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Rheological Characterization and *In Vitro* Antibacterial Dynamics of a Dual-Polymer Herbal Gel of *Tridax Procumbens*

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Abstract: *Tridax procumbens Linn.* (*Asteraceae*), a traditionally used haemostatic and wound-healing herb, is rich in antimicrobial flavonoids, yet few studies have translated its extract into a stable, standardized topical hydrogel. This study aims to formulate and evaluate a Carbopol 940-HPMC based topical hydrogel incorporating the 90% ethanolic leaf extract of *Tridax procumbens* and assess its *in vitro* antimicrobial efficacy. Authenticated *T. procumbens* leaves were extracted using 90% ethanol, yielding 7.33% w/w of dried extract. The extract's flavonoid content was analytically confirmed *via* TLC (major Rf 0.577) and UV-visible spectrophotometry (λ max 253 nm, 383 nm) against a quercetin standard. A 1.0% w/w extract-loaded herba gel was formulated and exhibited ideal physicochemical properties, including a homogeneous green appearance, optimal pH (6.42), spread ability (21.72 g.cm/sec), and viscosity (4770-5340 cP). *In vitro* antibacterial screening via the agar well diffusion method revealed significant zones of inhibition against *Staphylococcus aureus* (15.00 ± 0.33 mm) and *Escherichia coli* (8.00 ± 0.33 mm). In conclusion, the developed Tridax Daisy Herba Gel is a physiochemically stable, skin-compatible formulation. It effectively retains broad-spectrum antimicrobial activity within the gel matrix, highlighting its potential as a standardized, plant-based therapeutic alternative for managing topical wound and skin infections.

Keywords: Agar well diffusion; Antimicrobial activity; Carbopol 940; Herba gel; HPMC; Topical drug delivery; *Tridax procumbens;* Quercetin; Wound healing.

1. INTRODUCTION

Skin and soft-tissue infections remain among the most common reasons for outpatient consultation worldwide, and delayed wound healing imposes a substantial clinical and economic burden, particularly among vulnerable populations. Management of such infections is increasingly complicated by the emergence of antimicrobial-resistant organisms, notably methicillin-resistant *Staphylococcus aureus* and multidrug-resistant *Pseudomonas aeruginosa*, which limit the efficacy of conventional synthetic antibiotics [1]. This growing resistance crisis has renewed scientific interest in plant-derived antimicrobial agents, which typically act through multiple, overlapping mechanisms-membrane disruption, enzyme inhibition, and biofilm interference-that make resistance development comparatively slower than with single-target synthetic drugs [2].

Tridax procumbens Linn. (Family *Asteraceae*), commonly known as “coat buttons” or “Tridax daisy,” is a hardy, widely naturalized medicinal weed of tropical origin. [3] In India, it occupies a prominent place in Ayurvedic and Siddha medicine, where its leaf juice is traditionally applied to fresh wounds and cuts for its pronounced haemostatic and wound-healing properties [4,5]. Its documented ethnomedicinal uses

further extend to the management of bronchial catarrh, dysentery, diarrhoea, and various infections across diverse global traditions. [6,7,8]

Phytochemical investigations have consistently identified *T. procumbens* as a dense reservoir of secondary metabolites. Systematic profiling of the leaves has revealed a rich complement of flavonoids (notably quercetin, luteolin, and kaempferol), alkaloids, tannins, saponins, phytosterols, and carotenoids. [9,10] Pharmacognostic and standardization work has independently verified the presence of quercetin as a principal marker compound of the extracts. [12,13]

Comparative solvent-extraction studies indicate that polar solvents such as ethanol preferentially recover the flavonoid and phenolic-rich fractions responsible for much of the plant's bioactivity [14,15].

Modern pharmacological evaluation has substantiated many traditional claims. Extracts significantly accelerate wound contraction and closure, an effect mechanistically linked to increased lysyl oxidase activity and elevated protein and glycosaminoglycan content within granulation tissue [17,18]. The plant additionally demonstrates hepatoprotective, antihyperglycemic, anti-arthritic, immunomodulatory, antioxidant, and dose-dependent anti-inflammatory activities. [19-27] Of direct relevance, extracts of *T. procumbens* have repeatedly demonstrated broad-spectrum inhibitory activity against clinically important skin and wound pathogens, including *Staphylococcus aureus* and *Escherichia coli*, attributed to the combined membrane-disrupting and enzyme-inhibitory actions of its tannin, saponin, and flavonoid fractions [28,29,30].

