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Comprehensive Review on Tridax procumbens Linn: Phytochemistry, Pharmacology, and Therapeutic Prospects

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ABSTRACT
Tridax procumbens Linn., commonly referred to as coat button, kansari, or ghamara, is an ethnomedicinal plant belonging to the Asteraceae family and is widely distributed across tropical and subtropical regions. In traditional systems of medicine, including Ayurveda and folk practices, it has been extensively utilized for the management of wound healing, skin-related infections, hepatic disorders, diarrhea, dysentery, and various respiratory conditions. The plant is enriched with a wide variety of secondary metabolites such as flavonoids, alkaloids, tannins, carotenoids, phytosterols, fatty acids, and phenolic constituents, which are responsible for its diverse therapeutic properties. Contemporary scientific studies have reported several pharmacological activities of the plant, including antioxidant, antimicrobial, anti-inflammatory, hepatoprotective, immunomodulatory, vasodilatory, antileishmanial, and anticancer effects. Phytochemical investigations and fractionation techniques have identified multiple bioactive compounds exhibiting strong free radical scavenging ability, xanthine oxidase inhibition, and antibacterial potential, with flavonoids, sterols, and fatty acids being the primary active constituents. However, despite these promising biological activities, detailed and systematic research focusing on the isolation, structural characterization, and clinical evaluation of its active principles is still limited. This review compiles and discusses existing information on the taxonomy, morphology, geographical distribution, phytochemical profile, and pharmacological properties of *T. procumbens*. The findings highlight its importance as a cost-effective, safe, and readily available medicinal plant. Further in-depth investigation of its bioactive compounds may facilitate the development of novel therapeutic agents, especially for populations in tropical and resource-limited regions where this plant is abundantly available

1. INTRODUCTION:

Tridax procumbens Linn. is an important medicinal herb belonging to the family Asteraceae, widely distributed in tropical and subtropical regions including India, Asia, Africa, and South America. Commonly known as “coat buttons,” the plant has gained considerable medicinal importance due to its extensive traditional utilization in various indigenous systems of medicine such as Ayurveda and folk medicine. Traditionally, the whole plant and its extracts have been used for wound healing, liver disorders, inflammation, diarrhea, dysentery, diabetes, and infectious diseases. The growing scientific interest in medicinal plants has increased research attention toward *T. procumbens* because of

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its remarkable therapeutic efficacy and broad spectrum of biological activities [1,2]

The medicinal value of *T. procumbens* is mainly attributed to the presence of diverse phytoconstituents, including flavonoids, alkaloids, carotenoids, tannins, terpenoids, saponins, phenolic compounds, and sterols. Phytochemical investigations have identified several important bioactive compounds such as luteolin, quercetin, β-sitosterol, fumaric acid, glucoluteolin, and procumbenetin, which are reported to possess antioxidant, antimicrobial, anti-inflammatory, and anticancer activities. These phytochemical constituents contribute significantly to the therapeutic efficacy of the plant and have encouraged researchers to investigate its pharmaceutical potential for novel drug development.[1,3,4] Several pharmacological studies have scientifically validated many traditional claims associated with *T. procumbens*. Experimental evidence has demonstrated notable wound healing activity by promoting collagen formation and tissue regeneration. Furthermore, extracts of the plant have shown hepatoprotective, antimicrobial, anti-diabetic, antioxidant, anti-inflammatory, immunomodulatory, and hypotensive effects in different *in vitro* and *in vivo* experimental models. Such pharmacological findings support the use of *T. procumbens* as a promising medicinal plant for future therapeutic interventions and pharmaceutical applications. [1,5,6]

In recent years, there has been increasing global interest in herbal medicine and plant-derived bioactive compounds because of the limitations and adverse effects associated with synthetic drugs. Medicinal plants possessing multi-target therapeutic actions with improved safety profiles are increasingly preferred for managing chronic diseases and resistant infections. In this regard, *T. procumbens* has emerged as a potential candidate due to its accessibility, affordability, traditional medicinal relevance, and pharmacological versatility. [7,8] Although numerous studies have documented the phytochemical and pharmacological properties of *T. procumbens*, consolidated scientific evidence regarding its therapeutic prospects remains scattered. Therefore, the present review aims to comprehensively summarize the available literature on the phytochemistry, pharmacological activities, traditional medicinal uses, and therapeutic potential of *Tridax procumbens* Linn. Additionally, this review highlights recent advancements and future opportunities for its effective utilization in pharmaceutical and biomedical research. [1,2]

