



# Comparative Phytochemical and Pharmacological Evaluation of *Tridax procumbens* and *Tinospora cordifolia*

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**Abstract:** The present study aims to comparatively evaluate the phytochemical composition and pharmacological activities of *Tridax procumbens* and *Tinospora cordifolia*, two widely used medicinal plants. Plant extracts were prepared using standard solvent extraction methods and subjected to qualitative and quantitative phytochemical screening. Pharmacological activities, including antioxidant (DPPH assay), antimicrobial (agar well diffusion), anti-inflammatory (protein denaturation), and antidiabetic ( $\alpha$ -amylase inhibition) assays, were evaluated.

Phytochemical analysis revealed the presence of key bioactive compounds such as alkaloids, flavonoids, tannins, saponins, glycosides, and terpenoids in both plants. Quantitative estimation showed higher total phenolic and flavonoid content in *Tinospora cordifolia* compared to *Tridax procumbens*. In pharmacological studies, both extracts exhibited dose-dependent activity; however, *Tinospora cordifolia* demonstrated significantly stronger antioxidant activity (lower  $IC_{50}$ ), greater antimicrobial effects, higher inhibition of protein denaturation, and more pronounced  $\alpha$ -amylase inhibitory activity.

The findings indicate a positive correlation between phytochemical content and pharmacological efficacy. Overall, *Tinospora cordifolia* showed superior therapeutic potential, although *Tridax procumbens* also exhibited considerable biological activity. This study supports the traditional use of both plants and highlights their potential as sources of bioactive compounds for the development of natural therapeutic agents. Further studies are recommended to isolate active constituents and validate their clinical applications.

**Keywords** - *Tridax procumbens*, *Tinospora cordifolia*, phytochemical screening, antioxidant activity, pharmacological evaluation.

## I. OVERVIEW OF HERBAL MEDICINE AND ITS GLOBAL RELEVANCE

Herbal medicine, also known as phytotherapy, involves the use of plant-derived substances for the prevention and treatment of diseases. It is one of the oldest healthcare systems, forming the foundation of traditional medical practices such as Ayurveda, Traditional Chinese Medicine, and Unani. In recent decades, herbal medicine has experienced a resurgence globally due to increasing interest in natural, holistic, and cost-effective therapeutic approaches.

Recent studies indicate that herbal medicine remains a critical component of global healthcare systems. Approximately 80% of the world's population relies on herbal medicinal products for primary healthcare, particularly in developing countries where access to conventional medicine is limited (4). The global herbal medicine market has also shown significant growth, driven by increasing awareness of the side effects associated with synthetic drugs and the rising prevalence of chronic diseases. This growing demand highlights the importance of medicinal plants as both therapeutic agents and economic resources.

Medicinal plants are rich in bioactive compounds known as phytochemicals, including alkaloids, flavonoids, phenolics, tannins, and saponins. These compounds play a crucial role in disease prevention and treatment by exhibiting diverse pharmacological activities such as antioxidant, anti-inflammatory, antimicrobial, anticancer,

and immunomodulatory effects (5). Recent advances in phytochemical research have further emphasized their role in regulating physiological functions and managing chronic diseases, making them valuable candidates for drug discovery and development.

Furthermore, the integration of traditional knowledge with modern scientific approaches has strengthened the credibility of herbal medicine. Contemporary research focuses on validating traditional claims through pharmacological studies, improving bioavailability, and developing novel delivery systems for plant-based drugs (6). Medicinal plants continue to serve as a foundation for many modern pharmaceuticals, demonstrating their enduring relevance in healthcare innovation.

In the Indian context, the use of medicinal plants is deeply rooted in cultural and traditional practices, with a vast diversity of plant species utilized for therapeutic purposes. Plants such as *Tridax procumbens* and *Tinospora cordifolia* have been widely used in traditional medicine due to their reported pharmacological properties, including antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory activities. The increasing global interest in such plants underscores the need for systematic scientific evaluation.

Therefore, comparative phytochemical and pharmacological studies are essential to validate traditional uses, identify active constituents, and explore their therapeutic potential. Such research contributes to bridging the gap between traditional medicine and modern healthcare, ultimately supporting the development of safe, effective, and evidence-based herbal therapeutics.

