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Review Paper

Pharmacological and Therapeutic Potential of *Tridax Procumbens* Linn: A Comprehensive Review

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ABSTRACT

Tridax procumbens Linn., a member of the Asteraceae family, has attracted significant attention for its broad spectrum of medicinal properties. Traditionally used in various cultures for treating ailments such as fever, wounds, and digestive disorders, the plant is now the focus of modern pharmacological research. Studies have demonstrated its anti-inflammatory, antimicrobial, hepatoprotective, antioxidant, and wound-healing effects. This review explores the phytochemical composition, pharmacological activities, traditional uses, safety profile, and potential applications of *Tridax procumbens*. It also addresses the challenges and future directions for its integration into pharmaceutical formulations. Through this detailed exploration, the paper aims to provide a comprehensive overview of the plant's medicinal value and its prospects in modern medicine [1,2].

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INTRODUCTION



3.1 Significance of Herbal Medicine

Herbal medicines have gained considerable recognition in modern pharmacology due to their therapeutic efficacy and minimal side effects compared to synthetic drugs. The global shift toward natural remedies in health and wellness is exemplified by the increasing demand for plantbased treatments, which is reflected in the resurgence of *Tridax procumbens* as a medicinal plant [3,4].

3.2 Role of *Tridax procumbens* in Traditional and Modern Medicine

For centuries, *Tridax procumbens* has been integral to traditional healing systems such as Ayurveda in India and African medicine, where it has been used for a variety of health conditions. The plant's applications in modern medicine have expanded significantly with the advent of scientific studies validating its traditional uses [5,6].

3.3 Purpose of the Review

The purpose of this review is to provide an indepth evaluation of *Tridax procumbens* by analyzing its botanical, chemical, pharmacological, clinical, and safety aspects. Additionally, this paper will explore its potential in pharmaceutical formulations, emphasizing its therapeutic value and areas for future research [7,8].

4. Botanical Description and Distribution

4.1 Morphological Features

Tridax procumbens is a perennial herb typically growing to a height of 30-60 cm. It has a creeping, prostrate stem and simple, ovate leaves that are arranged alternately. The plant produces small, yellow flowers with a daisy-like structure, which are the key identification features. The plant's seeds are fine and achenes, dispersing easily via wind, contributing to its widespread presence [9,10].





4.2 Geographical Distribution

The plant is native to tropical regions but has since spread to temperate climates. It is found throughout tropical and subtropical regions of Asia, Africa, and the Americas. *Tridax procumbens* is commonly seen in disturbed habitats such as roadsides, agricultural fields, and wastelands, where it thrives in both dry and humid environments [11] [12].

4.3 Ecological Significance

Tridax procumbens plays an important ecological role by stabilizing soil in disturbed environments. Its resilience to poor soil conditions and ability to flourish in urban settings make it a pioneer species, helping to support local biodiversity [13] [14].

5. Taxonomy and Classification



5.1 Taxonomical Classification. - The plant belongs to the family **Asteraceae**, one of the largest families in the plant kingdom. The taxonomical hierarchy is as follows:

• Kingdom: Plantae

- **Phylum**: Angiosperms
- Class: Dicotyledons
- Order: Asterales
- Family: Asteraceae
- Genus: Tridax
- **Species**: *Tridax procumbens* [15] [16].



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| Rank | Classification | |
|--------------|--------------------------------|--|
| Kingdom | Plantae | |
| Subkingdom | Viridiplantae | |
| Infrakingdom | Streptophyta | |
| Division | Tracheophyta (vascular plants) | |
| Class | Magnoliopsida (Dicotyledons) | |
| Order | Asterales | |
| Family | Asteraceae (Compositae) | |
| Genus | Tridax | |
| Species | Tridax procumbens Linn. | |

5.2 Related Species and Distinctions

The genus *Tridax* shares similarities with other species within the Asteraceae family, such as *Echinacea* and *Chamomile*, which also exhibit medicinal properties. However, *Tridax procumbens* is unique in its particular

pharmacological profile, especially its strong wound-healing and anti-inflammatory effects [17] [18].

6. Phytochemical Profile

6.1 Flavonoids



Flavonoids are a key class of compounds found in *Tridax procumbens*. They include quercetin and luteolin, which are known for their potent antioxidant, anti-inflammatory, and antimicrobial properties. These compounds help neutralize free

radicals, reducing oxidative stress and the risk of chronic diseases [19,20].

6.2 Alkaloids



The plant contains alkaloids like Tridaxine and nicotine, contributing to its analgesic, antiinflammatory, and antimalarial effects. Alkaloids have been shown to inhibit microbial growth and relieve pain, which makes them useful in treating infections and inflammatory conditions [21,22]. **6.3 Terpenoids**



 β -sitosterol and caryophyllene, two terpenoids found in the plant, contribute to its antiinflammatory and antioxidant effects. These compounds also play a role in enhancing the plant's immune-boosting properties and are involved in modulating cellular mechanisms [23,24].