Topical drug delivery is an attractive route for localized infection management, delivering therapeutic concentrations directly to the injury site while bypassing hepatic metabolism and minimizing systemic toxicity. Hydrogels are preferred over conventional creams for wound care due to their non-greasy texture, superior spreadability, and the soothing cooling sensation they provide. [31] Carbopol 940 and hydroxypropyl methylcellulose (HPMC) are frequently combined because their synergistic action produces a clear, mechanically stable matrix capable of retaining botanical actives. However, comparatively little published work has focused on a Carbopol-HPMC hydrogel bearing defined physicochemical and microbiological benchmarks for the 90% ethanolic extract specifically. [34]

The present study was therefore undertaken to develop and comprehensively evaluate a Carbopol 940-HPMC based topical herba gel incorporating the 90% ethanolic leaf extract of *T. procumbens*. The specific objectives were to: (i) authenticate and extract the plant material; (ii) analytically confirm the marker flavonoid quercetin by thin-layer chromatography (TLC) and UV-visible spectrophotometry; (iii) formulate a 1.0% w/w extract-loaded hydrogel; (iv) evaluate its physicochemical quality attributes (pH, spread ability, viscosity, and homogeneity); and (v) determine its *in vitro* antimicrobial efficacy against *Staphylococcus aureus* and *Escherichia coli*, translating a well-documented ethnomedicinal remedy into a pharmaceutically standardized topical product. [36]

2. MATERIALS AND METHODS

2.1 Plant Material and Authentication

Fresh leaves of *Tridax procumbens* (family *Asteraceae*) were collected from the locality surrounding Coimbatore district, Tamil Nadu, India, during 2026 (Fig. 1). Taxonomic identification and authentication were carried out by Dr. Jagadeesh Ram, Scientist 'F' and Head of Office (I/C), Botanical Survey of India, Southern Regional Centre, Coimbatore. A voucher specimen (No. BSI/SRC/5/23/2026-27/Tech./1273) was prepared and deposited in the departmental herbarium for future reference.

Fig 1: Tridax procumbens Linn Leaves

2.2 Chemicals and Reagents

90% ethanol was used as the extraction solvent. Carbopol 940 and hydroxypropyl methylcellulose (HPMC K15M) served as the primary and secondary gelling agents respectively; triethanolamine (TEA) was used as the neutralizing/pH-adjusting agent; propylene glycol functioned as a co-solvent and permeation enhancer; glycerine was employed as a humectant; and methylparaben sodium served as the antimicrobial preservative. Standard quercetin was used as the reference marker for TLC and UV analysis. Mueller-Hinton agar, nutrient broth, Agar Agar Type-I, and standard subcultures of *Staphylococcus aureus* and *Escherichia coli* were used for the microbiological assay, with ofloxacin as the reference antibiotic. All reagents used were of standard laboratory grade.

2.3 Preparation of the Extract

The collected leaves were washed with distilled water, shade-dried at room temperature to preserve thermolabile constituents and reduced to a coarse powder using a mechanical blender. 60 grams of the coarse powder was packed into a filter-paper thimble and subjected to continuous hot percolation in a Soxhlet apparatus using 700 mL of 90% ethanol, with the heating mantle maintained at 60 °C for a minimum of 35-40 siphon cycles, until the solvent in the siphon tube ran colourless, indicating complete exhaustion of the plant material. The resulting liquid extract (550 mL) was concentrated by solvent evaporation at 40 °C using a heating mantle, and the dried, concentrated extract was transferred to a desiccator and stored at 4 °C until further use.

2.4 Pharmacognostical and Phytochemical Profiling Rationale

Because the macroscopic, microscopic, physicochemical and preliminary phytochemical profile of *T. procumbens* is already extensively documented and validated in the published Pharmacognostical literature [3,12,13,37,38], these baseline parameters were not repeated de novo for the present formulation study. Instead, they were adopted from these authenticated literature sources to provide a theoretical basis for the presence of the flavonoid, alkaloid and tannin constituents required for the intended wound-healing and antimicrobial action. The specific 90% ethanolic extract used in the present formulation was, however, independently confirmed for its flavonoid content by TLC and UV spectroscopy.

