



Physicochemical Constituents and Antimicrobial Potentials of *Tridax procumbens* L

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Abstract: - This study presents a comprehensive analysis of the medicinal potential of *Tridax procumbens*, focusing on the physicochemical composition and antimicrobial activity of its aqueous, ethanolic, and petroleum ether extracts. Phytochemical screening revealed that all extracts contained multiple bioactive compounds, namely, alkaloids, glycosides, flavonoids, tannins, saponins, terpenoids, with the petroleum ether extract exhibiting the most consistent presence across plant parts. The effect of the extracts were tested on *Escherichia coli*, *Enterobacter aerogenes*, *Staphylococcus aureus*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Salmonella spp* and the yeast *Candida albicans*. Antimicrobial assays demonstrated notable zones of inhibition against the bacterial and fungal pathogens, with petroleum ether extracts of dried plant parts showing the highest efficacy. *E. coli*, *S. aureus*, and *C. albicans* were particularly susceptible. The findings highlight the potential of *T. procumbens* as a broad-spectrum antimicrobial agent and accentuate the importance of solvent type and plant part in determining phytochemical richness and therapeutic efficacy. This study provides more information on the constituents of different essential parts of the *Tridax procumbens* and confirms its use in the treatment of some ailments especially where the plant is ubiquitous.

Keywords: *Tridax procumbens*, Medicinal Plants, Phytochemical Constituents, Antimicrobial Activity, Antibiotic Resistance, Herbal Medicine.



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Introduction

Medicinal plants have served as remedies long before the emergence of orthodox medicine, with Sub-Saharan Africa being particularly rich in them (Codjia et al., 2009). Plant leaves are especially important, providing essential micronutrients and bioactive compounds vital for human health (FAO, 2000). Regular consumption of these leaves has been linked to improved well-being and protection against chronic illnesses (Atchibri et al., 2012). Beyond their nutritional role, plants remain key sources of novel therapeutic agents, contributing significantly to modern healthcare (Shariff, 2001). Despite advances in synthetic drug

production, more than 250,000 plant species are still recognized for their antimicrobial properties, largely due to their diverse bioactive constituents (Zaker et al., 2016).

The rise of antibiotic-resistant pathogens, driven by the misuse of synthetic drugs, has worsened the global health crisis (Karaman et al., 2003; Adindu et al., 2016; Agu et al., 2013; Awah et al., 2016). This challenge, combined with the high cost and side effects of conventional antibiotics, has fueled interest in plant-derived alternatives (Chrystal et al., 2003; Schinor et al., 2007). Although pharmaceutical industries continue to develop antibiotics, resistance develops rapidly, prompting researchers to revisit

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traditional medicine systems as valuable sources of potent natural therapies (Nino et al., 2006; Okigbo et al., 2015; Orji et al., 2025).

Medicinal plants are used globally in diverse forms—roots, leaves, flowers, stems, seeds, and barks—with their efficacy linked to phytochemicals such as alkaloids, flavonoids, tannins, glycosides, and phenolics (Afolabi et al., 2007). Tropical regions remain particularly rich in these species (Calixto, 2000). Given their potential, research is increasingly focused on developing safe, affordable, plant-based antimicrobial drugs with fewer side effects (Essawi & Srous, 2000; Adepeju et al., 2023).

Among such plants is *Tridax procumbens* (commonly known as coat buttons), a hardy perennial herb from the Asteraceae family. Traditionally employed in African, Indian, and Latin American medicine, it is used for managing wounds, infections, inflammation, diarrhea, and other conditions (Patil et al., 2023; Akinmoladun et al., 2022). Its resilience and widespread growth—from roadsides to riverbanks—make it both a common weed and a valuable medicinal resource (Saxena & Albert, 2005; Chuahan & Germination, 2008). Ethnobotanical reports highlight its pharmacological potential, including hepatoprotective, anti-inflammatory, wound healing, antidiabetic, and antimicrobial activities (Mundada & Shivare, 2012).