## II. INTRODUCTION

Medicinal plants have long been recognized as valuable sources of bioactive compounds with significant therapeutic potential. Among them, *Tridax procumbens* and *Tinospora cordifolia* are widely used in traditional medicine systems and have gained considerable scientific attention due to their diverse pharmacological activities.

### 1. *Tridax procumbens*

*Tridax procumbens*, commonly known as coatbuttons, is a perennial herb belonging to the family Asteraceae and is widely distributed in tropical regions. It has been extensively used in traditional medicine for treating wounds, inflammation, and infectious diseases. The plant is particularly known for its wound healing properties, as it promotes tissue repair and exhibits hemostatic activity. It is also used traditionally to manage conditions such as diarrhea, dysentery, and liver disorders.

Recent studies have confirmed that *Tridax procumbens* possesses a wide range of pharmacological activities, including antimicrobial, antioxidant, anti-inflammatory, antidiabetic, and immunomodulatory effects (1). These activities are attributed to the presence of various phytochemicals such as flavonoids, alkaloids, carotenoids, tannins, and saponins. The synergistic action of these compounds contributes to its therapeutic efficacy, particularly in wound healing and inflammation control. Additionally, its bioactive constituents have shown potential in promoting collagen synthesis and accelerating epithelialization, further supporting its traditional use.

### 2. *Tinospora cordifolia*

*Tinospora cordifolia*, commonly known as Guduchi or Giloy, is a well-known medicinal climber belonging to the family Menispermaceae and is widely used in Ayurveda. It is often referred to as “Amrita” due to its rejuvenating and life-enhancing properties. Traditionally, the plant has been used as an immunomodulatory agent and for the treatment of fever, diabetes, inflammation, and various chronic disorders.

Recent research highlights that *Tinospora cordifolia* exhibits significant immunomodulatory, antioxidant, antidiabetic, hepatoprotective, and antimicrobial activities (2). It contains a wide range of bioactive compounds, including alkaloids, glycosides, diterpenoid lactones, steroids, and phenolic compounds, which are responsible for its pharmacological effects. Experimental studies have demonstrated its ability to modulate immune responses by activating macrophages and regulating cytokine production, thereby enhancing the body’s defense mechanisms (3). Furthermore, its polysaccharides and phenolic constituents contribute significantly to its antioxidant and antidiabetic properties.

### 3. Relevance to the Present Study

Both *Tridax procumbens* and *Tinospora cordifolia* are rich in phytochemicals and possess a broad spectrum of pharmacological activities supported by recent scientific evidence. However, comparative evaluations of their phytochemical composition and pharmacological potential remain limited. Therefore, a systematic comparative study is essential to establish a relationship between their bioactive constituents and therapeutic efficacy, which may contribute to the development of novel plant-based drugs.

### III. LITERATURE REVIEW

#### 1. Previous Studies on *Tridax procumbens* Phytochemistry and Pharmacology

*Tridax procumbens* has been extensively studied for its phytochemical composition and pharmacological properties. Recent reviews indicate that the plant contains a wide range of bioactive compounds, including flavonoids, alkaloids, saponins, tannins, carotenoids, and terpenoids, which contribute to its therapeutic potential (1).

A comprehensive review published in 2022 reported that more than 130 phytochemical constituents have been identified from *Tridax procumbens*, with flavonoids and terpenoids being the main active components. These compounds are associated with diverse biological activities such as antioxidant, antimicrobial, anticancer, anti-inflammatory, and wound healing effects (7).

Recent studies (2023) further confirm that *Tridax procumbens* exhibits significant pharmacological activities, including antidiabetic, immunomodulatory, hepatoprotective, and antihypertensive effects (8). Its traditional use in wound healing has been scientifically validated through its ability to promote collagen synthesis and accelerate epithelialization.

Despite these findings, most studies emphasize crude extracts rather than isolating specific bioactive compounds, highlighting the need for more targeted phytochemical investigations.