2.5 Analytical Confirmation of Flavonoid Content

2.5.1 Thin-Layer Chromatography (TLC)

TLC was performed on pre-coated silica gel 60 F254 plates, using the concentrated ethanolic extract reconstituted in a minimal volume of ethanol, with standard quercetin run alongside as a reference marker. Three trial mobile-phase systems composed of toluene, ethyl acetate and formic acid in varying ratios (60:40:0.3, 60:40:5 and 60:40:4) were evaluated during method optimization but produced poor spot resolution and significant tailing. A finalized, more polar mobile phase of ethyl acetate: formic acid: glacial acetic acid: water (100:11:11:26) was subsequently adopted; the twin-trough development chamber was pre-saturated with this solvent system for 30 minutes at room temperature prior to development. Samples were spotted approximately 1 cm from the plate base using a micro-capillary tube and developed by the

ascending technique to a solvent-front distance of 11.6 cm. Spots were visualized under UV light (365 nm) and by exposure to iodine vapour, and the retention factor (Rf) for each spot was calculated as:

$$Rf = \frac{\text{Distance traveled by the solute}}{\text{Distance traveled by the solvent front}}$$

2.5.2 UV-Visible Spectral Analysis

UV-visible spectra of the extract and the quercetin standard, prepared in HPLC-grade ethanol, were recorded on a JASCO V-730 double-beam spectrophotometer over a measurement range of 200-800 nm (scan speed 400 nm/min; data interval 1 nm; bandwidth 1.0 nm; D2/WI light source), following baseline correction with an ethanol blank. Absorption maxima (λmax) were assigned to Band I (300-380/400 nm, cinnamoyl/B-ring chromophore) and Band II (240-295 nm, benzoyl/A-ring chromophore), the two absorption regions characteristic of flavonoid compounds.

2.6 Formulation of Tridax Daisy Herba Gel

A Carbopol 940-HPMC based hydrogel was formulated as detailed in Table 1. Carbopol 940 was weighed and dispersed in distilled water and allowed to swell overnight; HPMC K15M was separately dispersed in a small volume of water. Methylparaben sodium was dissolved in propylene glycol and incorporated into the swollen gel base. The concentrated ethanolic extract (1.0% w/w) was then slowly incorporated under continuous mechanical stirring to prevent lump formation, and glycerine was added as a humectant to impart moisturizing properties. The pH of the gel was adjusted to the skin-compatible range of 6.5-7.0 by drop-wise addition of triethanolamine with slow stirring, producing a transparent, highly viscous gel; the final volume was made up with distilled water, and the finished formulation was filled into clean, sterile containers and labelled for evaluation.

Table 1: Composition of Tridax Daisy Herba Gel Formulation

S. No	Ingredient	Role	Quantity (% w/w)
1	*Tridax procumbens* 90% ethanolic extract	Active ingredient	1.0 g
2	Carbopol 940	Gelling agent (primary)	1.0 g
3	HPMC K15M	Gelling agent (secondary)	0.5 g
4	Triethanolamine (TEA)	pH-adjusting agent	q.s.
5	Propylene glycol	Co-solvent / permeation enhancer	10.0 mL
6	Glycerine	Humectant	1.0 mL
7	Methylparaben sodium	Preservative	0.2 g
8	Distilled water	Vehicle	q.s. to 100 g

2.7 Physicochemical Evaluation

Formulated gel was evaluated for the following quality-control parameters:

(a) Physical appearance: Assessed by direct visual inspection against a light background for colour, clarity/opacity, and by sensory assessment for characteristic odour.

(b) pH: Measured in triplicate using a calibrated digital pH meter, with the glass electrode fully immersed in the gel and the reading allowed to stabilize at room temperature; the mean of three readings was reported.

(c) Spreadability: Determined by the glass-slide (slip-and-drag) method. An exact quantity of gel (0.5 g) was sandwiched between two glass slides, a 50 g weight was applied to the upper slide for a few minutes to expel entrapped air, and the time taken for the slide to travel a fixed distance (3 cm) under the pulling weight was recorded in triplicate. Spreadability (S) was calculated as $S = (m \times l) / t$, where m is the applied mass (g), l is the distance travelled (cm) and t is the time taken (sec).

