

PHARMACOLOGICAL EVALUATION OF WOUND HEALING POTENTIAL OF A POLYHERBAL FORMULATION CONTAINING IXORA CHINENSIS AND MURRAYA PANICULATA EXTRACTS USING IN VIVO EXPERIMENTAL WOUND MODELS

SOURAV MISHRA^{1*}

¹M. Pharm Final Year, Department of Pharmacology,
Ravishankar College of Pharmacy, Bhopal, Madhya Pradesh, India

Mrs.RASHMI CHOURLAIYA²

² Associate Professor,
Ravishankar College of Pharmacy, Bhanpur, Bhopal [Madhya Pradesh]

***Corresponding author:**

Sourav Mishra¹

E-mail: souravmishra000001@gmail.com,

ABSTRACT

Objective: The objective of this study was to develop a polyherbal gel formulation containing methanolic leaf extracts of *Ixora chinensis* and *Murraya paniculata*, and to evaluate its wound healing potential using an in vivo excision wound model, so as to find a safe, natural, and effective alternative to conventional wound care agents.

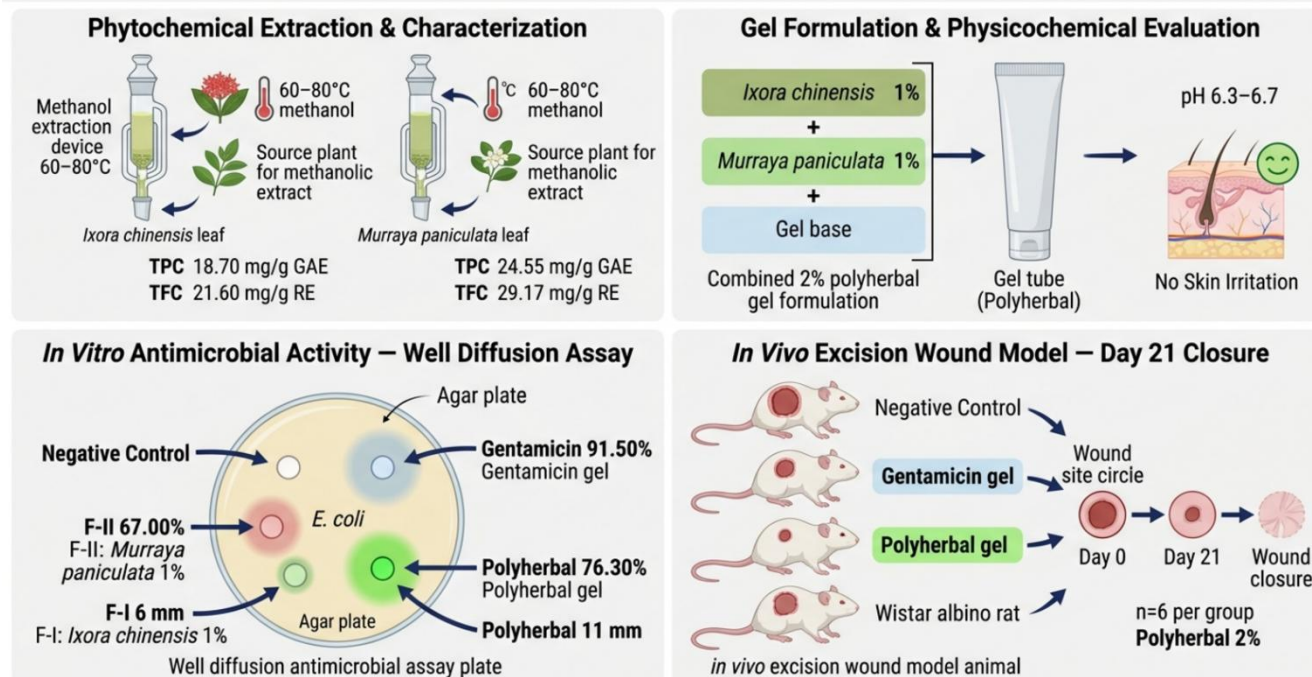
Methods: Shade-dried leaves of *Ixora chinensis* (400 g) and *Murraya paniculata* (350 g) were extracted using methanol solvent (60–80°C) in a Soxhlet apparatus, and the percentage yield was calculated. The qualitative phytochemical screening and quantitative estimation (Total Phenolic Content and Total Flavonoid Content, using Folin-Ciocalteu and aluminum chloride colorimetric methods) were performed for both extracts. Three gel formulations with Carbopol-940 and carboxymethyl cellulose base were prepared — individual extract gels (1% each) and a combined polyherbal gel (2%) — and their pH, viscosity, spreadability, and skin irritation were evaluated. In vitro antimicrobial activity against *E. coli* was checked using the well diffusion assay. Wound healing activity was assessed in Wistar albino rats (180–200 g) using a full-thickness excision wound model, with five groups (n=6 each): negative control (gel base), Formulation I (*Ixora chinensis* gel 1%), Formulation II (*Murraya paniculata* gel 1%), Polyherbal formulation (2%) and standard Gentamicin gel (1%) were included. Wound contraction was measured on days 4, 8, 12, 16, and 21.