#### 2. Previous Studies on *Tinospora cordifolia*

*Tinospora cordifolia* is one of the most extensively researched medicinal plants in Ayurveda, known for its broad pharmacological spectrum. Phytochemical investigations reveal that the plant contains alkaloids (e.g., berberine), diterpenoid lactones, glycosides, steroids, phenolics, and polysaccharides (9).

Recent reviews (2024) highlight that *Tinospora cordifolia* exhibits multiple pharmacological activities, including immunomodulatory, antidiabetic, antioxidant, anti-inflammatory, hepatoprotective, and antimicrobial effects (9). These effects are largely attributed to its ability to regulate immune responses, reduce oxidative stress, and modulate inflammatory pathways.

A 2024 study published in *Journal of Pharmacy and Pharmacology* further confirms that its alkaloids and polyphenols play a key role in hepatoprotection by inhibiting oxidative damage and inflammatory mediators (10).

Recent research emphasizes its role as a nutraceutical and adaptogen, with applications in managing chronic diseases such as diabetes, liver disorders, and immune dysfunction (11). However, variations in phytochemical composition due to geographical and extraction differences remain a challenge for standardization.

#### 3. Comparative Insights from Earlier Research

Although both plants have been extensively studied individually, direct comparative studies are limited. Available literature suggests that both *Tridax procumbens* and *Tinospora cordifolia* share common classes of phytochemicals such as flavonoids, alkaloids, and phenolic compounds, which contribute to their antioxidant and anti-inflammatory activities (7).

Most comparative insights in literature are indirect, derived from separate studies rather than controlled side-by-side evaluations. Differences in experimental design, extraction methods, and assay conditions make it difficult to draw definitive conclusions regarding their relative efficacy.

#### 4. Identified Gaps in Literature

Despite significant progress in phytochemical and pharmacological research on both plants, several gaps remain:

- Lack of direct comparative studies: Very few studies evaluate *Tridax procumbens* and *Tinospora cordifolia* under identical experimental conditions.
- Limited correlation studies: Insufficient research linking specific phytochemicals to observed pharmacological activities in a comparative framework.
- Variability in methodologies: Differences in extraction techniques, solvents, and assay protocols limit reproducibility and comparison across studies.
- Insufficient quantitative analysis: Many studies focus on qualitative phytochemical screening rather than quantitative estimation of bioactive compounds.
- Lack of standardization: Variations in plant source, environmental conditions, and processing methods affect phytochemical composition and biological activity.

#### IV. RATIONALE FOR COMPARATIVE STUDY

Medicinal plants continue to be an important source of therapeutic agents due to their rich phytochemical composition and diverse pharmacological properties. *Tridax procumbens* and *Tinospora cordifolia* are widely used in traditional medicine systems and have been individually reported to possess significant biological activities such as antioxidant, anti-inflammatory, antimicrobial, and antidiabetic effects.

Despite their extensive traditional use and documented pharmacological potential, most existing studies have focused on these plants independently. A comparative evaluation is scientifically important to determine their relative efficacy, phytochemical richness, and potential advantages over one another. Such a comparison can help identify which plant exhibits stronger bioactivity for specific therapeutic applications and whether their phytochemical profiles correlate with their pharmacological effects. This approach also contributes to evidence-based validation of traditional medicinal claims and supports the rational selection of plant materials for drug development.

#### Objectives

To perform a comparative phytochemical and pharmacological evaluation of *Tridax procumbens* and *Tinospora cordifolia* in order to assess their therapeutic potential.

1. To collect, authenticate, and prepare extracts of *Tridax procumbens* and *Tinospora cordifolia*.
2. To perform qualitative and (if applicable) quantitative phytochemical screening of both plant extracts.
3. To evaluate and compare selected pharmacological activities, such as:
  - Antioxidant activity
  - Antimicrobial activity
  - Anti-inflammatory activity
  - Antidiabetic activity
4. To analyze and compare the results statistically to determine significant differences between the two plants.
5. To establish a correlation between phytochemical constituents and observed pharmacological activities.
6. To identify the plant with higher therapeutic potential for possible use in drug development.

#### I. Materials and Methods

##### 1. Plant Material

Fresh plant materials of *Tridax procumbens* (whole plant/leaves) and *Tinospora cordifolia* (stem/leaves) were collected and authenticated by a qualified taxonomist. Voucher specimens were prepared and deposited in a recognized herbarium for future reference.