2. Botanical Description, Taxonomy and Ethnomedicinal Uses of *Tridax procumbens* Linn:

2.1 Botanical Description:

Tridax procumbens Linn. is a perennial herbaceous weed belonging to the family Asteraceae. The plant is commonly distributed in tropical and subtropical climates and grows abundantly in roadsides, agricultural fields, grasslands, wastelands, and disturbed habitats. It possesses a creeping or procumbent growth habit with ascending flowering branches. The stem is cylindrical, branched, rough, hairy, and capable of rooting at nodes, which contributes to its rapid vegetative spread. The leaves are simple, opposite, petiolate, ovate to lanceolate in shape with serrated margins and covered by trichomes. The plant produces solitary flower heads (capitula) with characteristic white ray florets and yellow tubular disc florets, which contribute to its common name “coat buttons.” Fruits are achene-type seeds bearing feathery pappus hairs that facilitate wind dispersal and propagation. Due to its adaptive growth characteristics and high ecological tolerance, *T. procumbens* has become widely naturalized across tropical regions. [1,2,9]

2.2 Taxonomical Classification:

The taxonomical classification of *Tridax procumbens* Linn. is presented below according to standard botanical nomenclature systems. The plant belongs to the kingdom Plantae and is classified under the family Asteraceae, one of the largest flowering plant families known for medicinally important species. Accurate taxonomic classification plays a significant role in medicinal plant authentication, phytochemical standardization, and pharmacognostic evaluation. [1,10]

Taxonomical Classification of *Tridax procumbens* Linn:

Table No2.2: Taxonomical Classification of *Tridax procumbens* Linn.

Taxonomic Rank	Classification
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Asterales
Family	Asteraceae
Genus	*Tridax*
Species	*Tridax procumbens* Linn.

The genus *Tridax* comprises several species; however, *T. procumbens* is the most extensively investigated species due to its wide ethnomedicinal importance and significant pharmacological properties. Botanical authentication and taxonomic identification are considered essential to avoid adulteration and ensure consistency in medicinal plant-based formulations. [2,10]

2.3 Ethnomedicinal Uses:

Tridax procumbens has been widely utilized in

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traditional medicine for centuries due to its broad therapeutic potential. Different parts of the plant, including leaves, stems, flowers, and whole plant extracts, have been used by indigenous communities and traditional healers to treat various ailments. Traditionally, fresh leaf juice is applied externally for wound healing, cuts, burns, and skin infections because of its antimicrobial and anti-inflammatory properties. The plant has also been employed in the management of diarrhea, dysentery, bronchial disorders, fever, malaria, and gastrointestinal disturbances. In rural healthcare systems, crushed leaves are frequently used to stop bleeding and promote tissue repair. [1,11]

In Ayurveda and folk medicinal practices, *T. procumbens* has been used for the treatment of diabetes, hypertension, liver disorders, anemia, and inflammatory diseases. Decoctions prepared from leaves and flowers are consumed orally to improve immunity, reduce fever, and manage metabolic disorders. Moreover, traditional reports indicate its use as a hair growth promoter and in preventing hair fall due to its nourishing effect on the scalp. Ethnopharmacological studies have further demonstrated that medicinal plants possessing multiple therapeutic actions often serve as important leads for pharmaceutical drug discovery, thereby increasing scientific interest in *T. procumbens*. [11,7,8,12]