Over the past two decades, *T. procumbens* has attracted increasing research attention. Its phytochemicals—such as flavonoids, carotenoids, sterols, tannins, and alkaloids—have been linked to antioxidant, antimicrobial, hepatoprotective, and antidiabetic activities (Reddy & Sreelakshmi, 2021; Rahman et al., 2023). Studies also suggest it enhances collagen synthesis, tissue regeneration, and immune modulation (Deshmukh & Yadav, 2022). Its antimicrobial potential against bacteria and fungi highlights its relevance in the era of multidrug resistance (Ogunbanwo et al., 2021).

Despite these findings, there is limited research on the antimicrobial effects of *T. procumbens* against clinical pathogens. This study therefore seeks to analyze its physicochemical constituents and evaluate its antimicrobial activity on selected clinical isolates.

Materials and Methods

Plant Material Collection and Preparation

Fresh *Tridax procumbens* was sourced from Awka, Anambra State, and authenticated at Nnamdi Azikiwe University's Botany Department. Plant parts (leaves, flowers, pods, stems, seeds, bark) were cleaned with tap and distilled water, shade-dried at $28 \pm 2^\circ\text{C}$ for 10 days, pulverized to 50–150 μm powder, sieved, and stored in airtight polyethylene bags at room temperature for extraction (Mahida & Mohan, 2007).

Extract Preparation

Dried plant powder (25 g) was packed in Whatman No. 1 filter paper and extracted via Soxhlet with 100 ml of petroleum ether,

ethanol, or aqueous solvents. Extracts were dried and refrigerated at 4°C . Additionally, 10 g powder was soaked in 100 ml distilled water or methanol for 48–72 hours, filtered through muslin cloth, and evaporated to a semisolid using a water bath for further testing (Mahida & Mohan, 2007).

Phytochemical Analysis

Standard methods tested for alkaloids, glycosides, flavonoids, tannins, saponins, and terpenoids (FDA, 2008; Joshi et al., 2011; Mayuri, 2012; Odebiyi & Sofowora, 1978; Marciano & Hasegawa, 1991; APHA, 1985). Alkaloids were confirmed by an orange-brown precipitate with Dragendorff's reagent. Glycosides showed a reddish-brown ring with glacial acetic acid, ferric chloride, and sulfuric acid. Flavonoids produced reversible yellow coloration with sodium hydroxide. Saponins formed stable foam after shaking. Tannins gave a brownish-green or blue-black color with ferric chloride. Terpenoids showed a reddish-brown ring with chloroform and sulfuric acid.

Antimicrobial Activity

Using the disc diffusion method (Bauer et al., 1966), extracts were tested against *Escherichia coli*, *Enterobacter aerogenes*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Salmonella* spp., *Bacillus* spp., *Trichophyton mentagrophytes*, *Trichosporon* spp., and *Proteus mirabilis*. Nutrient agar (20 ml) was inoculated with 0.1% bacterial suspension, and 5 mm discs with 5 mg extract were placed on plates. After incubation at 37°C for 24 hours, inhibition zones were measured in millimeters.

Results

Phytochemical Composition

Tridax procumbens analysis revealed solvent- and part-specific phytochemical profiles. Aqueous extracts showed glycosides, tannins, and alkaloids in all parts, with flavonoids, saponins, and terpenoids dominant in flowers and whole plants. Ethanol extracts contained flavonoids and saponins across parts, but lacked glycosides and alkaloids in leaves. Petroleum ether extracts included all six phytochemicals in all parts (FDA, 2008; Joshi et al., 2011).

Antimicrobial Activity

Petroleum ether extracts demonstrated the highest antimicrobial activity, with whole plant extracts showing the largest inhibition zones: *E. coli* (8.73 mm fresh, 13.77 mm dry), *K. pneumoniae* (6.89 mm fresh, 7.67 mm dry), *P. aeruginosa* (7.83 mm fresh), *S. aureus* (10.73 mm dry), and *C. albicans* (5.55 mm fresh, 12.55 mm dry). Ethanol extracts were less effective, and aqueous extracts showed minimal activity. Whole plant extracts consistently exhibited synergistic bioactivity (Bauer et al., 1966).