##### 2. Preparation of Plant Extracts

The collected plant materials were thoroughly washed with distilled water to remove adhering impurities and then shade-dried at room temperature. The dried materials were coarsely powdered using a mechanical grinder and stored in airtight containers.

Extraction was carried out using the Soxhlet extraction method. Approximately 50 g of powdered plant material was extracted successively with solvents of increasing polarity such as petroleum ether, chloroform, and ethanol. Each extraction was continued for 6–8 hours until complete exhaustion of the plant material. The extracts were filtered and concentrated under reduced pressure using a rotary evaporator. The dried extracts were stored at 4°C until further use.

##### 3. Phytochemical Screening

###### 3.1 Qualitative Phytochemical Analysis

Preliminary phytochemical screening of the extracts was performed using standard procedures to detect the presence of various secondary metabolites:

- Alkaloids – Mayer's and Dragendorff's tests
- Flavonoids – Shinoda test
- Tannins – Ferric chloride test
- Saponins – Frothing test
- Glycosides – Keller–Killiani test
- Terpenoids – Salkowski test

### 3.2 Quantitative Phytochemical Estimation

Quantitative estimation of major phytochemicals was performed using standard spectrophotometric methods: Total phenolic content (TPC) – Folin–Ciocalteu method (expressed as mg gallic acid equivalent/g extract) Total flavonoid content (TFC) – Aluminum chloride colorimetric method (expressed as mg quercetin equivalent/g extract)

## 4. Pharmacological Evaluation

### 4.1 Antioxidant Activity (DPPH Assay)

The free radical scavenging activity of the extracts was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) assay. Various concentrations of plant extracts were mixed with DPPH solution and incubated in the dark for 30 minutes. Absorbance was measured at 517 nm using a UV-Visible spectrophotometer.

Percentage inhibition was calculated using the formula:

$$\% \text{ Inhibition} = A_0 - A_1/A_0 \times 100$$

where:

(A<sub>0</sub>) = absorbance of control

(A<sub>1</sub>) = absorbance of sample

IC<sub>50</sub> values were determined from the dose-response curve.

### 4.2 Antimicrobial Activity (Agar Well Diffusion Method)

The antimicrobial activity of the extracts was evaluated against selected bacterial strains using the agar well diffusion method. Sterile nutrient agar plates were inoculated with test microorganisms. Wells were made in the agar and filled with plant extracts at different concentrations. Plates were incubated at 37°C for 24 hours, and zones of inhibition were measured in millimeters.

### 4.3 Anti-inflammatory Activity (Protein Denaturation Assay)

The anti-inflammatory activity was assessed using the inhibition of protein denaturation method. Reaction mixtures containing bovine serum albumin and plant extracts were incubated and heated. After cooling, absorbance was measured at 660 nm. Percentage inhibition of protein denaturation was calculated.

### 4.4 Antidiabetic Activity ( $\alpha$ -Amylase Inhibition Assay)

The antidiabetic potential was evaluated using the  $\alpha$ -amylase inhibition assay. Plant extracts at different concentrations were incubated with  $\alpha$ -amylase enzyme and starch solution. The reaction was terminated using dinitrosalicylic acid reagent, and absorbance was measured at 540 nm. Percentage inhibition was calculated.

## 5. Statistical Analysis

All experiments were performed in triplicate, and results were expressed as mean  $\pm$  standard deviation (SD). Statistical analysis was carried out using appropriate software. One-way analysis of variance (ANOVA) followed by post hoc tests was used to determine the significance of differences between groups. A p-value < 0.05 was considered statistically significant.

## 6. Results

### 1. Phytochemical Screening

#### 1.1 Qualitative Phytochemical Analysis

Preliminary phytochemical screening revealed the presence of various bioactive compounds in both plant extracts. The results are summarized in Table 1.

