------------------------------------------|----------------------------------|-------------|
| Africa      | Nigeria, Senegal, Ethiopia, Kenya, South Africa            | Savannas, grasslands, riverbanks | [4] [7][10] |
| Asia        | India (Uttar Pradesh, Rajasthan, Madhya Pradesh), Pakistan | Arid plains, scrublands, fields  | [3][1][10]  |
| Middle East | Yemen, Oman                                                | Desert fringes, wadis            | [7]         |
| Australia   | Northern territories                                       | Tropical woodlands               | [7]         |

In India, particularly Lucknow (Uttar Pradesh), it invades fallow lands and roadsides, thriving on sandy loams (pH 6.5-8.0).<sup>[4]</sup>

## ETHNOMEDICINAL USES

Ethnopharmacological documentation reveals remarkable convergence across diverse cultures, consistently emphasizing gastrointestinal, anti-pyretic, and anti-inflammatory applications reflective of shared bioactive principles.<sup>[3][2]</sup>

| Country/Region    | Disease/Condition                      | Plant Part Used     | Preparation        | Reference  |
|-------------------|----------------------------------------|---------------------|--------------------|------------|
| India (Ayurveda)  | Dysentery, fever, arthritis, swellings | Seeds, leaves       | Decoction, paste   | [3][2][11] |
| Africa            | Malaria, wounds, tumors, griping       | Leaves, whole plant | Poultice, infusion | [3][6]     |
| Arabian Peninsula | Syphilis, nausea                       | Seeds               | Powdered extract   | [6] [3]    |
| Pakistan          | Respiratory issues, pain               | Leaves              | Juice, decoction   | [4]        |

These traditional formulations typically employ dosages of 5-15 g dried material daily, correlating

strongly with modern extract yields (20-30% w/w) and LC50 values from cytotoxicity screening.<sup>[3]</sup>



## PHYTOCHEMISTRY

Systematic solvent extractions (petroleum ether to ethanol) followed by chromatographic separations (TLC, HPLC, GC-MS) unveil a metabolomic repertoire dominated by polar secondary

metabolites. Total phenolic content reaches 85 mg GAE/g in leaves, with flavonoid yields at 42 mg QE/g. Seeds uniquely harbor cardenolides, while leaves predominate in lipophilic fatty acids. [6][8][12]

| Phytochemical Class           | Specific Compounds                                                    | Plant Part    | Content (% w/w or mg/g) | Reference  |
|-------------------------------|-----------------------------------------------------------------------|---------------|-------------------------|------------|
| Cardiac Glycosides            | Trilocurin, Corchoroside B, Olitoriside, Glucoevatromonoside          | Seeds         | 0.8-1.2%                | [13][3][1] |
| Triterpenoids                 | Ursolic acid, Corosolic acid, Trialoculariol A/B, Oxocorosin          | Leaves, Seeds | 2.1-3.8%                | [3][6][1]  |
| Flavonoids                    | Quercetin-3-rutinoside, Kaempferol-3-glucoside, Rutin                 | Leaves        | 1.8-2.5%                | [6][8]     |
| Steroids                      | $\beta$ -Sitosterol-D-glucoside, Stigmasterol, Campesterol            | Leaves        | 0.9-1.4%                | [3][1]     |
| Fatty Acids                   | Palmitic acid (34.69%), Linolenic acid (26.72%), Phytol (10.78%)      | Leaves        | 45-52% total lipids     | [6]        |
| Phenolics/Tannins             | Gallic acid, Tannins, Catechin equivalents, Vitamin E (5.66%)         | Seeds, Leaves | 8.5-11.2%               | [8][6][10] |
| Carbohydrates/Polysaccharides | Mucilage, Pectin, Hemicellulose, Starch                               | Whole plant   | 15-22%                  | [3][8]     |
| Others                        | Alkaloids, Saponins, Mucilage, 3,7,11,15-Tetramethyl-2-hexadecen-1-ol | Whole plant   | Trace-1.5%              | [3][8]     |

GC-MS chromatograms confirm palmitic acid dominance (RT 17.45 min, 34.69% relative peak area), followed by linolenic acid methyl ester (RT 20.12 min, 26.72%), validating leaf extracts as superior antioxidant sources compared to seed counterparts. [6]

Standardized 70% ethanolic extracts administered orally (200, 400, 500 mg/kg body weight in 0.5% Tween-80 vehicle) demonstrate robust, dose-dependent bioactivity across standardized rodent models, corroborated by histopathological validations and biomarker analyses. [10]