(d) Viscosity: Measured using a rotational (Brookfield-type) viscometer at a constant room temperature of 24 °C, with readings taken after a run time of 60 seconds at spindle speeds of 70, 75 and 80 rpm.

(e) Homogeneity: Assessed visually for phase separation, particulate matter or lumps, and physically by pressing the gel between the thumb and index finger to confirm uniform texture.

(f) Texture: Assessed sensorially by applying and rubbing a small quantity of gel between the thumb and index finger to evaluate smoothness, grittiness and greasiness.

2.8 *In Vitro* Antimicrobial Evaluation

Antimicrobial activity was determined by the agar well diffusion method against *Staphylococcus aureus* (Gram-positive) and *Escherichia coli* (Gram-negative). A solid culture medium of nutrient broth and Agar Agar Type-I was prepared, and the medium, along with the required glassware, was sterilized by autoclaving (121 °C, 15 psi, 15-20 min). Under strict aseptic conditions within a laminar air flow chamber, approximately 20-25 mL of the warm medium was poured into sterile Petri dishes and allowed to solidify. Standardized inoculum of each test organism was uniformly swabbed onto the solidified plates to create a confluent bacterial lawn, and wells of 8 mm diameter were aseptically punched using a sterile stainless-steel cork borer. A measured quantity of the saturated herbal extract (test sample) and ofloxacin (standard reference control) were introduced into their respectively labelled wells, and the plates were incubated at 37 °C for 24 hours. Following incubation, the diameter of the clear zones of inhibition formed around each well was measured in millimetres using a calibrated scale, and the Activity Index (AI) was calculated as:

$$\text{Activity Index} = \frac{\text{Zone of inhibition of the test sample (Herbal Extract)}}{\text{Zone of inhibition of the standard control (Ofloxacin)}}$$

2.9 Statistical Analysis

All antimicrobial assay values are expressed as mean ± SEM of triplicate observations.

3. RESULTS AND DISCUSSION

3.1 Authentication of Plant Material

The botanical classification of the authenticated specimen is presented in Table 2. The collected specimen was confirmed as *Tridax procumbens Linn*. (Family *Asteraceae*) and authenticated by the Botanical Survey of India, Coimbatore (voucher no. BSI/SRC/5/23/2026-27/Tech./1273), consistent with the taxonomic and morphological descriptions reported for the species in the pharmacognostic literature [3,37]. The plant was verified with established botanical descriptions of the species [38].

Table 2: Botanical Classification of *Tridax procumbens Linn*.

Rank	Classification
Kingdom	*Plantae*
Sub-kingdom	*Tracheobionta*
Division	*Spermatophyta*
Subdivision	*Magnoliophyta*
Class	*Magnoliopsida*
Order	*Asterales*
Family	*Asteraceae*
Genus	*Tridax L.*
Species	*Tridax procumbens L.*

3.2 Percentage Yield of Extract

Soxhlet extraction of 60 g of coarse leaf powder with 90% ethanol yielded 4.4 g of dried extract (calculated as the difference between the weight of the beaker containing extract, 187.24 g, and the empty beaker, 182.84 g), corresponding to a percentage yield of 7.33% w/w [(4.4/60) × 100]. This yield is consistent with the moderate-to-high extractive values reported for ethanolic extraction of *T. procumbens* leaves in the Pharmacognostical literature [12,13], and reflects efficient recovery of the polar flavonoid- and phenolic-rich fraction of the leaf, in line with reports that ethanol preferentially extracts these constituents relative to less polar solvents [14].

3.3 Thin-Layer Chromatographic Analysis

Under the finalized solvent system (ethyl acetate: formic acid: glacial acetic acid: water, 100:11:11:26), the standard quercetin migrated 6.1 cm (Rf = 0.525), while the extract resolved into three distinct spots at 6.7 cm (Rf = 0.577), 9.2 cm (Rf = 0.793) and 10.7 cm (Rf = 0.922) (Table 3). The close correspondence between the major extract spot (Rf 0.577) and the quercetin standard (Rf 0.525) is consistent with previous

HPTLC-based confirmations of quercetin as a marker compound of *T. procumbens* extracts [12], while the two additional spots, both falling within the generally accepted flavonoid Rf range of 0.65-0.95 for this solvent system, indicate the presence of further flavonoid derivatives, in agreement with the multi-flavonoid profile (quercetin, luteolin, kaempferol) reported for the species [9,11].