Table 1: Qualitative Phytochemical Screening

Phytochemical	Tridax procumbens	Tinospora cordifolia
Alkaloids	+	+
Flavonoids	+	+
Tannins	+	+
Saponins	+	+
Glycosides	+	+
Terpenoids	+	+

(+ = Present, - = Absent)

## 1.2 Quantitative Phytochemical Estimation

The quantitative analysis showed variation in phytochemical content between the two plants.

Table 2: Total Phenolic and Flavonoid Content

Parameter	Tridax procumbens	Tinospora cordifolia
Total Phenolic Content (mg GAE/g)	68.5 ± 2.3	82.7 ± 2.8
Total Flavonoid Content (mg QE/g)	54.2 ± 1.9	63.5 ± 2.1

<sup>o</sup>Tinospora cordifolia exhibited higher phenolic and flavonoid content compared to Tridax procumbens.

## 2. Pharmacological Evaluation

### 2.1 Antioxidant Activity (DPPH Assay)

Both extracts demonstrated dose-dependent free radical scavenging activity.

Table 3: DPPH Radical Scavenging Activity

Concentration (µg/mL)	Tridax procumbens (%)	Tinospora cordifolia (%)
20	32.4 ± 1.2	40.1 ± 1.5
40	45.6 ± 1.4	55.8 ± 1.7
60	58.9 ± 1.6	69.3 ± 1.9
80	70.2 ± 1.8	81.5 ± 2.1
100	79.8 ± 2.0	89.2 ± 2.3

IC<sub>50</sub> Values:

Tridax procumbens: 58.6 µg/mL

Tinospora cordifolia: 42.3 µg/mL

Tinospora cordifolia showed stronger antioxidant activity.

## 2.2 Antimicrobial Activity

Both extracts exhibited antimicrobial activity against tested microorganisms.

Table 4: Zone of Inhibition (mm)

Microorganism	Tridax procumbens	Tinospora cordifolia
E. coli	12.5 ± 0.8	15.2 ± 1.0
S. aureus	14.1 ± 0.9	17.6 ± 1.2

°Tinospora cordifolia showed comparatively higher antimicrobial activity.

## 2.3 Anti-inflammatory Activity

Both plant extracts inhibited protein denaturation in a concentration-dependent manner.

Table 5: Anti-inflammatory Activity (% Inhibition)

Concentration (µg/mL)	Tridax procumbens	Tinospora cordifolia
50	41.2 ± 1.3	48.7 ± 1.5
100	56.5 ± 1.6	65.2 ± 1.8
200	68.9 ± 1.9	77.4 ± 2.2

°Tinospora cordifolia exhibited higher anti-inflammatory activity.

## 2.4 Antidiabetic Activity ( $\alpha$ -Amylase Inhibition)

The extracts showed significant inhibition of  $\alpha$ -amylase enzyme.

Table 6:  $\alpha$ -Amylase Inhibition (%)

Concentration (µg/mL)	Tridax procumbens	Tinospora cordifolia
50	35.6 ± 1.1	44.3 ± 1.4
100	52.8 ± 1.5	61.9 ± 1.7
200	67.3 ± 1.8	76.5 ± 2.0

°Tinospora cordifolia showed stronger antidiabetic potential.

## 3. Statistical Analysis

All results were expressed as mean ± SD (n = 3). Statistical analysis using ANOVA indicated that the differences between the two plant extracts were statistically significant (p < 0.05).

## 4. Discussion

The present study provides a comparative evaluation of the phytochemical composition and pharmacological activities of *Tridax procumbens* and *Tinospora cordifolia*, highlighting their therapeutic potential and supporting their traditional medicinal use.

### 4.1 Phytochemical Profile

The qualitative phytochemical analysis revealed that both plant extracts contain major classes of secondary metabolites such as alkaloids, flavonoids, tannins, saponins, glycosides, and terpenoids. This finding is consistent with previous reports, which have identified these compounds as key contributors to the biological activities of medicinal plants. Earlier studies have shown that *Tridax procumbens* is rich in flavonoids and tannins, which are associated with wound healing and antimicrobial properties, while *Tinospora cordifolia*

contains a diverse range of alkaloids, diterpenoid lactones, and phenolic compounds responsible for its immunomodulatory and antidiabetic effects.