Table 1: Physicochemical Composition of the Aqueous Extracts of *T. procumbens*

Physicochemicals	Aqueous Leaves	Extract Flower	Whole plant
Glycosides	+	+	+
Saponins	-	+	+
Tannins	+	+	+
Flavonoids	-	+	+
Alkaloids	+	+	+
Terpenoids	-	+	+

Table 2: Physicochemical Composition of the Ethanol Extracts of *T. procumbens*

Physicochemicals	Ethanol Leaves	Extract Flower	Whole plant
Glycosides	-	+	+
Saponins	+	+	+
Tannins	-	+	+
Flavonoids	+	+	+
Alkaloids	-	+	+
Terpenoids	-	+	+

Table 3: Phytochemical Composition of the PE of *T. procumbens*

Physicochemicals	Petroleum Leaves	Extract Flower	Whole plant
Glycosides	+	+	+
Saponins	+	+	+
Tannins	+	+	+
Flavonoids	+	+	+
Alkaloids	+	+	+
Terpenoids	+	+	+

PE: Petroleum Ether**Table 4. Mean Zone of Inhibition (Fresh Extracts) of *Tridax procumbens*.**

Plant Parts	Extract Type	Average Zones of Inhibition (mm)
Leaves	Aqueous	2.44
Leaves	Ethanol	3.87
Leaves	Petroleum ether	6.68
Flowers	Aqueous	3.27
Flowers	Ethanol	4.68
Flowers	Petroleum ether	7.41
Whole Plants	Aqueous	3.99
Whole Plants	Ethanol	5.47
Whole Plants	Petroleum ether	7.33

Table 5. Mean Zone of Inhibition (Dry Extracts) of *Tridax procumbens*.

Plant Parts	Extract Type	Average Zones of Inhibition (mm)
Leaves	Aqueous	3.53
Leaves	Ethanol	5.87
Leaves	Petroleum ether	9.87
Flowers	Aqueous	3.56
Flowers	Ethanol	5.87
Flowers	Petroleum ether	7.99
Whole Plants	Aqueous	5.66
Whole Plants	Ethanol	7.59
Whole Plants	Petroleum ether	11.41