Table 3: Rf Values of Standard Quercetin and Extract Spots

Sample	Distance Travelled (cm)	Rf Value	Remarks
Standard quercetin	6.1	0.525	Reference marker
Extract - Spot 1	6.7	0.577	Corresponds closely to quercetin
Extract - Spot 2	9.2	0.793	Within flavonoid Rf range (0.65-0.95)
Extract - Spot 3	10.7	0.922	Within flavonoid Rf range (0.65-0.95)

Solvent system: Ethyl acetate: Formic acid: Glacial acetic acid: Water (100:11:11:26); total solvent-front distance = 11.6 cm; visualization under UV light (365 nm) and iodine vapour.

3.4 UV-Visible Spectral Analysis

Standard quercetin exhibited major absorption maxima at 252 nm and 385 nm, with minor peaks at 243, 305, 340 and 353 nm, while the extract showed corresponding maxima at 253 nm and 383 nm, with minor peaks at 229, 340, 364 and 660 nm (Fig. 2 and 3; Table 4). The extract's Band II absorption at 253 nm (240-295 nm range, A-ring/benzoyl chromophore) and Band I absorption at 383 nm (300-400 nm range, B-ring/cinnamoyl chromophore) closely mirror the standard's spectral signature, corroborating the TLC evidence for a quercetin-type flavonoid glycoside as a principal bioactive marker of the extract [11,26]. Taken together, the TLC and UV spectral data provide convergent analytical confirmation that the extraction process successfully preserved the flavonoid marker compounds associated with the plant's known wound-healing and antimicrobial bioactivity.

Table 4: UV-Visible Spectral Absorption Maxima of Standard Quercetin and Extract

Sample	λmax - Band II (nm)	λmax - Band I (nm)	Other Minor Peaks (nm)
Standard quercetin	252	385	243, 305, 340, 353
Tridax procumbens extract	253	383	229, 340, 364, 660