3. Phytochemistry and Phytochemical Constituents of *Tridax procumbens* Linn:

3.1 Overview of Phytochemistry:

The therapeutic importance of *Tridax procumbens* Linn. is primarily attributed to its diverse phytochemical composition, which comprises numerous biologically active secondary metabolites. Medicinal plants synthesize these phytoconstituents as protective agents against environmental stress, pathogens, and herbivores, while also contributing to their pharmacological properties in humans. Extensive phytochemical investigations on *T. procumbens* have revealed the presence of flavonoids, alkaloids, carotenoids, tannins, saponins, steroids, terpenoids, polysaccharides, fatty acids, and phenolic compounds. These phytoconstituents are responsible for the plant's antioxidant, antimicrobial, anti-inflammatory, hepatoprotective, wound healing, anti-diabetic, and anticancer activities, thereby supporting its traditional medicinal applications. [1,2]

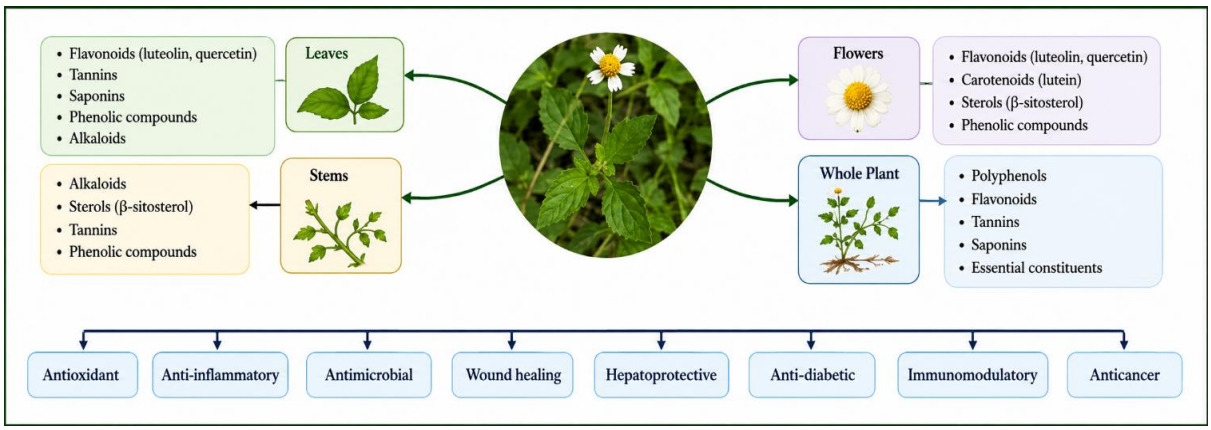

Figure 3.1: Distribution of phytoconstituents in different parts of *Tridax procumbens* Linn.

3.2 Major Phytochemical Constituents:

Several studies have identified important phytochemicals from different parts of *T. procumbens*, including leaves, stems, flowers, and roots. Among flavonoids, luteolin, quercetin, glucoluteolin, and isoquercetin have been extensively reported and are known for their antioxidant and anti-inflammatory properties. Steroidal compounds such as β-sitosterol and stigmasterol contribute to anti-inflammatory and cholesterol-lowering activities. Additionally, carotenoids including lutein and other pigments have demonstrated antioxidant effects that may help in preventing oxidative stress-induced tissue damage.[1,3,4] The plant also contains tannins, saponins, and alkaloids, which play a vital role in antimicrobial defense and wound healing mechanisms. Tannins contribute to tissue contraction and accelerated wound repair, while saponins are associated with membrane stabilization and immune-enhancing effects. Furthermore, phenolic acids and volatile constituents isolated from *T. procumbens* have demonstrated free radical scavenging and anti-inflammatory activities, thereby strengthening the pharmacological significance of the plant. Recent phytochemical studies have also reported the presence of polysaccharides and fatty acid derivatives that may contribute to immunomodulatory and cytoprotective effects. [2,13]

3.3 Bioactive Compounds and Their Therapeutic Relevance:

The pharmacological efficacy of *T. procumbens* is

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strongly correlated with the synergistic interaction of its bioactive constituents. Flavonoids such as quercetin and luteolin exhibit potent antioxidant activity by scavenging reactive oxygen species and reducing oxidative stress. β-sitosterol has demonstrated anti-inflammatory and immunomodulatory potential, whereas tannins and saponins contribute significantly to wound healing and antimicrobial effects. Such phytoconstituents may provide promising leads for the development of plant-based therapeutic agents targeting chronic inflammatory diseases, diabetes, microbial infections, and cancer-related complications. [1,4,8]