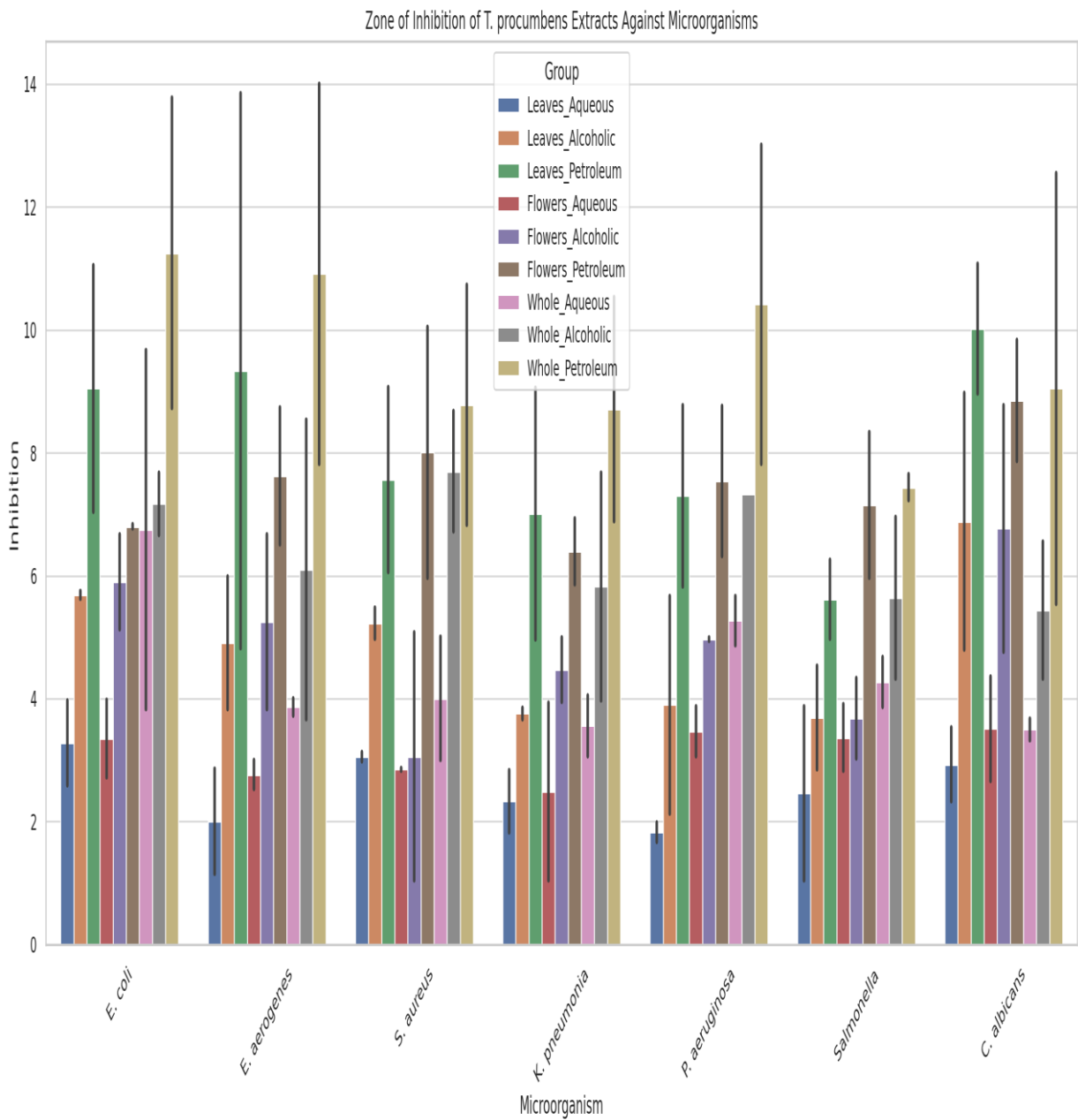


Figure 1: Zones of inhibition of *Tridax procumbens* extracts against microorganisms

Table 6: Average Zones of Inhibition (mm) by Extract Type and Form

Plant Parts	Extract Type	Average Inhibition (mm)
Dry	Ethanol	6.18
Dry	Aqueous	3.77
Dry	Petroleum ether	9.46
Fresh	Ethanol	4.67
Fresh	Aqueous	2.98
Fresh	Petroleum ether	7.19

Fresh Extracts – F-statistic = 59.32, p-value $\approx 6.1 \times 10^{-15}$ (highly significant)

Dry Extracts – F-statistic = 33.64, p-value $\approx 1.6 \times 10^{-10}$ (highly significant)