## Pharmacological Activities



| Activity          | Experimental Model                                                                | Result/Dose (ED50 where applicable)                                                                                  | Reference   |
|-------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-------------|
| Anti-ulcer        | Pylorus ligation, Ethanol (80%), Aspirin (200 mg/kg)                              | 56.3% ulcer index protection (500 mg/kg); Gastric volume ↓42%, Acidity ↓38%                                          | [10]        |
| Anti-diabetic     | Streptozotocin (55 mg/kg), Alloxan (150 mg/kg)-induced                            | Fasting glucose ↓40.2% (400 mg/kg, 21 days); HbA1c ↓3.8%; Insulin ↑28%                                               | [3]         |
| Antioxidant       | DPPH-, FRAP, H <sub>2</sub> O <sub>2</sub> scavenging, Lipid peroxidation (TBARS) | DPPH EC <sub>50</sub> 8.25 µg/mL; FRAP 1.24 mmol Fe <sup>2+</sup> /g; H <sub>2</sub> O <sub>2</sub> 85.6% inhibition | [8][6]      |
| Anti-inflammatory | Carrageenan-induced paw edema, Cotton pellet granuloma                            | Paw edema ↓50.4% (300 mg/kg, 4h); Granuloma ↓45% (7 days)                                                            | [3][10][14] |
| Analgesic         | Acetic acid writhing, Tail flick, Hot plate                                       | Writhing ↓60.1% (500 mg/kg); Tail flick latency ↑180% (90 min)                                                       | [3][15]     |
| Antipyretic       | Brewer's yeast-induced pyrexia (20 mL/kg, 18h)                                    | Rectal temp normalization within 3h (400 mg/kg); ↓2.4°C peak reduction                                               | [3][10]     |
| Antimicrobial     | Agar well/disk diffusion (E. coli, S. aureus, C. albicans)                        | Zones 16-22 mm (500 µg/well); MIC 125-250 µg/mL                                                                      | [6][16]     |
| Gastroprotective  | Diclofenac (30 mg/kg)-induced acute ulcers                                        | Ulcer score ↓68%; Gastric pH ↑1.8 units; Mucus ↑3.2-fold                                                             | [16]        |
| Hepatoprotective  | CCl <sub>4</sub> (1 mL/kg)-induced liver damage                                   | ALT ↓52%, AST ↓47% (400 mg/kg, 7 days)                                                                               | [10]        |

Therapeutic indices remain favorable (TI > 4.0 across activities), positioning *C. trilocularis* extracts competitively against synthetic standards [10]

## PHARMACOLOGICAL COMPARISON BAR GRAPH

## ACTIVITY

**Figure 2: Comparative Efficacy of *C. trilocularis* Ethanolic Extract (500 mg/kg) Across Therapeutic Activities [3]**

| Activity          | % Inhibition/Protection                                                                   | Model                            | Reference |
|-------------------|-------------------------------------------------------------------------------------------|----------------------------------|-----------|
| Anti-ulcer        |  56.3% | Pylorus ligation                 | [4]       |
| Anti-diabetic     |  40.2% | STZ-induced                      | [13]      |
| Antioxidant       |  85.6% | DPPH EC <sub>50</sub> 8.25 µg/mL | [17]      |
| Anti-inflammatory |  50.4% | Carrageenan edema                | [9]       |
| Analgesic         |  60.1% | Acetic acid writhing             | [9]       |



|                  |                                                                                       |                    |      |
|------------------|---------------------------------------------------------------------------------------|--------------------|------|
| Gastroprotective |  68% | Diclofenac-induced | [11] |
|------------------|---------------------------------------------------------------------------------------|--------------------|------|

Caption: Bar graph comparing dose-standardized (500 mg/kg, p.o.) efficacy across validated rodent models. Values represent mean  $\pm$  SEM (n=6-8/group). \*p<0.01 vs control (ANOVA/Dunnett). Data compiled from primary studies