The growing demand for natural bioactive compounds in pharmaceutical and nutraceutical industries has further accelerated phytochemical research on medicinal plants. Since *T. procumbens* contains multiple pharmacologically active metabolites with broad therapeutic applications, it has emerged as a valuable medicinal plant for future drug development. However, further studies involving phytochemical standardization, molecular characterization, toxicity evaluation, and clinical validation are required to establish its safety and efficacy for therapeutic use. [7,8]

Table 3.1 Major Phytochemical Constituents of *Tridax procumbens* Linn:

Phytochemical Class	Major Constituents	Therapeutic Importance
Flavonoids	Luteolin, Quercetin, Isoquercetin	Antioxidant, Anti-inflammatory
Steroids	β-sitosterol, Stigmasterol	Anti-inflammatory, Hypocholesterolemic
Tannins	Polyphenolic compounds	Wound healing, Antimicrobial
Saponins	Glycosidic saponins	Immunomodulatory
Alkaloids	Various nitrogen-containing compounds	Antimicrobial
Carotenoids	Lutein	Antioxidant
Phenolic Compounds	Phenolic acids	Free radical scavenging

4. Pharmacological Activities of *Tridax procumbens* Linn:

The pharmacological potential of *Tridax procumbens* Linn. has been extensively investigated due to the presence of diverse bioactive phytoconstituents including flavonoids, tannins, alkaloids, steroids, terpenoids, and phenolic compounds. Scientific studies have validated several traditional medicinal claims and demonstrated a wide spectrum of biological activities such as wound healing, anti-inflammatory, antimicrobial, antioxidant, hepatoprotective, anti-diabetic, anticancer, hypotensive, and immunomodulatory effects. These pharmacological actions are mainly attributed to the synergistic interaction of phytochemical constituents present in different parts of the plant. [1,2]

4.1 Wound Healing Activity:

Wound healing is one of the most extensively studied pharmacological properties of *T. procumbens*. Traditionally, fresh leaf extracts have been applied to wounds, cuts, and burns to accelerate healing and control bleeding. Experimental studies have reported that plant extracts significantly enhance wound contraction, collagen synthesis, epithelialization, and tissue regeneration. The wound healing effect is mainly attributed to flavonoids, tannins, and alkaloids that exhibit antimicrobial and antioxidant activities, thereby preventing infection and oxidative tissue damage. Furthermore, increased collagen deposition and fibroblast proliferation contribute to faster wound closure and improved tissue remodeling. [1,9]

4.2 Anti-inflammatory Activity:

Inflammation is a protective physiological response against tissue injury and infection; however, chronic inflammation may lead to several pathological conditions. Various *in vivo* studies have demonstrated significant anti-inflammatory activity of *T. procumbens* extracts through inhibition of inflammatory mediators and reduction of edema formation. The presence of flavonoids, sterols, and phenolic compounds contributes to the suppression of inflammatory pathways and oxidative stress. Due to its natural anti-inflammatory potential, *T. procumbens* may serve as a safer alternative to synthetic anti-inflammatory drugs associated with adverse effects. [1,14]

4.3 Antimicrobial Activity:

Numerous investigations have demonstrated broad-spectrum antimicrobial activity of *T. procumbens* against various bacterial and fungal pathogens. Plant extracts have shown inhibitory effects against microorganisms such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. The antimicrobial efficacy is primarily attributed to tannins, alkaloids, flavonoids, and essential phytoconstituents capable of disrupting microbial cell membranes and inhibiting microbial growth. These findings support the traditional use of the plant in treating skin infections, wounds, and gastrointestinal disorders. [2,9]

4.4 Antioxidant Activity:

Oxidative stress caused by free radicals is associated with aging, inflammation, diabetes, cardiovascular diseases, and cancer. *T. procumbens* exhibits potent antioxidant activity due to the presence of flavonoids, phenolic compounds, and carotenoids that effectively scavenge reactive oxygen species (ROS). Several studies have reported significant free

