World Journal of Pharmaceutical and Life Sciences

Impact Factor: 8.21 www.wjpls.org Coden USA: WJPLA7

PHARMACOGNOSTICAL, PHYTOCHEMICAL AND PHARMACOLOGICAL INVESTIGATIONS OF TRIDAX PROCUMBENS LINN: A COMPHRENSIVE REVIEW

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DOI: https://doi.org/10.5281/zenodo.22842738

How to cite this Article: M. Naveen*[1], S. Lokaravind[2], B. Sindhu[3], Kamalesh Iniyanathan, E.V. Balaji, A. Subhashree (2026). Pharmacognostical, Phytochemical And Pharmacological Investigations Of Tridax Procumbens Linn: A Comphrensive Review. World Journal of Pharmaceutical and Life Sciences, 12(9), 148–156.

Article Received on 05/08/2026 **Article Revised on 25/08/2026** **Article Published on 01/09/2026**

ABSTRACT

Tridax procumbens L. is a medicinal plant from the Asteraceae family. People in traditional medicine use it a lot to treat wounds, skin problems, swelling, fever, diabetes, and different kinds of infections. Many studies done in labs and on living things have backed up its healing powers. This review gives an overview of the plant's botany, how people have used it traditionally, what chemicals it contains, and what biological effects it has. Information came from scientific papers and databases like PubMed, Google Scholar, Scopus, ScienceDirect, and Web of Science. According to the literature, T. procumbens has plenty of active compounds - things like flavonoids, alkaloids, tannins, saponins, terpenoids, phenolic compounds, glycosides, and essential oils. These compounds give the plant its wide range of biological actions. Some of the reported effects include antioxidant, antimicrobial, anti-inflammatory, antidiabetic, wound-healing, liver-protecting, anticancer, and immune-modulating properties. The current evidence indicates that T. procumbens is a valuable source of natural bioactive compounds with significant therapeutic potential, including cardioprotective effects. While the findings are encouraging, further phytochemical studies and well-designed clinical trials are needed to better understand its medicinal properties and support the development of safe and effective therapeutic agents.

KEYWORD: Tridax procumbens, Asteraceae, phytochemistry, pharmacognosy, pharmacological activities, medicinal plant.

INTRODUCTION

When it comes to the varied genetic history of medicinal plants, particularly those essential to ancient systems like Ayurveda and Yoga, India is one of the most resource-rich nations in the world. Herbal remedies have been used for years to treat a wide range of medical conditions. Because they are generally well-tolerated and thought to be both gentle and effective in promoting human well-being, these plant-derived therapies offer a valuable alternative to contemporary chemical-based medications. Due to its flower-like appearance, Tridax procumbens Linn., often known as "Ghamra" or "coat buttons" in English, is used extensively in traditional Ayurvedic medicine to treat a variety of ailments. It is also utilized similarly to "Bhringraj," a well-known herbal medicine for liver-related issues, in some traditional practices. This plant has long been used in parts of Africa, Southeast Asia, and South Asia as a herbal infusion to treat liver issues, gastrointestinal disorders like diarrhoea and dysentery, and respiratory ailments like bronchial catarrh, despite once being thought of as a weed that harmed various crops. Originally from Central America, this herbaceous plant, which can be either annual or perennial, is now found all over India. It is especially common as a weed in places like Maharashtra, Madhya Pradesh, and Chhattisgarh. It usually roots at the nodes and produces solitary, long-stemmed, heterogamous, bisexual yellow composite flowers with characteristic white floral heads. The plant has petiolate, ovate or lanceolate-shaped, coarsely serrated, densely hairy leaves.[1-2]

TAXONOMICAL CLASSIFICATION

Table 1: Taxonomical classification.

Taxonomic Rank	Classification
Kingdom	Plantae
Subkingdom	Tracheobionta (Vascular plants)
Superdivision	Spermatophyta (Seed plants)[4,5]
Division	Magnoliophyta (Angiosperms)[5]
Class	Magnoliopsida (Dicotyledons)[5]
Subclass	Asteridae[5,6]
Order	Asterales[5,6]
Family	Asteraceae (Compositae)[5,6]
Genus	Tridax[6]
Species	Tridax procumbens L.[6]

SYNONYMS

Commonly cited synonyms include:

1. Balbisia procumbens (L.) DC.
2. Tridax angustifolia Kunth
3. Tridax diffusa Rose
4. Tridax mexicana A. Gray
5. Tridax trilobata (L.) Hitchc.
6. Chrysanthemum procumbens L. [(historical name in older literature)

VENACULAR NAMES

Table 2: Vernacular names.