Results: The percentage yield was 7.90% for *Ixora chinensis* and 8.57% for *Murraya paniculata*. *Murraya paniculata* had higher Total Phenolic Content (24.55 mg/g GAE) and Total Flavonoid Content (29.17 mg/g RE) compared to *Ixora chinensis* (18.70 mg/g GAE and 21.60 mg/g RE). All the gel formulations were physicochemically stable (pH 6.3–6.7) and showed no skin irritation. In the in vitro antimicrobial study, the polyherbal formulation showed the largest zone of inhibition (11 mm) compared to the individual formulations (6 mm and 8 mm). In the excision wound model, by the 21st day, the polyherbal formulation showed 76.30% wound closure, which was significantly better than Formulation I (62.80%) and Formulation II (67.00%) but slightly less than the standard Gentamicin gel (91.50%).

Conclusion: The combined polyherbal formulation of *Ixora chinensis* and *Murraya paniculata* extracts shows synergistically better wound healing activity compared to individual extracts, thanks to their combined antioxidant, antimicrobial, and anti-inflammatory phytoconstituents. This formulation could be a promising, safe, and natural alternative for routine wound care.

Keywords: *Ixora chinensis*, *Murraya paniculata*, Polyherbal formulation, Wound healing, Excision wound model, Total phenolic content, Total flavonoid content, Antimicrobial activity.

Polyherbal Gel of *Ixora chinensis* & *Murraya paniculata* for Wound Healing



INTRODUCTION

The skin is the largest organ of the human body in terms of surface area, and it acts as a crucial protective barrier against mechanical injury, microbial invasion, UV radiation, and extreme temperatures. Whenever this barrier gets disrupted — due to trauma, surgery, burns, or chronic conditions like diabetes — wound healing kicks in as a complex, multi-phase biological process involving overlapping stages of hemostasis, inflammation, proliferation, and remodeling. Every year, in the United States alone, non-healing wounds carry an economic burden of around \$50 billion, which clearly shows how high the demand is for effective and affordable wound care interventions (Leavitt et al., 2016).

In conventional wound care, synthetic antimicrobial agents and growth-factor based dressings are used, but they also have limitations — like high cost, risk of microbial resistance, and sometimes delayed healing or adverse skin reactions. That's why herbal and polyherbal formulations have become an attractive alternative, because plants naturally contain bioactive compounds (flavonoids, phenolics, alkaloids, tannins) that have antioxidant, antimicrobial, and anti-inflammatory properties — which can favorably modulate different stages of the wound healing process. According to WHO, about 80% of the world's population relies on herbal medicine for primary healthcare, and the global herbal products market is over \$60 billion (Sendker and Sheridan, 2017).

Ixora chinensis (family Rubiaceae), commonly known as Chinese ixora, is an ornamental shrub native to southeastern China, Indochina, and the Philippines. Its leaves and flowers are used in traditional medicine for anti-inflammatory, pain-relieving, antimicrobial, antioxidant, liver-protective, and wound-healing purposes. On the other hand, *Murraya paniculata* (family Rutaceae), popular as orange jasmine or mock orange, is widely distributed in South and Southeast Asia and is traditionally used for treating diarrhea, dysentery, fever, inflammation, and wounds because it has antimicrobial, anti-inflammatory, and antioxidant properties.

Both plants are individually promising phytochemically and pharmacologically, but there's limited data in the literature on their combined polyherbal effects. It's well-established that polyherbal formulations, when combined rationally, tend to show synergistic therapeutic effects compared to single-plant extracts — as shown in recent studies where combined plant extracts demonstrated enhanced wound closure rates, better antimicrobial activity, and stronger antioxidant potential compared to individual extracts.