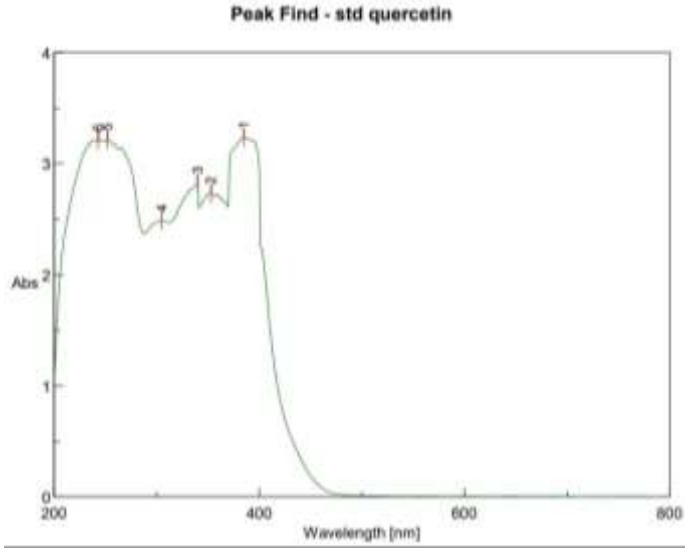

Fig 2: UV spectral report of standard quercetin

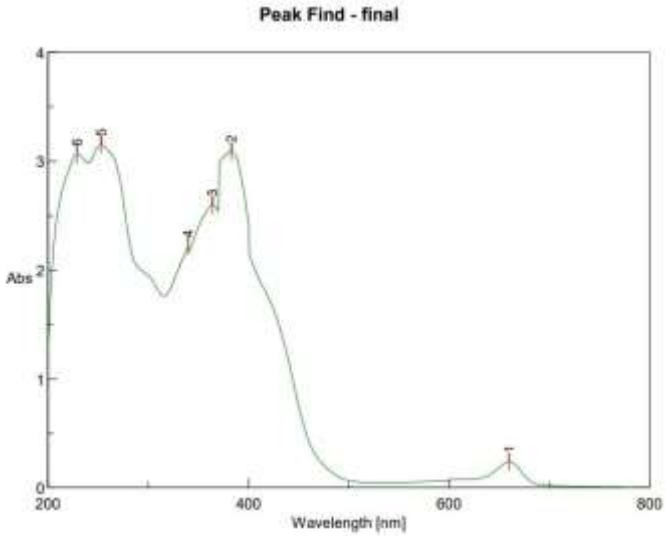

Fig 3: UV spectral report of the *Tridax procumbens* extract

3.5 Formulation of the Herba Gel

A homogeneous, green, opaque-to-translucent gel was successfully obtained by incorporating 1.0% w/w of the *T. procumbens* ethanolic extract into a Carbopol 940 (1.0% w/w)-HPMC K15M (0.5% w/w) base, neutralized to a skin-compatible pH with triethanolamine (Table 1; Fig. 4). No visible extract precipitation, phase separation, or incompatibility with the gelling agents was observed during preparation, indicating satisfactory compatibility between the polar botanical extract and the hydrophilic polymer matrix - a prerequisite noted in prior formulation work combining Carbopol and HPMC as synergistic gelling agents for herbal actives [31,34].

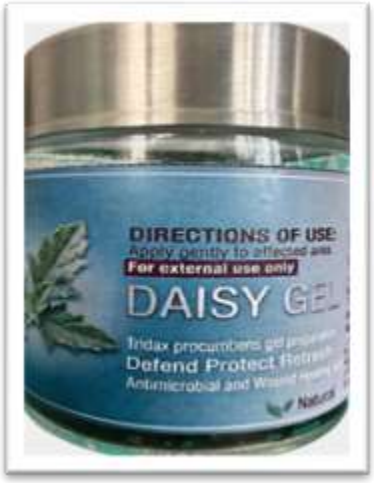

Fig 4: Formulated Daisy Herba Gel

3.6 Physicochemical Evaluation

The results of the physicochemical evaluation are summarized in Table 5. The gel exhibited a characteristic green colour with a pleasant odour and an opaque-to-translucent, cosmetically acceptable appearance. The mean pH, calculated from three independent readings (5.98, 6.29 and 6.99) as 6.42, falls close to the standard wound-skin pH range of 4.5-6.5, indicating that the formulation is unlikely to irritate or disrupt the skin's natural acid mantle upon application. Spreadability, assessed across three trials (21.42, 18.75 and 25.00 g.cm/sec), averaged 21.72 g.cm/sec, comfortably within the target acceptance range of 10-35 g.cm/sec and indicating that the gel spreads with an appropriate balance of ease and residence at the application site. Viscosity, recorded at 24 °C across 70, 75 and 80 rpm, ranged from 4770 to 5340 cP, exceeding the minimum 3,000 cP threshold required for a semi-solid topical consistency while remaining below the 7,000 cP upper limit, consistent with an optimal balance between structural integrity and ease of application. The formulation demonstrated excellent homogeneity, being free from lumps or phase

separation, and a smooth, non-gritty, non-greasy texture on skin application. These findings are broadly consistent with the physicochemical profiles reported for other Tridax-based topical gels and polyherbal wound-care formulations [33,34,36], and support the cosmetic and dermatological acceptability of the Carbopol-HPMC base selected for this study.

Table 5: Summary of Physicochemical Evaluation Parameters

S.No	Parameter	Method	Observed Result	Acceptance Criteria
1	Physical appearance	Visual inspection	Green, opaque-translucent, pleasant odour	Homogeneous, pleasant odour
2	pH	Digital pH meter	6.42	4.5 - 6.5
3	Spreadability	Glass slide method	21.72 g.cm/sec	10 - 35 g.cm/sec
4	Viscosity	Viscometer (24 °C)	4770 - 5340 cP	> 3,000 cP; < 7,000 cP
5	Homogeneity	Visual examination	No lumps, uniform texture	Uniform texture throughout
6	Texture	Sensory examination	No grittiness or greasiness	Uniform smooth texture