English	Coat Buttons and Tridax Daisy,
Hindi	Ghamra,
Sanskrit	Jayanti Veda,
Marathi	Dagadi Pala,
Telugu	Gaddi Chemanthi,
Tamil	Thata poodu,
Malayalam	Chiravanak,

MOROPHOLOGICAL STRUCTURE

LEAVES

Typically fashioned like an arrow, leaves have uneven teeth. They range in size from 3 to 7 cm and are simple, ovate, opposite, exstipulate, and lanceolate. basal leaf with a wedge form, small petioles, and hair on both sides.[7]

Figure – 1 Tridax procumbens whole plant and leaf.

STEMS

The grew up right [assending] to a height of 30-50cm. they are branched, sparsely hairy, and capable of rooting at nodes.[7]

Figure – 2: Tridax procumbens stems.

FLOWERS
The flowers resemble some small daisies and are arranged in capitulum in floreseences on long, slender peduncnes [flower stalks].[7,8]

STRUCTURE: The floral heads consist of two flower types; outer ray florets and central, featuring a basal placentation arrangement.[7,8,9]

PETAL AND COLOUR
The ray florets feature three-lobed tips, with coloration ranging from white to yellow surrounding a distinct yellow centre.

FRUIT/ SEEDS UNIT: The resulting achenes are black, narrowly obconical, measuring 2.0-2.5mm in length, and topped with feathery pappus.

FLOWERING: PERIOD: The plant flowers and produces fruit continuously throughout the year.[9-11]

Figure – 3: Tridax procumbens flow.

FRUIT
The fruit is hard, hairy achene featuring a white, faether-plume acts as a parachute, allowing the wind to easily carry the seeds over long distances-a key fcontributing to the plant's invasive nature.[11]

Figure – 4: Tridax procumbens fruit.

CALYX
The calyx is either reduced to tiny scales or modified entirely into pappus structure.

Figure – 5: Tridax procumbens calyx.

SEEDS

The seeds contain a pendulous embryo and lack endos.[7,11]

Figure – 6: Tridax procumbens seeds.

PHYTOCHEMICAL CONSTITUENTS

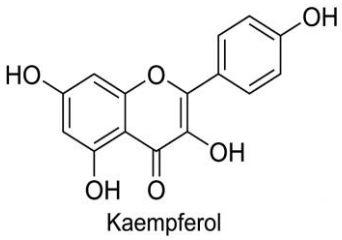
Flavonoids, alkaloids, carotenoids, hydroxycinnamates, lignans, derivatives of benzoic acid, phytosterols, tannins, crude proteins, crude fiber, soluble carbohydrates, and calcium oxide have all been found in the leaf and other portions of T. procumbens L.

There have also been reports of fumaric acid, β-sitosterol, and the pentacyclic triterpenoid oleanolic acid There have been reports of luteolin, glucoluteolin, quercetin, and isoquercetin in flower extracts 2,6-dihydroxyacetophenone, 2-O-β-D-glucopyranoside, echioidinin, pinostrobin, dihydroechioidinin, tectochrysin-5-glucoside, methyl salicylate glucoside, 5,7,8-trimethoxyflavone, skullcapflavone-2-methyl ether, androechin, tectochrysin, 5,7,2'-trimethoxyflavone, and andrographidine.[12]

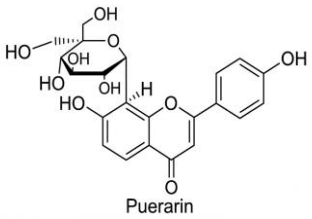
Flavonoids

Free radical scavenging, anti-inflammatory, antiallergic, antiplatelet aggregation, antibacterial, antiulcer, antiviral, anticancer, and antihepatotoxicity are among the pharmacological actions that the flavonoids found in T. procumbens are known to mediate. Along with four known compounds with antioxidant activity, puerarin, esculetin, oleanolic acid, and betulinic acid, two new flavones, 8,3′-dihydroxy-3,7,4′-trimethoxy-6-O-β-D-glucopyranosylflavone and 6,8,3′-trihydroxy-3,7,4′-trimethoxyflavone From the aerial portions of T. procumbens, a novel flavonoid called procumbenetin was identified as 3,6-dimethoxy-5,7,2',3',4'-pentahydroxyflavone 7-O-β-D-gluco-pyranoside using spectroscopic and chemical methods.[12,13]