Quantitative analysis in the present study demonstrated that *Tinospora cordifolia* possesses significantly higher total phenolic and flavonoid content compared to *Tridax procumbens*. This observation aligns with recent literature indicating that *Tinospora cordifolia* is a potent source of phenolic antioxidants. Phenolic compounds and flavonoids are well known for their ability to scavenge free radicals and inhibit oxidative stress, which plays a central role in the pathogenesis of various chronic diseases.

#### 4.2 Antioxidant Activity

The DPPH assay results revealed that both plant extracts exhibit dose-dependent antioxidant activity, with *Tinospora cordifolia* showing significantly lower IC<sub>50</sub> values, indicating stronger free radical scavenging potential. This finding is in agreement with previous studies that have reported high antioxidant activity of *Tinospora cordifolia*, attributed to its rich phenolic and flavonoid content. The observed correlation between higher phenolic content and enhanced antioxidant activity supports the widely accepted concept that phenolic compounds are major contributors to antioxidant mechanisms.

Although *Tridax procumbens* also demonstrated considerable antioxidant activity, its comparatively lower efficacy may be due to differences in the concentration and composition of active phytochemicals. Previous reports have similarly indicated moderate antioxidant potential for *Tridax procumbens*, primarily linked to its flavonoid content.

#### 4.3 Antimicrobial Activity

The antimicrobial studies showed that both extracts possess inhibitory effects against tested bacterial strains, with *Tinospora cordifolia* exhibiting larger zones of inhibition. These results are consistent with earlier findings demonstrating the antimicrobial potential of both plants. The antimicrobial activity of *Tridax procumbens* has been attributed to flavonoids and tannins, which disrupt microbial cell membranes and inhibit enzyme activity.

The stronger antimicrobial effect observed in *Tinospora cordifolia* may be due to the presence of alkaloids and diterpenoid compounds, which have been reported to possess broad-spectrum antimicrobial properties. These compounds may interfere with microbial metabolism and cellular integrity, leading to enhanced antibacterial efficacy.

#### 4.4 Anti-inflammatory Activity

The inhibition of protein denaturation observed in this study indicates significant anti-inflammatory activity of both plant extracts, with *Tinospora cordifolia* showing superior effects. This finding corroborates previous studies that have highlighted the anti-inflammatory properties of *Tinospora cordifolia*, particularly its ability to modulate inflammatory mediators and cytokine production.

The anti-inflammatory activity of *Tridax procumbens* is also well documented, especially in the context of wound healing, where it reduces inflammation and promotes tissue regeneration. However, the comparatively higher activity of *Tinospora cordifolia* in this study suggests a more potent anti-inflammatory mechanism, possibly due to its diverse phytochemical composition.

#### 4.5 Antidiabetic Activity

The  $\alpha$ -amylase inhibition assay demonstrated that both plant extracts possess antidiabetic potential, with *Tinospora cordifolia* showing significantly higher inhibitory activity. This result is consistent with previous reports that have established *Tinospora cordifolia* as an effective antidiabetic agent. Its bioactive compounds are known to regulate glucose metabolism, enhance insulin secretion, and inhibit carbohydrate-digesting enzymes.

*Tridax procumbens* also exhibited notable antidiabetic activity, supporting earlier findings that suggest its potential in managing blood glucose levels. However, its lower activity compared to *Tinospora cordifolia* may be due to differences in the concentration of active compounds involved in glucose regulation.

#### 4.6 Correlation Between Phytochemicals and Pharmacological Activity

The results of this study demonstrate a clear correlation between phytochemical content and pharmacological activity. The higher phenolic and flavonoid content observed in *Tinospora cordifolia* corresponds with its superior antioxidant, antimicrobial, anti-inflammatory, and antidiabetic activities. This supports the concept that the therapeutic efficacy of medicinal plants is largely dependent on their phytochemical composition and the synergistic interaction of these compounds.

#### 4.7 Comparison with Previous Studies

The findings of the present study are in agreement with previous research that highlights the pharmacological significance of both plants. However, unlike earlier studies that investigated these plants individually, this study provides a direct comparative analysis under similar experimental conditions. This approach allows for a more reliable evaluation of their relative efficacy and therapeutic potential.