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radical scavenging activity in different plant extracts, which contributes to cellular protection against oxidative damage. This antioxidant potential further enhances its therapeutic role in chronic disease management and tissue repair. [1,13]

4.5 Anti-diabetic Activity:

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels. Several experimental studies have demonstrated the anti-diabetic activity of *T. procumbens* through reduction of blood glucose levels and improvement of metabolic function. The plant extract has shown promising results in alloxan-induced diabetic animal models by regulating glucose metabolism and improving antioxidant defense mechanisms. Flavonoids and phenolic compounds are considered major contributors to its anti-diabetic action through pancreatic protection and enhancement of insulin sensitivity. [5,6]

4.6 Hepatoprotective Activity:

The liver plays an essential role in metabolism and detoxification; therefore, hepatic protection is important in disease prevention. Studies have shown that *T. procumbens* possesses hepatoprotective activity against chemically induced liver damage due to its antioxidant and anti-inflammatory effects. Plant extracts help in reducing liver enzyme levels, minimizing oxidative stress, and protecting hepatocytes from toxic injury. Such findings indicate its therapeutic potential in the management of liver disorders and hepatic dysfunction. [1,15]

4.7 Anticancer Activity:

Recent pharmacological studies have highlighted the anticancer potential of *T. procumbens* owing to the presence of bioactive phytoconstituents capable of inducing apoptosis and inhibiting tumor growth. Flavonoids and phenolic compounds may interfere with cancer cell proliferation by modulating oxidative stress pathways and cellular signaling mechanisms. Although preclinical findings are encouraging, extensive molecular studies and clinical investigations are still required to establish its efficacy and safety in cancer therapy. [1,8]

5. Mechanism of Action and Therapeutic Prospects of *Tridax procumbens* Linn:

5.1 Mechanism of Action:

The therapeutic efficacy of *Tridax procumbens* Linn. is mainly associated with the synergistic activity of multiple phytoconstituents, including flavonoids, tannins, phenolic compounds, alkaloids, carotenoids, and sterols. These bioactive compounds exert pharmacological actions through antioxidant, anti-inflammatory, antimicrobial, immunomodulatory, and cytoprotective mechanisms. The presence of flavonoids such as quercetin and luteolin contributes significantly to free radical scavenging activity by neutralizing reactive oxygen species (ROS), thereby reducing oxidative stress and preventing cellular damage. Such antioxidant activity plays an important role in preventing chronic inflammatory diseases, metabolic disorders, and tissue degeneration. [1,2]
The anti-inflammatory mechanism of *T. procumbens* is associated with inhibition of inflammatory mediators such as prostaglandins, cytokines, and nitric oxide pathways. Flavonoids and phenolic constituents suppress oxidative stress-mediated inflammatory responses and reduce edema formation in inflammatory conditions. Moreover, phytosterols present in the plant contribute to membrane stabilization and regulation of immune responses, thereby minimizing inflammatory tissue injury. These findings explain its traditional use in wound healing and inflammatory disorders. [1,14]

The antimicrobial activity of *T. procumbens* is mainly mediated through disruption of microbial cell membrane integrity and inhibition of microbial growth. Alkaloids, tannins, and phenolic compounds interfere with microbial enzymatic systems and prevent bacterial colonization. Additionally, tannins contribute to tissue contraction and protection against microbial invasion, enhancing wound repair and minimizing infection risks. Such multiple-target therapeutic actions provide a scientific basis for the ethnomedicinal applications of *T. procumbens*. [2,9]

Experimental studies have also suggested that the anti-diabetic activity of *T. procumbens* may involve enhancement of insulin sensitivity, regulation of glucose metabolism, pancreatic β-cell protection, and reduction of oxidative stress-induced damage. Furthermore, hepatoprotective effects are mediated through stabilization of hepatic antioxidant defense systems and reduction of toxic metabolite-induced cellular injury. These mechanisms collectively indicate the broad pharmacological versatility of the plant and support its use as a multi-target therapeutic agent. [5,15]