To address this gap, the present study combined methanolic leaf extracts of *Ixora chinensis* and *Murraya paniculata* into a topical polyherbal gel formulation and systematically evaluated their wound healing efficacy — starting from phytochemical

screening, quantitative phenolic/flavonoid estimation, physicochemical gel characterization, in vitro antimicrobial testing, and finally comparing with Gentamicin (standard antimicrobial drug) in an in vivo excision wound model. This comprehensive approach ensures that both the efficacy and safety of the formulation can be scientifically validated, and establishes its potential as an alternative natural wound-care agent.

MATERIALS AND METHODS

Plant material and procurement

Leaves of *Ixora chinensis* and *Murraya paniculata* (400 gm and 350 gm respectively) were collected from local areas of Bhopal (Madhya Pradesh, India) and authenticated by a qualified botanist. The plant material was shade-dried at room temperature for about two weeks and then ground into a fine powder using an electronic grinder.

Reagents and chemicals

All the reagents and chemicals used in the study — glacial acetic acid, petroleum ether, conc. sulphuric acid, methanol, sodium hydroxide, conc. hydrochloric acid, chloroform, copper sulphate solution, formalin, DPPH, ascorbic acid, phosphate buffer saline, and Hematoxylin & Eosin — were procured from reputable suppliers (Merck, Sigma-Aldrich, Rankem, Molychem) and were of analytical grade (Table 1).

Table 1: List of major reagents and chemicals used

S. No.	Reagent/Chemical	Source
1	Glacial acetic acid	Merck
2	Petroleum ether	Research Lab
3	Methanol	Molychem
4	Sodium hydroxide	Merck
5	DPPH (2,2-Diphenyl-1-picrylhydrazyl)	Sisco Research Laboratories
6	Ascorbic acid	Merck
7	Phosphate buffer saline (PBS)	Sigma-Aldrich
8	Hematoxylin & Eosin (H&E)	Macsen Laboratories
9	Formalin	Pandora Industries

Instruments used

Table 2: List of instruments

S. No.	Instrument	Model
1	Magnetic stirrer	Remi
2	Weighing machine	Jyoti
3	UV-Visible spectrophotometer	Shimadzu 1700
4	Digital pH meter	EI
5	Soxhlet apparatus	Borosilicate
6	Brookfield viscometer	—

Extraction by Soxhlet method

Both plant powders (*Ixora chinensis* 400 gm, *Murraya paniculata* 350 gm) were placed separately in thimbles and exhaustively extracted with methanol in a Soxhlet apparatus at 60–80°C until the extraction was complete. The resulting filtrate was concentrated using a rotary vacuum evaporator, dried in a desiccator, and the percentage yield was calculated using the formula: % Yield = (Weight of extract / Weight of plant material used) × 100.

Qualitative phytochemical screening

Both extracts were screened using standard qualitative tests for carbohydrates (Molisch's, Fehling's, Benedict's, Barfoed's tests), saponins (froth test), tannins/phenolics (ferric chloride, gelatin, lead acetate tests), triterpenoids/steroids (Liebermann-

Burchard, Salkowski tests), glycosides (Bontrager's, Keller-Killiani tests), proteins/amino acids (Biuret, Ninhydrin tests), alkaloids (Dragendroff's, Wagner's, Mayer's, Hager's tests), and flavonoids (lead acetate, alkaline reagent tests).

Quantitative estimation of phytoconstituents

Total Phenolic Content (TPC) was determined using the Folin-Ciocalteu reagent method, considering gallic acid as the standard. Briefly, 0.2 mL of the extract solution was mixed with 5 mL of diluted Folin-Ciocalteu reagent, 4 mL of sodium carbonate solution (7.5% w/v) was added, the volume was made up to 25 mL with deionized water, and after 90 minutes, absorbance was measured at 760 nm using a UV spectrophotometer. TPC results were expressed in mg gallic acid equivalent (GAE) per gram of dry extract.

Total Flavonoid Content (TFC) was estimated using a colorimetric aluminium chloride method, taking rutin as the standard. 0.3 mL of the extract solution (in 45% ethanol) was mixed with 8 mL of 10% aluminium chloride solution and 4 mL of 0.2 M sodium acetate, made up to 25 mL, and allowed to react at room temperature for 30 minutes before measuring absorbance at 510 nm. The results were expressed in mg rutin equivalent (RE) per gram of dry extract.