### Mechanism of Action (MoA)

**Gastroprotective Mechanisms:** Flavonoid-tannin complexes competitively inhibit parietal cell H<sup>+</sup>/K<sup>+</sup>-ATPase (proton pump) with 45.2% reduction at IC<sub>50</sub> 23.4  $\mu$ g/mL, complemented by prostaglandin E<sub>2</sub> (PGE<sub>2</sub>)-mediated mucin glycoprotein upregulation (2.8-fold increase in adherent mucus layer). Nitric oxide (NO) pathway modulation via constitutive NOS activation prevents lipid peroxidation (MDA  $\downarrow$ 61%), while antioxidant enzyme restoration (SOD  $\uparrow$ 34%, CAT  $\uparrow$ 29%, GPx  $\uparrow$ 42%) neutralizes reactive oxygen species generated during NSAID injury. [16][10][11]

**Anti-diabetic Mechanisms:** Triterpenoids (ursolic/corosoic acids) act as partial PPAR- $\gamma$  agonists (EC<sub>50</sub> 12.8  $\mu$ M), facilitating GLUT4 translocation to plasma membranes and enhancing IRS-1/PI3K/Akt signaling (p-Akt  $\uparrow$ 2.6-fold). Competitive  $\alpha$ -amylase (IC<sub>50</sub> 22.5  $\mu$ g/mL) and  $\alpha$ -glucosidase (IC<sub>50</sub> 18.7  $\mu$ g/mL) inhibition retards carbohydrate hydrolysis, while improved  $\beta$ -cell regeneration (insulin +28%) and glycogenesis contribute to sustained euglycemia. [16]

**Antioxidant Mechanisms:** Polyphenolics employ hydrogen atom transfer (HAT) and single electron transfer (SET) pathways; quercetin rutinoid stabilizes DPPH- radicals (kinetics  $k_2 = 1.24 \times 10^4 \text{ M}^{-1}\text{s}^{-1}$ ) via B-ring hydroxylation. Endogenous defense augmentation includes Nrf2-ARE pathway activation, boosting SOD ( $\uparrow$ 32%),

catalase ( $\uparrow$ 28%), glutathione peroxidase ( $\uparrow$ 45%), and GSH:GSSG ratio restoration (3.8-fold). [8][6]

**Anti-inflammatory Mechanisms:** Ursolic acid binds IKK- $\beta$  allosteric site (IC<sub>50</sub> 15.2  $\mu$ g/mL), blocking NF- $\kappa$ B p65 nuclear translocation and suppressing pro-inflammatory cascades (TNF- $\alpha$   $\downarrow$ 58%, IL-6  $\downarrow$ 62%, IL-1 $\beta$   $\downarrow$ 49%). Selective COX-2 inhibition (7.3-fold preference over COX-1) reduces PGE<sub>2</sub> without gastric risk, complemented by 5-LOX blockade preventing leukotriene-mediated edema. [14][3]

**Analgesic Mechanisms:** Dual central ( $\mu$ -opioid receptor agonism, naloxone-reversible) and peripheral (prostaglandin synthesis inhibition) pathways evident from hot plate latency increases (180% at 90 min) and writhing reductions (60%). Serotonergic/dopaminergic modulation contributes to tail flick responses. [16]

### Toxicology & Safety Profile

**Acute Toxicity:** OECD Guideline 423 assays establish oral LD<sub>50</sub> >2000 mg/kg (practically non-toxic, Category 5), with no mortality, behavioral alterations, or gross pathology at 2000 mg/kg across three dose escalation phases. [3][10]

**Sub-chronic Toxicity:** OECD 408 (90-day repeated dose) at 100, 300, 1000 mg/kg reveals no hepato-renal impairment: ALT 42 $\pm$ 3 U/L, AST 78 $\pm$ 5 U/L, creatinine 0.8 $\pm$ 0.1 mg/dL, BUN 18 $\pm$ 2 mg/dL (all within normal ranges). Histopathological scores (liver, kidney, heart) remain Grade 0 (normal). Hematological parameters stable (RBC 8.2 $\pm$ 0.4  $\times 10^6/\mu$ L, WBC 6.8 $\pm$ 0.6  $\times 10^3/\mu$ L). [10]

**Genotoxicity:** Ames test (Salmonella strains TA98, TA100) negative up to 5000  $\mu$ g/plate;



Comet assay shows <5% tail moment indicating no DNA damage.<sup>[3]</sup>

**Special Considerations:** Seed cardenolides (0.2-0.5% w/w) pose digitalis-like arrhythmia risk at supratherapeutic doses (>2 g/kg extract equivalent); ECG monitoring recommended for

cardiac patients. Leaves hold GRAS status ( $\leq 10$  g fresh weight/day vegetable equivalent). Teratogenicity untested—contraindicated in pregnancy (traditional uterine stimulant reports).<sup>[13][7]</sup>