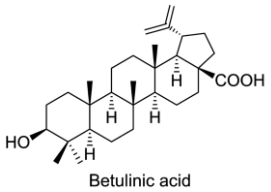
The primary flavonoid in T. procumbens L. leaves is kaempferol, whose structure is depicted in Figure 1. According to preclinical research, kaempferol and its glycosidic derivatives have a variety of therapeutic qualities, including anti-inflammatory, antimicrobial, antifungal, anticancer, cardioprotective, neuroprotective, hepatoprotective, antidiabetic, hypocholesterolemic, hypotriglyceridemic, antiosteoporotic, estrogenic/antiestrogenic, anxiolytic, and antiallergic activities (11–14). By mediating anti-inflammatory or immunomodulatory actions, kaempferol has numerous positive benefits on inflammatory disorders. It suppresses matrix-degrading enzymes and blocks a number of signaling pathways.[13,16]



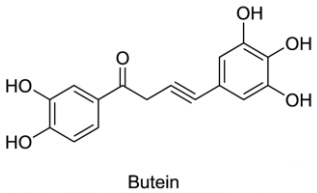
Kaempferol



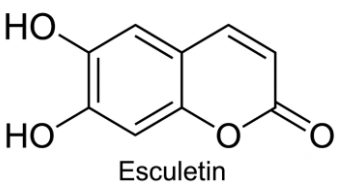
Puerarin



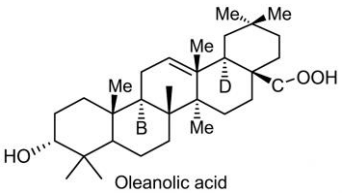
Betulinic acid



Butein



Esculetin



Oleanolic acid

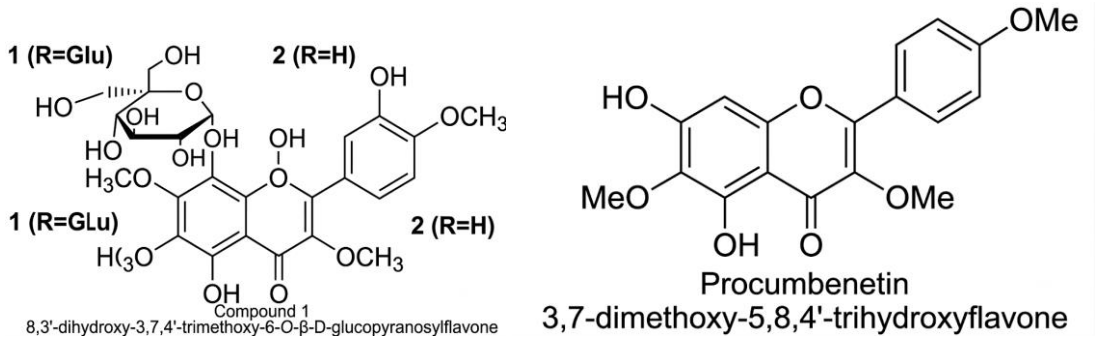


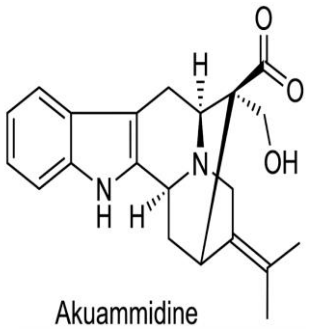
Figure – 7: Structure of some flavonoids identified.

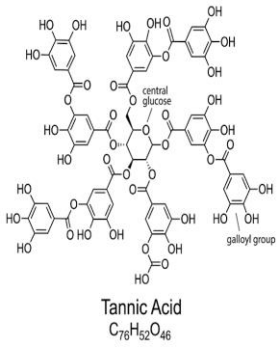
Table 3: Anti-inflammatory mechanisms of kaempferol on inflammatory diseases. [12]