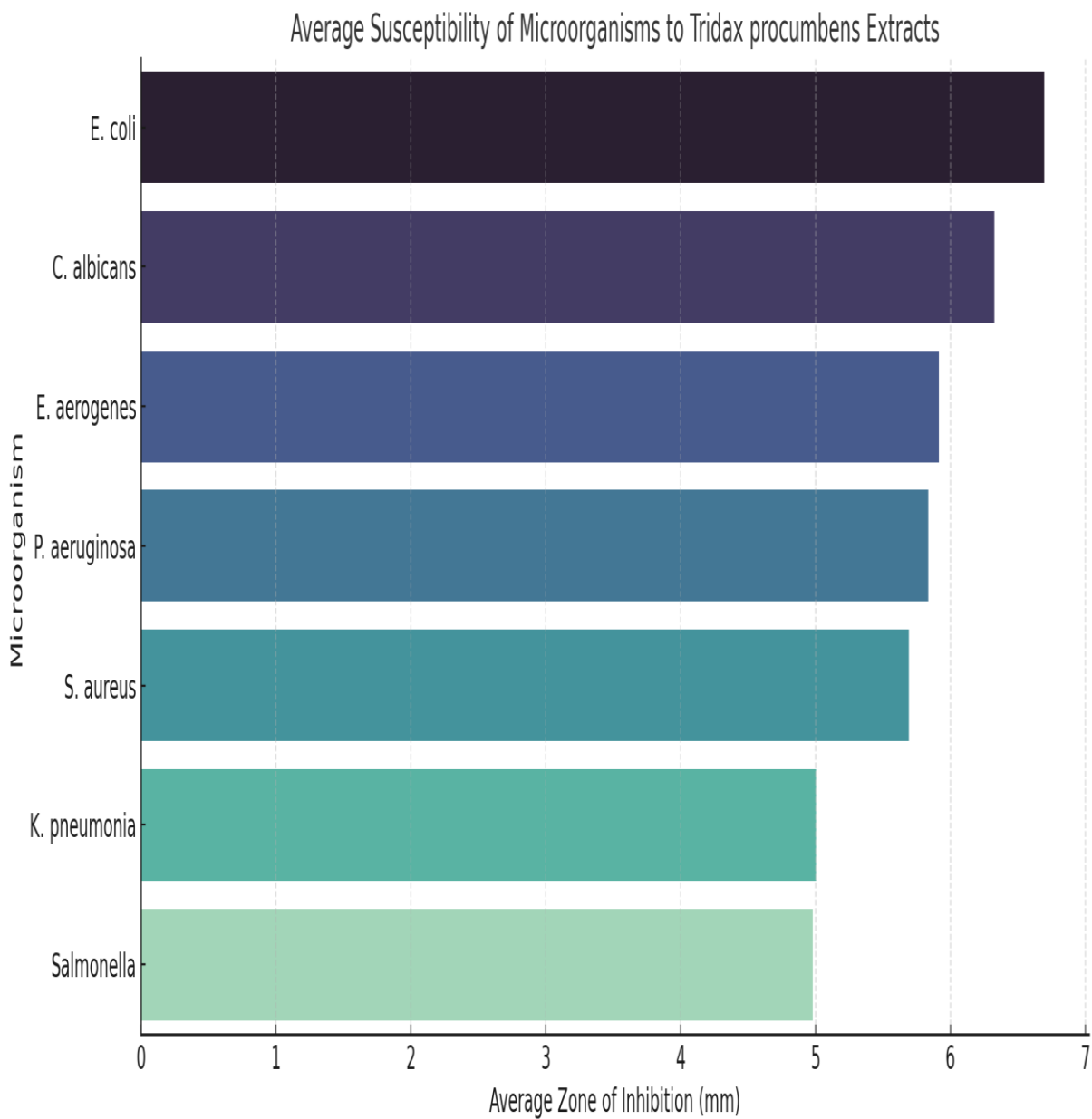


Figure 2: Average susceptibility of microorganisms to *Tridax procumbens* extracts

Discussion

The increasing reliance on traditional and complementary medicine is now evident globally, particularly across African nations, where it serves as a primary source of health care (WHO, 2013). The ethnomedicinal use of *Tridax procumbens* has long been associated with antimicrobial applications (Mundada & Shivhare, 2010). Several studies highlight its diverse therapeutic roles. For instance, *Tridax* has been documented for managing typhoid fever, cough, gastrointestinal disorders, fever, epilepsy, and body pains in Nigeria (Soladoye et al., 2013; Mann et al., 2003). In rural Africa, it is also used in veterinary practices for treating livestock ailments (Byavu et al., 2000). Reports from Togo describe the application of freshly crushed leaves as wound dressings, while leaf decoctions are traditionally employed against abdominal pain, mycotic infections, and malaria (Agban et al., 2013). Beyond Africa, ethnopharmacological accounts from India note its effectiveness against diarrhea, jaundice, and hair loss (Saraf & Dixit, 1991; Saraf et al., 1990; Policegoudra et al., 2014). In Central America, especially Guatemala, the plant is widely recognized for treating protozoal diseases such as malaria, leishmaniasis, and dysentery (Caceres et al., 1998; Berger et al., 1998; Martín-Quintal et al., 2009; Gamboa-Leon et al., 2014; Ebiloma et al., 2017).