6.4 Tannins and Saponins

These bioactive compounds contribute to the plant's wound-healing properties. Tannins exhibit astringent effects, helping to tighten tissues, while saponins possess antimicrobial properties and support immune health [25,26].



6.5 Phytochemical Extraction Methods

Phytochemicals are extracted using various methods such as maceration, solvent extraction, and more recently, supercritical fluid extraction

(SFE) to enhance yield and purity. These methods are critical in isolating the active compounds for pharmacological and clinical studies [27,28].

Phytochemical Profile chart

| Phytochemical | Key | Pharmacological | Therapeutic Applications |
|-----------------|--------------------|----------------------------|------------------------------------|
| Class | Compounds | Actions | |
| Flavonoids | Quercetin, | Antioxidant, anti- | Anti-inflammatory drugs, |
| | Luteolin, | inflammatory, anticancer, | cardiovascular protection, cancer |
| | Apigenin | cardioprotective | therapy |
| Alkaloids | Tridaxine, | Analgesic, antimicrobial, | Pain relief, antimicrobial agents, |
| | Pseudoephedrine | cytotoxic | potential anticancer therapy |
| Carotenoids | β -carotene, | Antioxidant, pro-vitamin | Eye health, immune modulation, |
| | Lutein | A activity, anti- | cancer prevention |
| | | mutagenic | |
| Tannins | Gallotannins, | Astringent, antimicrobial, | Wound healing, oral and |
| | Ellagitannins | anti-inflammatory | gastrointestinal infections |
| Saponins | Triterpenoid | Hypocholesterolemic, | Cholesterol management, immune |
| | saponins | immunomodulatory, | boosting, anticancer formulations |
| | | cytotoxic | |
| Steroids | β-sitosterol, | Anti-inflammatory, | Anti-inflammatory medications, |
| | Stigmasterol | hormone regulation | hormone-related disorders |
| Essential Oils | Terpenoids, | Antimicrobial, antiseptic, | Topical antiseptics, antimicrobial |
| | Monoterpenes | wound healing | creams |
| Phenolic | Caffeic acid, | Antioxidant, | Liver protection, |
| Compounds | Chlorogenic | hepatoprotective, | neurodegenerative disorder |
| | acid | neuroprotective | prevention |
| Polysaccharides | Glycans, Plant | Immunostimulant, anti- | Chronic fatigue, immune- |
| | mucilage | fatigue, regenerative | deficiency conditions |
| Glycosides | Flavone | Antioxidant, | Cardiovascular health, diabetes |
| | glycosides | cardioprotective | care |

7. Pharmacological Activities of *Tridax* procumbens Linn



7.1 Anti-inflammatory Properties

Tridax procumbens has shown remarkable antiinflammatory activity in multiple in vitro and in vivo studies. The plant inhibits the production of pro-inflammatory cytokines, such as TNF- α and IL-6, and reduces the activity of COX and LOX enzymes, which are central in the inflammatory process. These findings make it a promising candidate for treating conditions like rheumatoid arthritis and inflammatory bowel disease [29,30].

7.2 Antimicrobial and Antifungal Activity

The plant's antimicrobial effects are attributed to its flavonoids, alkaloids, and terpenoids. Studies have shown its activity against both Gram-positive and Gram-negative bacteria, such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Additionally, *Tridax procumbens* has antifungal properties, notably against *Candida albicans*, making it valuable in treating infections [31,32].

7.3 Antioxidant Activity

The flavonoids and phenolic compounds in *Tridax procumbens* contribute significantly to its antioxidant activity. The plant scavenges free radicals and protects against oxidative damage to cells, making it useful in preventing chronic diseases like cancer and cardiovascular diseases [33,34].

7.4 Hepatoprotective Effects

Animal studies have demonstrated that *Tridax procumbens* protects against liver damage induced by toxic substances like CCl4. The plant promotes liver regeneration by increasing antioxidant enzyme activity and reducing liver enzyme markers, highlighting its potential as a hepatoprotective agent [35,36].



7.5 Wound Healing and Skin Regeneration

The plant accelerates wound healing by promoting collagen formation and enhancing epithelialization. *Tridax procumbens* extracts have been used topically to treat burns, cuts, and ulcers, with studies showing faster healing times and reduced infection rates [37,38].

7.6 Antidiabetic and Hypolipidemic Properties

Tridax procumbens exhibits hypoglycemic effects by stimulating insulin release and enhancing insulin sensitivity. The plant also helps lower lipid levels, making it a promising adjunct in managing diabetes and hyperlipidemia [39,40]. Preliminary studies suggest that *Tridax procumbens* has anticancer properties. The plant induces apoptosis in cancer cells by activating caspases and modulating the cell cycle. Studies on breast, liver, and colon cancer cells show promising results, but more research is needed for clinical applications [41,42].