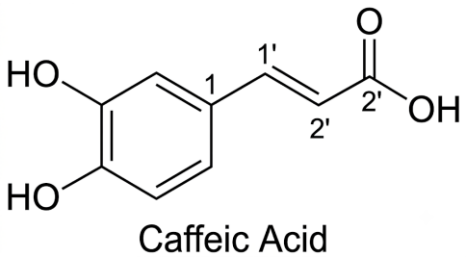
Anti-inflammatory Disease	**Mode of Action**
Intervertebral Disc Degeneration (IVD)	Inhibition of lipopolysaccharide (LPS) induced apoptosis, chondrogenic markers (collagen II, SOX-9 and aggrican), matrix degrading enzymes and lipid anabolism associated genes
Osteoarthritis	Inhibition of NF-kB signaling pathway
Colitis	Inhibition of NF-kB signaling pathway
Mastitis	Suppression of myeloperoxidase (MPO), IL-6, TNF-α and ANGPTL2 expression
Rheumatoid Arthritis	Inhibition of fibroblast like synoviocytes (FLS) by blocking mitogen activated protein kinase (MAPK) pathway without affecting TNF-α receptors
Allergic asthma	Suppression of eosinophil infiltration
Mucus Hypersecretion	Disturbance of Transforming growth factor β (TGF-β) and ER stress signaling of inositol requiring enzyme 1α/TNF receptor associated factor 2/c-JuN-terminal kinase (JNK)
Gastric Ulcer	Inhibition of neutrophil accumulation, MPO activity and inflammatory cytokines; improves NO production.

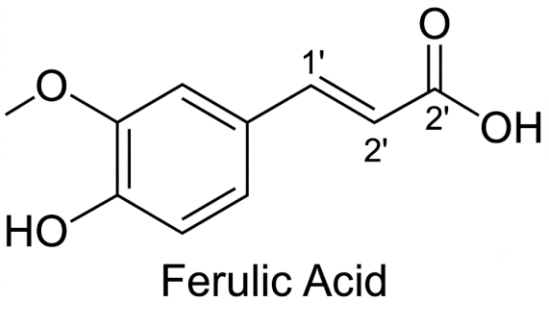
Alkaloids

According to a recent study by Ikewuchi et al., the total alkaloid content of T. procumbens L. leaves was 102.421 g/kg of dry weight and 10.191 g/kg of wet weight.[12,16]









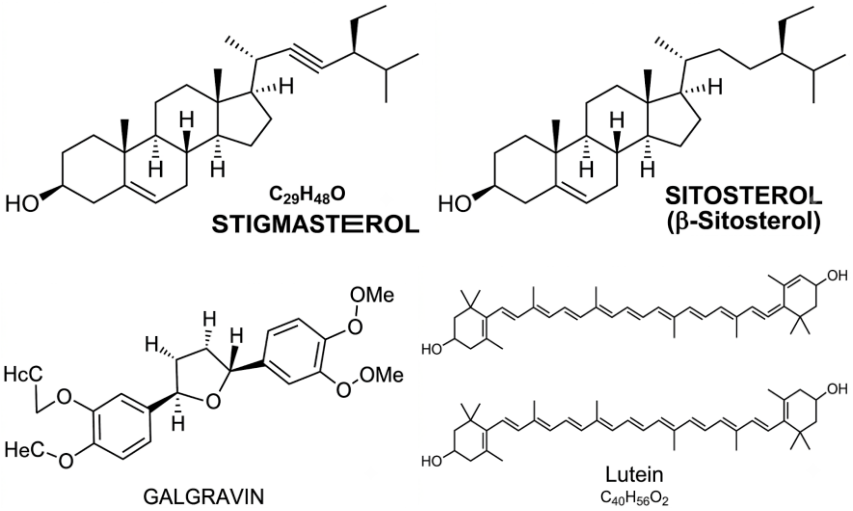


Figure – 7: Other phytochemicals present in T. procumbens.

Biological properties of akuammidine include antibacterial, antifungal, antimalarial, anti-inflammatory, hypotensive, skeletal muscle relaxant, local analgesic, and antidepressant. The presence of several alkaloids in T. procumbens L. leaves was also confirmed by other research. These alkaloids have been qualitatively isolated using various solvents, such as methanol and chloroform, and various techniques, such as infusion and decoction.[12,16]

PHARMACOLOGICAL ACTIVITY

ANTICANCER ACTIVITY

Cancer is a complex illness. T. procumbens has recently been studied for its anticancer properties. Crude flower aqueous and acetone extract were used to evaluate prostate epithelial malignant cells (PC3). Acetone extract has 82.28% activity against cancer cells within 24 hours of therapy, but aqueous extract has very little anticancer activity. The development of tumour nodules in the lungs inhibits the growth of new blood vessels. Oils from the plant T. procumbens can cause apoptosis.[17,22]