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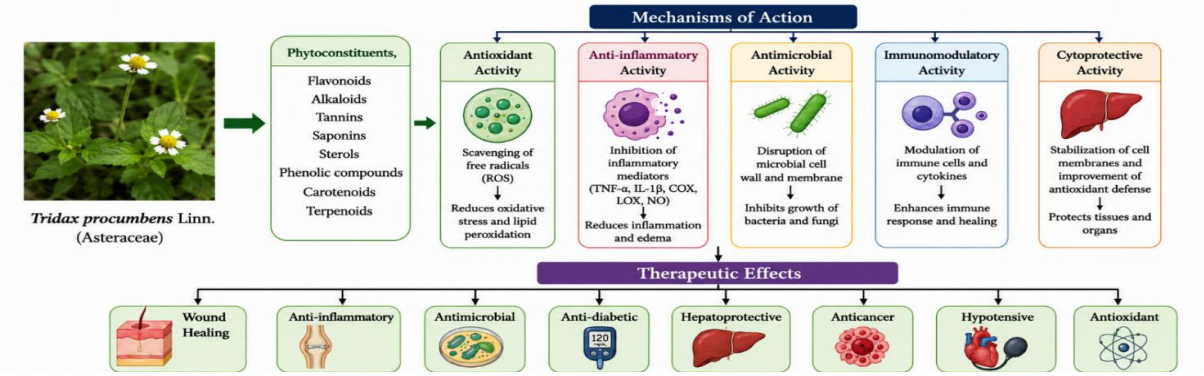

Figure No5.1: Schematic representation of the pharmacological mechanism of *Tridax procumbens* Linn.

5.2 Therapeutic Prospects:

The increasing demand for plant-based medicines and safer therapeutic alternatives has accelerated scientific interest in medicinal plants with multifunctional biological properties. Due to its extensive pharmacological activities and rich phytochemical composition, *Tridax procumbens* has emerged as a promising candidate for pharmaceutical and biomedical applications. The plant possesses significant potential for the development of herbal formulations, wound healing products, antimicrobial agents, anti-inflammatory drugs, and nutraceutical supplements. [1,7]

Furthermore, advancements in phytochemical isolation, nanotechnology-based drug delivery systems, and molecular pharmacology have opened new opportunities for the utilization of medicinal plants in modern therapeutics. Bioactive compounds isolated from *T. procumbens* may serve as lead molecules for the development of novel drugs targeting chronic inflammatory diseases, diabetes, liver disorders, and cancer. However, despite encouraging preclinical evidence, further investigations involving phytochemical standardization, toxicity profiling, pharmacokinetic evaluation, and large-scale clinical studies are necessary to establish safety, efficacy, and therapeutic reliability. [1,8]

The integration of traditional medicinal knowledge with evidence-based pharmacological research may significantly contribute to the future therapeutic development of *T. procumbens*. Considering its accessibility, affordability, medicinal versatility, and broad biological activities, the plant holds substantial promise for future pharmaceutical innovations and natural product-based drug discovery. [7,8]

6. Toxicological Profile, Limitations and Future Perspectives of *Tridax procumbens* Linn:

6.1 Toxicological Profile:

The safety evaluation of medicinal plants is essential before their therapeutic utilization in pharmaceutical formulations and clinical applications. Although *Tridax procumbens* Linn. has been extensively used in traditional medicine for centuries, scientific evidence regarding its toxicity profile remains relatively limited. Available experimental studies have suggested that extracts of *T. procumbens* exhibit low toxicity at therapeutic doses and are generally considered safe in animal models. Acute and subacute toxicity studies have demonstrated minimal adverse effects, thereby supporting its traditional medicinal applications. However, variations in phytochemical composition due to geographical origin, extraction methods, environmental conditions, and dosage may influence toxicity outcomes. [1,2]