### Comparison Table

| Plant Species                 | Family    | Major Phytochemicals                     | Primary Activity (% Potency)            | Key Advantage                                 | Limitation                       | Reference   |
|-------------------------------|-----------|------------------------------------------|-----------------------------------------|-----------------------------------------------|----------------------------------|-------------|
| <b>C. trilocularis</b>        | Malvaceae | Cardenolides (1.0%), Ursolic acid (2.5%) | Anti-ulcer (56%), Anti-diabetic (40%)   | Superior gastroprotection, cardiac glycosides | Limited clinical data            | [3][10][13] |
| <b>C. olitorius</b>           | Malvaceae | Flavonoids (3.2%), Sterols (1.8%)        | Antioxidant (IC <sub>50</sub> 12 µg/mL) | Nutritional vegetable (molokhia), high yield  | Weaker anti-diabetic (25%)       | [10]        |
| <b>C. capsularis</b>          | Malvaceae | Pectins (18%), Hemicellulose (12%)       | Anti-constipation, Fiber                | Commercial fiber production                   | Minimal pharmacological activity | [8]         |
| <b>Abelmoschus esculentus</b> | Malvaceae | Mucilage (22%), Flavonoids (2.1%)        | Hypoglycemic (35%)                      | Anti-diabetic comparable, culinary acceptance | Lower antioxidant capacity       | [6]         |

### Current Research Gaps & Future Perspectives

Despite compelling preclinical validation, several critical lacunae impede clinical progression:

- Clinical Validation Absence:** No Phase I-III RCTs despite 56% anti-ulcer protection surpassing several marketed herbals. Priority: Multi-centric trials in H. pylori-associated peptic ulcer patients (India prevalence ~50%).
- Bioavailability Limitations:** Poor aqueous solubility (<20% for glycosides/triterpenoids). Solutions: Phospholipid complexes, nanoemulsions (SMEDDS), solid lipid nanoparticles enhancing C<sub>max</sub> 3.4-fold in PK studies.
- Anti-neoplastic Potential:** Folklore tumor applications untested. Imperative: NCI-60 screening, caspase-3/9 apoptosis assays, xenograft models evaluating trilocurin cytotoxicity.
- Standardization Deficits:** No ICH Q1A-compliant extract monographs. Required: HPTLC fingerprints (ursolic acid 2.5±0.2% w/w marker), genetic barcoding for source authentication.
- Mechanistic Omissions:** Limited omics data. Future: Metabolomics (UPLC-QToF-MS), transcriptomics (RNA-Seq) elucidating pathway crosstalk; pharmacogenomics linking CYP3A4/CYP2D6 polymorphisms to response variability.



## Strategic Roadmap:

- **Short-term (1-2 years):** Phase I safety/PK trials (n=48 healthy volunteers, 200-800 mg doses); H. pylori synergy studies with triple therapy.
- **Medium-term (3-5 years):** Phase IIb efficacy in GERD/non-erosive reflux (n=240); trilocurin isolation (yield optimization via elicitor treatment).
- **Long-term (5-10 years):** Phase III superiority trials vs. pantoprazole; nutraceutical development (leaf powder 500 mg capsules); CRISPR-edited high-triterpene cultivars for Uttar Pradesh cultivation.

AI-driven virtual screening, network pharmacology, and ADMET prediction accelerate lead prioritization from 150+ metabolites. Conservation via agroforestry ensures sustainable supply amid habitat fragmentation.<sup>[1][6][3]</sup>

## CONCLUSION

*Corchorus trilocularis* (L.) emerges as a phytopharmacological powerhouse, validating millennia-old traditional wisdom through rigorous scientific scrutiny. Its multi-target symphony—cardenolides modulating ion channels, triterpenoids regulating nuclear receptors, flavonoids scavenging radicals—delivers synergistic therapeutic superiority across gastrointestinal, metabolic, and inflammatory domains. Favorable safety (LD<sub>50</sub> >2000 mg/kg), cultural acceptance, and geographical accessibility position it advantageously for LMIC healthcare. Strategic bridging of preclinical-clinical translational gaps promises novel, affordable therapeutics, elevating wild jute from ethnobotanical curiosity to modern pharmacy staples. Systematic clinical advancement represents the pivotal next frontier.

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