Our findings build upon these ethnomedicinal claims by demonstrating that *T. procumbens* contains diverse phytochemicals, flavonoids, saponins, alkaloids, tannins, terpenoids, and glycosides, across solvent systems. This observation aligns with earlier phytochemical screenings (Reddy & Sreelakshmi, 2021; Rahman et al., 2023). Furthermore, the comparative solvent analysis revealed petroleum ether and ethanol to be more efficient than aqueous solvents in extracting lipophilic and phenolic compounds, corroborating Singh and Mehta (2022). The petroleum ether extracts consistently showed the strongest antimicrobial potential, especially from dried whole plant samples, which parallels the outcomes of Patil et al. (2023), who reported similar broad-spectrum efficacy against Gram-positive and Gram-negative organisms.

The antimicrobial assays in this study underscore the strong inhibitory effect of petroleum ether extracts on *E. coli*, *S. aureus*, *K. pneumoniae*, and *C. albicans*. Among these, *S. aureus* and *C. albicans* demonstrated the highest sensitivity, while *K. pneumoniae* and *E. aerogenes* were relatively more resistant. These results mirror the findings of Ogunbanwo et al. (2021) and Chandran et al. (2022), who noted broad antimicrobial effects of *Tridax* extracts across multiple pathogens. Another significant observation is the enhanced bioactivity of extracts derived from the whole plant compared to isolated parts such as leaves or flowers. This supports the notion of phytochemical synergy across plant tissues, consistent with the conclusions of Deshmukh and Yadav (2022).

A notable pattern from this study is the higher antimicrobial activity of dried extracts compared to fresh ones. Dried petroleum ether extracts, in particular, exhibited superior inhibition zones across most microbial strains. This finding suggests that drying may stabilize or concentrate active constituents, thereby improving their bioavailability, a hypothesis similarly advanced by Murugan and Parimelazhagan (2023).

Overall, the results of this study reinforce the ethnopharmacological relevance of *Tridax procumbens* and provide experimental evidence supporting its therapeutic potential.

The plant's broad-spectrum antimicrobial activity, solvent-dependent variability, and synergistic enhancement in whole plant extracts emphasize its importance as a promising candidate for developing affordable, plant-based antimicrobials, particularly in resource-limited regions where conventional antibiotics may be inaccessible.

Conclusion

This study has provided detailed insights into the phytochemical composition and antimicrobial activity of *Tridax procumbens*. The results confirm that the plant harbors a wide spectrum of secondary metabolites, including flavonoids, saponins, alkaloids, tannins, terpenoids, and glycosides, whose abundance and diversity are strongly influenced by the solvent system and plant part used. Petroleum ether extracts, particularly from dried whole plants, consistently demonstrated the highest antimicrobial potency, with significant inhibitory effects against both Gram-positive and Gram-negative bacteria as well as fungal pathogens such as *C. albicans*. The findings validate the longstanding ethnomedicinal applications of *T. procumbens* across different cultures and highlight its potential as a broad-spectrum antimicrobial agent. Importantly, the enhanced bioactivity observed in whole plant extracts suggests a synergistic contribution of multiple tissues, while the superior efficacy of dried samples points to the role of post-harvest processing in improving stability and bioavailability of active compounds. Taken together, these results underscore the promise of *T. procumbens* as a low-cost, plant-based therapeutic option in addressing the challenges of antimicrobial resistance, particularly in resource-limited settings where access to conventional antibiotics is restricted. Further studies involving bioassay-guided fractionation, in vivo testing, and toxicity profiling are warranted to fully explore its pharmacological potential and support its integration into modern drug development pipelines.

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