ANTIOXIDANT ACTIVITY

The transcription factor NF-κB is activated by the oxygen free radicals produced by phagocytes, leading to the generation of inflammatory cytokines and the activation of cyclooxygenase-2 (COX-2). This starts a cascade of tissue damage that needs to be stopped. T. Procombens has antioxidant properties. DPPH (2, 2-diphenyl-picrylhydrazyl hydrate) and ABTS [2, 2'azino-bis (3-ethyl benzothiazoline6-sulfonic acid)] techniques were used to confirm this. With IC50 values of 37.39 µg/ml, the ethanol extract's chloroform and ethyl acetate fractions had the highest activity in the DPPH technique. Furthermore, in the DPPH mode, the methanol extract demonstrated antioxidant activity. The action is mostly caused by the extracts' flavonoids and alkaloids.[23,27]

ANTI-DIABETIC ACTIVITY

Aqueous, methanolic, and ethanolic extracts of T. procumbens shown antidiabetic action. When taken orally for seven days in a row, the extracts decreased blood glucose levels, which in turn decreased the alloxan-induced diabetes condition in the Wistar rat animal model. Alloxan induces diabetes by killing the pancreatic beta cells that produce insulin. Alloxan causes cell necrosis because it is poisonous to beta cells. Alloxan's cytotoxic action is enhanced by reactive oxygen species and a rise in the concentration of calcium in the cytosol, which causes beta cells to be rapidly destroyed. The extracts increase peripheral glucose utilization, promote insulin release, restore pancreatic beta cells damaged by alloxan, or enhance glycolytic and glycogenic activities by lowering glycogenolysis and gluconeogenesis. One of T's active principles is dihydroxy-olide The hexane extract's active ingredient, procumbens, has antidiabetic properties. In people with type-II diabetes, it lowers glucose absorption and prevents blood glucose levels from rising after a meal.[28,31]

ANALGESIC ACTIVITY

Male mice and male Sprague-Dawley rats are used in two analgesic and one inflammatory in-vivo pain models to assess the analgesic activity. The extract showed significant inhibition in the late phase (beginning about 20 minutes and lasting about 40 to 60 minutes) of the Formalin-induced persistent pain (Biphasic pain), which appears to be caused by tissue and functional changes in the dorsal horn of the spinal cord. This suggests that they contain active analgesic principles acting centrally. T. procumbens extract effectively and dose-dependently decreased abdominal writhing in the acetic acid-induced writhing test (peripheral pain) (abdominal constriction test). Mechanical hyperanalgesia was considerably lessened in rats with complete Freund's adjuvant (CFA)-induced hyperanalgesia (inflammatory pain).[32,34]

In comparison to the writhes of the control group, animals pretreated with TPEE (Ethanolic extract) and TPEAE (Ethyl Acetate extract) at a dose of 300 mg/kg reduce acetic acid-induced writhing by up to 68.2% and 30.8%, respectively. Rats writhed more intensely when exposed to NaCl than when exposed to acetic acid; these

writhes were inhibited up to 71.2% by 300 mg/kg T. procumbens ethanolic extract and 22.8% by 300 mg/kg T. procumbens ethyl acetate extract as compared to the control group. In comparison to the negative control group, T. procumbens ethanolic extract at 300 mg/kg exhibits significant ($P<0.01$) analgesic activity and less significant ($P<0.05$) at 200 mg/kg, whereas its ethyl acetate extract was less significant ($P<0.05$) at 300 mg/kg and not significant ($P>0.05$) at 200 mg/kg.[34]

WOUND HEALING

Wounds have long been treated using Tridax procumbens. T. procumbens enhances wound healing through interactions with epidermal, dermal, extracellular matrix, soluble proteins, and angiogenesis processes regulated by a range of cytokines and growth factors. investigated the possible effect of ethanol and aqueous extracts of Tridax procumbens Linn in wound healing. Both models of incision and excision wounds were evaluated. The animals were split up into groups for intervention and control. The results showed that the wounds in the intervention group had significantly greater tensile strength than those in the control group. In the excision wound model, biochemical tissue markers like collagen, hydroxyproline, and hexosamine were significantly higher in the therapy group on the fifteenth day. The wound area of the intervention group was different from the controls. The results showed that the wounds of the intervention group had a significantly higher tensile strength than those of the controls. In the excision wound model, biochemical tissue markers like collagen, hydroxyproline, and hexosamine were significantly greater in the treatment group on the fifteenth day. The intervention group's wound area was significantly smaller than that of the controls. Previous research has shown that the elimination of collagen and other cellular "macromolecules" created as part of the acute inflammation that takes place during wound healing leads to the creation of a scar. Histopathological evaluations revealed a rapid turnover of collagen and an elevated granulation spike.[35]