7.8 Immunomodulatory Effects

Tridax procumbens has been shown to enhance immune function, promoting the activity of phagocytic cells and increasing the production of antibodies. This makes the plant useful in boosting immunity, particularly in individuals with weakened immune systems [43,44].

7.7 Anticancer Potential

Pharmacological Activities chart

| Activity | Experimental Model | Mechanism of Action | Therapeutic |
|-------------------|---------------------------|---|-----------------------|
| | | | Application |
| Anti-inflammatory | Carrageenan-induced | Inhibits COX/LOX pathways, | Arthritis, chronic |
| | paw edema in rats | suppresses TNF- α , IL-6, and NO | inflammation, pain |
| | | production | relief |
| Antimicrobial | Agar diffusion against | Disrupts microbial membranes, | Wound care, |
| | S. aureus, E. coli, C. | inhibits DNA/protein synthesis | infections, oral |
| | albicans | | hygiene |
| Antioxidant | DPPH, FRAP, ABTS | Scavenges ROS, boosts SOD, | Aging, cardiovascular |
| | assays | CAT, GPx enzyme activity | and neurodegenerative |
| | | | diseases |
| Hepatoprotective | CCl4 and | Reduces liver enzymes (ALT, | Hepatitis, liver |
| | paracetamol-induced | AST), prevents lipid peroxidation | toxicity |
| | liver damage in rats | | |
| Wound Healing | Excision and incision | Enhances epithelialization, | Burns, cuts, ulcers |
| | wound models | collagen synthesis, angiogenesis | |
| Antidiabetic | STZ-induced diabetic | Stimulates insulin release, inhibits | Type 2 diabetes, |
| | rats | α -amylase and α -glucosidase | metabolic syndrome |
| Hypolipidemic | HFD-induced | Decreases cholesterol, LDL, | Hyperlipidemia, |
| | hyperlipidemic models | triglycerides; increases HDL | cardiovascular risk |
| Anticancer | MCF-7, HeLa, A549 | Induces apoptosis, ROS | Breast, cervical, and |
| | cell lines | generation, downregulates Bcl-2, | lung cancer research |
| | | upregulates caspases | |
| Immunomodulatory | Macrophage and | Enhances phagocytosis, | Immune deficiency, |
| | lymphocyte activation | lymphocyte proliferation | vaccine adjuvant |
| | assays | | |
| Antipyretic | Yeast-induced fever in | Inhibits prostaglandin synthesis | Fever, febrile |
| | rats | | conditions |
| Analgesic | Hot plate and tail-flick | Modulates central and peripheral | Pain management |
| | models in mice | pain pathways | |

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| Antimalarial | Plasmodium berghei- | Inhibits parasite replication | Malaria management |
|--------------|------------------------|-------------------------------|----------------------|
| | infected mice | | (experimental) |
| Insecticidal | Mosquito larvicidal | Interferes with larval | Vector control, eco- |
| | assays (Aedes aegypti) | development and respiration | friendly pesticides |

8. Traditional Uses and Ethnopharmacology

Tridax procumbens has been used for centuries in traditional medicine for its antimicrobial, antiinflammatory, and wound-healing properties. In Ayurveda, it is used to treat digestive disorders, skin conditions, and infections. In Africa, it is used for managing hypertension, malaria, and respiratory ailments. Ethnopharmacological studies reveal the wide-ranging applications of the plant in various cultures and its integral role in folk medicine [45,46].

9. Role in Modern Pharmaceutical Formulations



9.1 Topical Formulations

Tridax procumbens is used in the formulation of topical creams, ointments, and gels to treat wounds, burns, and skin infections. The plant's antimicrobial and healing properties make it a natural choice for skin-care products [47,48].

9.2 Oral Formulations

Extracts of *Tridax procumbens* are incorporated into capsules and syrups for their hypoglycemic, anti-inflammatory, and hepatoprotective effects. These formulations are being tested for their potential in managing diabetes, liver disorders, and inflammatory conditions [49,50].

9.3 Advanced Drug Delivery Systems



The use of nanoparticles, liposomes, and other drug delivery systems is enhancing the bioavailability of *Tridax procumbens* compounds. These technologies improve the therapeutic efficacy of the plant's active constituents by protecting them from degradation and ensuring targeted delivery [51,52].

10. Toxicological Profile and Safety Assessments

10.1 Acute Toxicity

Studies on the acute toxicity of *Tridax procumbens* indicate that the plant has a low toxicity profile. No significant adverse effects have been observed at normal therapeutic doses in both in vitro and animal studies [53,54].

10.2 Long-Term Safety

Long-term studies show that chronic use of *Tridax procumbens* does not lead to toxicity or organ damage. The plant does not cause significant changes in blood chemistry or organ function, making it safe for prolonged use in therapeutic settings [55,56].

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