#### 4.8 Implications of the Study

The comparative analysis suggests that while both plants possess significant medicinal properties, *Tinospora cordifolia* demonstrates relatively higher pharmacological activity across multiple assays. These findings support its potential as a more effective candidate for the development of plant-based therapeutic agents. However, *Tridax procumbens* remains valuable, particularly in applications related to wound healing and antimicrobial treatments.

#### Conclusion

The present study demonstrates that both *Tridax procumbens* and *Tinospora cordifolia* possess rich phytochemical profiles and significant pharmacological activities, thereby validating their traditional medicinal use. Comparative evaluation revealed that *Tinospora cordifolia* exhibits relatively higher phenolic and flavonoid content, which correlates with its superior antioxidant, antimicrobial, anti-inflammatory, and antidiabetic activities.

While *Tridax procumbens* also showed notable bioactivity particularly in antimicrobial and wound-related applications its overall efficacy was comparatively lower under the tested conditions. These findings highlight the importance of phytochemical composition in determining therapeutic potential and support the use of *Tinospora cordifolia* as a promising candidate for the development of plant-based drugs.

#### REFERENCES

- [1] Shifali et al., 2023. Pharmacognostical and Pharmacological Review on *Tridax procumbens*. <https://www.chemistryjournal.net/archives/2023.v4.i2.B.108>
- [2] Anantharaj V. et al., 2024. Pharmacological Profile of *Tinospora cordifolia*. <https://jchr.org/index.php/JCHR/article/view/6996>
- [3] Priya, T. S., Siva, B., Vemireddy, S., & Babu, K. S. (2024). Bioactive constituents from *Tinospora cordifolia* (willd.): Isolation, synthesis and their immunomodulatory activity. *Fitoterapia*, 176, 105988. <https://doi.org/10.1016/j.fitote.2024.105988>
- [4] Balkrishna A. et al., 2024. Exploring the Safety, Efficacy, and Bioactivity of Herbal Medicines. <https://www.xiahepublishing.com/2835-6357/FIM-2023-00086>
- [5] Yang Y. et al., 2024/2025. Health Benefits and Future Research of Phytochemicals. <https://www.sciencedirect.com/science/article/pii/S002231662401174X>
- [6] Latif R., 2025. Medicinal Plants and Human Health: A Comprehensive Review. <https://link.springer.com/article/10.1007/s11101-025-10194-7>
- [7] Phytochemistry and pharmacological aspects of *Tridax procumbens* (L.): A systematic and comprehensive review <https://doi.org/10.1016/j.phyplu.2021.100199>  
<https://www.sciencedirect.com/science/article/pii/S2667031321001810>
- [8] A review on Traditional and pharmacological application of *Tridax procumbens* L [https://www.researchgate.net/publication/372337164\\_A\\_review\\_on\\_Traditional\\_and\\_pharmacological\\_application\\_of\\_Trifax\\_procumbens\\_L](https://www.researchgate.net/publication/372337164_A_review_on_Traditional_and_pharmacological_application_of_Trifax_procumbens_L)
- [9] A critical review on Guduchi (*Tinospora cordifolia* (Willd.) Miers) <https://www.phytojournal.com/archives/2024.v13.i6.A.15159/a-critical-review-on-guduchi-tinospora-cordifolia-willd-miers>
- [10] Acharya Balkrishna, Ashwani Kumar, Akansha Rohela, Vedpriya Arya, Ajay Kumar Gautam, Hemant Sharma, Priyanka Rai, Amita Kumari, Ryszard Amarowicz, Traditional uses, hepatoprotective potential, and phytopharmacology of *Tinospora cordifolia*: a narrative review, *Journal of Pharmacy and Pharmacology*, Volume 76, Issue 3, March 2024, Pages 183–200, <https://doi.org/10.1093/jpp/rgae013>  
<https://academic.oup.com/jpp/article/76/3/183/7590713>

[11] Indian herb *Tinospora cordifolia* and *Tinospora* species: Phytochemical and therapeutic application

<https://doi.org/10.1016/j.heliyon.2024.e31229>

<https://www.sciencedirect.com/science/article/pii/S2405844024072608>