Some experimental investigations have reported that prolonged or excessive administration of herbal extracts may produce biochemical alterations and organ-specific effects depending on dose concentration and duration of treatment. Therefore, determination of the therapeutic index, safe dosage range, chronic toxicity, mutagenicity, reproductive toxicity, and carcinogenicity remains necessary before clinical recommendations can be established. In addition, standardization of extraction procedures and quality control parameters is essential to ensure consistency, efficacy, and safety of plant-based formulations derived from *T. procumbens*. [2,16]

6.2 Limitations of Current Research:

Despite significant progress in phytochemical and pharmacological investigations, several limitations remain in the scientific understanding of *T. procumbens*. Most of the currently available studies are limited to *in vitro* and animal-based experimental models, whereas well-designed clinical trials in human subjects are scarce. Furthermore, variations in extraction solvents, plant parts used, dosage forms, and experimental methodologies have resulted in inconsistent findings and difficulties in comparative evaluation. Such variability limits reproducibility and standardization of therapeutic outcomes. [1,17]

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Another major challenge lies in the incomplete characterization of active phytoconstituents responsible for specific pharmacological actions. Although flavonoids, tannins, alkaloids, and phenolic compounds have been identified, detailed molecular mechanisms and pharmacokinetic behavior of many bioactive compounds remain insufficiently explored. Additionally, limited toxicological evidence and absence of regulatory guidelines for herbal standardization create barriers to pharmaceutical development and clinical acceptance. [8,17]

6.3 Future Perspectives:

Future research on *Tridax procumbens* should focus on advanced phytochemical characterization, molecular pharmacology, toxicity profiling, and evidence-based clinical validation. Modern analytical techniques such as high-performance liquid chromatography (HPLC), gas chromatography–mass spectrometry (GC–MS), liquid chromatography–mass spectrometry (LC–MS), and metabolomics-based approaches may help in identifying novel phytochemicals and understanding their biological significance. Such advancements may facilitate the discovery of new therapeutic lead molecules from the plant. [1,7]

Additionally, integration of nanotechnology and novel drug delivery systems may improve bioavailability, stability, and therapeutic efficiency of *T. procumbens*-derived phytoconstituents. Herbal nanoformulations, phytosomes, and targeted drug delivery approaches may enhance pharmacological outcomes while minimizing toxicity. Future investigations involving multicenter clinical studies and international standardization protocols are essential to establish the plant as a scientifically validated therapeutic agent for pharmaceutical and biomedical applications. [7,18]

7. CONCLUSION:

Tridax procumbens Linn. is an important medicinal plant possessing significant ethnomedicinal relevance and a wide spectrum of pharmacological activities. Traditionally, the plant has been extensively used for the management of wounds, inflammation, liver disorders, diabetes, microbial infections, gastrointestinal disturbances, and various other ailments. Scientific investigations have supported many of these traditional claims and demonstrated that the therapeutic efficacy of *T. procumbens* is mainly associated with the presence of diverse phytoconstituents such as flavonoids, alkaloids, tannins, terpenoids, steroids, carotenoids, and phenolic compounds. These bioactive constituents contribute substantially to its antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, anti-diabetic, wound healing, immunomodulatory, and anticancer activities.The broad pharmacological profile of *T. procumbens* highlights its potential as a promising medicinal plant for herbal drug development and natural product-based therapeutics. Various experimental investigations have demonstrated encouraging therapeutic outcomes in different disease models, thereby strengthening its medicinal importance. However, despite substantial pharmacological evidence, most investigations remain limited to preclinical studies, while well-designed clinical studies in humans are still insufficient. Moreover, variability in phytochemical composition, extraction procedures, dosage forms, and limited toxicological evidence continue to challenge its pharmaceutical standardization and therapeutic acceptance.

Future investigations should focus on advanced phytochemical characterization, elucidation of molecular mechanisms, toxicity assessment, pharmacokinetic evaluation, and evidence-based clinical validation to establish its safety and efficacy. Furthermore, incorporation of advanced pharmaceutical approaches such as novel drug delivery systems and standardized herbal formulations may improve therapeutic effectiveness and bioavailability. Therefore, *Tridax procumbens* Linn. possesses substantial therapeutic potential and may serve as an important source of bioactive compounds for future pharmaceutical and biomedical research.

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