ANTIHYPERTENSIVE ACTIVITY

Heart failure, myocardial infarction (MI), and cardiovascular and coronary artery disease are all predicted by elevated pulse pressure, regardless of diastolic or systolic blood pressure. On the other hand, tachycardia, or elevated heart rate, is linked to a higher risk of dying from cardiovascular and noncardiac causes . In Sprague-Dawley rat models, an aqueous extract of T. procumbens leaves decreased heart rate and mean arterial blood pressure.[36,37]

FINDINGS AND DISCUSSION

The review of *Tridax procumbens* Linn. indicates that the plant possesses significant pharmacognostic, phytochemical, and pharmacological properties. Pharmacognostic evaluation reveals characteristic morphological and microscopic features that are useful for proper identification and standardization of the plant. Phytochemical investigations have demonstrated the presence of important bioactive constituents such as flavonoids, alkaloids, tannins, saponins, terpenoids, steroids, phytosterols, carotenoids, phenolic compounds, and essential oils. Flavonoids such as luteolin, quercetin, glucoluteolin, and isoquercetin are among the important constituents reported from the plant. These phytochemicals may contribute to the various biological activities of *T. procumbens*. Pharmacological studies have reported antioxidant, antimicrobial, anti-inflammatory, analgesic, wound-healing, antidiabetic, hepatoprotective, immunomodulatory, and anticancer activities. The wound-healing, antimicrobial, and anti-inflammatory properties particularly support several of its traditional medicinal applications. However, most available studies have been conducted using crude extracts and experimental models, and the results can vary depending on the plant part, extraction method, geographical source, and dosage. Further studies are therefore required to identify the specific active compounds, establish mechanisms of action, evaluate toxicity, and standardize the extracts.

CONCLUSION

Tridax procumbens Linn. is an important medicinal plant with considerable pharmacognostic, phytochemical, and pharmacological potential. The present review indicates that the plant contains a wide variety of biologically active phytoconstituents, including flavonoids, alkaloids, tannins, saponins, terpenoids, steroids, phenolic compounds, carotenoids, and essential oils. These constituents are believed to contribute to the diverse therapeutic properties of the plant. Pharmacological investigations have demonstrated several important activities, including antioxidant, antimicrobial, anti-inflammatory, analgesic, wound-healing, antidiabetic, hepatoprotective, immunomodulatory, and anticancer effects. Among these, the antioxidant, antimicrobial, anti-inflammatory, and wound-healing properties are particularly significant and provide scientific support for some of its traditional medicinal applications.

The pharmacognostic characteristics of *T. procumbens* are useful for its proper identification, authentication, and quality control, while phytochemical studies provide valuable information regarding the chemical constituents responsible for its biological activities. The presence of compounds such as flavonoids and phenolic substances may play an important role in reducing oxidative stress and inflammation, whereas other phytoconstituents may contribute to its antimicrobial and wound-healing effects. The combined action of these constituents may be responsible for the overall therapeutic potential of the plant.

Although numerous experimental studies have demonstrated promising pharmacological effects, most of the available evidence is based on laboratory and animal studies. Therefore, the results cannot be directly considered as proof of clinical efficacy in humans.

Variations in plant material, geographical location, plant part used, extraction procedure, solvent, concentration, and experimental conditions may also influence the reported activities. Hence, proper standardization of *T. procumbens* extracts is essential for obtaining consistent and reproducible results.

Further research should focus on the isolation and characterization of specific active compounds, investigation of their mechanisms of action, determination of effective and safe doses, toxicity studies, pharmacokinetic evaluation, and well-designed clinical trials. Such studies will help to establish the therapeutic value and safety profile of *T. procumbens* more clearly. In conclusion, *Tridax procumbens* Linn. can be considered a valuable natural source of bioactive compounds and a promising candidate for the development of standardized herbal formulations and future pharmaceutical products. Its rich phytochemical profile and wide range of reported pharmacological activities justify continued scientific investigation and may contribute to the discovery of new and effective natural therapeutic agents.

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