3.7 *In Vitro* Antimicrobial Activity

The antimicrobial screening results are summarized in Tables 6 and 7. The formulated gel's herbal extract produced a zone of inhibition of 15.00 ± 0.33 mm against *Staphylococcus aureus*, corresponding to an Activity Index of 0.50 relative to ofloxacin (30.00 ± 0.57 mm), and a zone of inhibition of 8.00 ± 0.33 mm against *Escherichia coli*, corresponding to an Activity Index of 0.36 relative to ofloxacin (22.00 ± 0.57 mm); no activity was observed for the ethanol blank in either assay. The consistently larger zone of inhibition and higher Activity Index recorded against the Gram-positive *S. aureus* relative to the Gram-negative *E. coli* is in agreement with previous reports of greater susceptibility of Gram-positive organisms to *Tridax procumbens* extracts, an observation generally attributed to the additional lipopolysaccharide-rich outer membrane of Gram-negative bacteria, which restricts the penetration of polyphenolic actives [28,29]. The retention of clear, measurable antimicrobial activity within the finished gel matrix - despite the pH adjustment, polymer cross-linking and mechanical processing involved in formulation - indicates that the flavonoid, tannin and saponin fractions of the extract remained biologically active after incorporation, a non-trivial finding given that such processing can diminish the bioactivity of sensitive plant constituents [1,30].

Table 6: *In Vitro* Antimicrobial Activity of Tridax Herbal Extract Against *Staphylococcus aureus*

Sample	Zone of Inhibition (mm)	Activity Index
Blank (ethanol)	0	0
Standard (ofloxacin)	30.00 ± 0.57	-
Sample (saturated herbal extract)	15.00 ± 0.33	0.50

Values are expressed as mean ± SEM of triplicate observations. (-) denotes not applicable.

Table 7: *In Vitro* Antimicrobial Activity of Tridax Herbal Extract Against *Escherichia coli*

Sample	Zone of Inhibition (mm)	Activity Index
Blank (ethanol)	0	0
Standard (ofloxacin)	22.00 ± 0.57	-
Sample (saturated herbal extract)	8.00 ± 0.33	0.36

Values are expressed as mean ± SEM of triplicate observations. (-) denotes not applicable.

3.8 Mechanistic Basis of Bioactivity

Mechanistically, the antimicrobial action of the extract is attributable to the synergistic activity of its principal secondary metabolites. Tannins and saponins are reported to interact with the bacterial cell wall and disrupt membrane integrity, causing leakage of intracellular constituents and eventual cell death, while flavonoids such as quercetin and luteolin are reported to inhibit vital bacterial enzymes, including DNA

gyrase, thereby preventing bacterial DNA replication [11,29]. In parallel, the same flavonoid and phenolic fractions are believed to support the plant's wound-healing action through up-regulation of lysyl oxidase-mediated collagen cross-linking, enhanced granulation-tissue protein and glycosaminoglycan content, and antioxidant/anti-inflammatory suppression of oxidative stress at the wound site [17,18,26]. The combination of confirmed flavonoid content, favourable physicochemical characteristics and retained antimicrobial efficacy therefore supports the rational basis for formulating *T. procumbens* extract as a topical hydrogel for wound and skin-infection management.

4. CONCLUSION

The present study successfully developed and characterized a Carbopol 940-HPMC based topical herba gel incorporating the 90% ethanolic leaf extract of *Tridax procumbens Linn*. Soxhlet extraction yielded 7.33% w/w of extract, and TLC and UV spectral analysis provided convergent analytical confirmation of quercetin-type flavonoid content, closely matching the standard reference. The formulated 1.0% w/w Tridax Daisy Herba Gel exhibited a cosmetically acceptable green, homogeneous appearance; a skin-compatible pH of 6.42; spreadability (21.72 g.cm/sec) and viscosity (4770-5340 cP) within their respective target acceptance ranges; and a smooth, non-gritty texture - collectively meeting the fundamental pharmaceutical quality benchmarks expected of a dermatologically applied semi-solid dosage form.

Critically, the gel retained measurable, broad-spectrum antimicrobial activity against both the Gram-positive pathogen *Staphylococcus aureus* and the Gram-negative pathogen *Escherichia coli* following its incorporation into the polymer matrix, fulfilling the core therapeutic rationale underlying its development. These findings provide a reproducible, quantifiable scientific basis for the long-standing traditional use of *Tridax procumbens* in wound care, and position the Tridax Daisy Herba Gel as a promising, cost-effective, plant-based alternative to synthetic antimicrobial topical preparations for the management of localized skin and wound infections.

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