Preparation of polyherbal gel formulation

Carbopol-940 was soaked in 50 mL of warm water (A) for 2 hours, then uniformly dispersed using a magnetic stirrer at 600 rpm. Separately, carboxymethyl cellulose and methyl paraben were mixed in 50 mL of warm water (B) with continuous stirring to make a smooth gel base. After mixing combinations A and B, triethanolamine was added drop-wise to neutralize the pH (pH 6.5–7.0). Formulations I and II contained a 1% concentration of their respective extracts, while the polyherbal Formulation III had both extracts at 1% each (total 2%). Propylene glycol was added as a permeation enhancer, and the final dispersion was shaken to make a smooth, lump-free gel (Table 3).

Table 3: Composition of prepared herbal gel formulations

Ingredient	Formulation I	Formulation II	Polyherbal Formulation
Carbopol 940	0.8 g	1.2 g	1.0 g
Carboxymethyl cellulose	1.5 g	1.0 g	1.3 g
Propylene glycol	1.0 ml	0.8 ml	0.9 ml
Methyl paraben	0.1 g	0.15 g	0.1 g
Ixora chinensis extract	2.0 g	—	1.0 g
Murraya paniculata extract	—	2.0 g	1.0 g
Triethanolamine	q.s (pH 6.5–7.0)	q.s	q.s
Distilled water	up to 100 ml	up to 100 ml	up to 100 ml

Quality control of formulations

The prepared gels were evaluated for pH (using a calibrated digital pH meter), viscosity (with a Brookfield viscometer, spindle no. 61), spreadability (using the slide method, formula $S = M \times L / T$), and skin irritation studies (on Wistar rats, with 7 days of topical application).

In vitro antimicrobial activity (well diffusion assay)

The antimicrobial activity was evaluated using the well diffusion assay on E. coli culture in nutrient agar media. The bacterial suspension was standardized to 10^8 CFU/mL, and 6 mm wells were made where 100 μ L of different formulations (1, 2, and 3) were loaded. After incubating the plates at 37°C for 18–24 hours, the zone of inhibition (ZOI) was measured in millimeters.

In vivo wound healing study

Healthy Wistar albino rats (180–200 g) were used at the authorized animal house facility of Pinnacle Biomedical Research Institute (PBRI), Bhopal, after approval from the Institutional Animal Ethics Committee. The animals were acclimatized to standard laboratory conditions ($25 \pm 2^\circ\text{C}$, 44–56% relative humidity, 12:12 h light/dark cycle) and given standard diet and water freely.

Animals were randomly divided into five groups (n=6 each): Group I — negative control (gel base only); Group II — Ixora chinensis extract gel (1%, Formulation I); Group III — Murraya paniculata extract gel (1%, Formulation II); Group IV — polyherbal formulation gel (2%, combined extracts); Group V — standard Gentamicin gel (1%).

For the excision wound model, the animals were anesthetized with ketamine hydrochloride (150 mg/kg body weight), the dorsal area was shaved, and a full-thickness circular excision wound was created using sterile surgical instruments. 500 mg of the respective gel formulation was applied topically once daily from day zero until complete healing. Wound contraction was calculated by tracing the wound margins on transparent tracing paper, and the percentage reduction in wound area was recorded on days 4, 8, 12, 16, and 21, considering the initial wound area as 100%.

Statistical analysis

The results were expressed as mean $\pm$ standard deviation. Wound contraction data was compared across different treatment groups against the control and standard drug, using descriptive comparative analysis to assess statistical significance.

RESULTS

Percentage yield of plant extracts

The methanolic extraction gave a yield of 31.63 g (7.90%) for *Ixora chinensis* and 30.02 g (8.57%) for *Murraya paniculata*, based on their respective theoretical weights (Table 4). A slightly higher yield was observed in *Murraya paniculata*, which indicates greater extractability of its methanol-soluble phytoconstituents.

Table 4: Percentage yield of plant material

S. No.	Plant Name	Solvent	Theoretical Weight (g)	Yield (g)	% Yield
1	<i>Ixora chinensis</i>	Methanol	400	31.63	7.90
2	<i>Murraya paniculata</i>	Methanol	350	30.02	8.57

Qualitative phytochemical screening

The methanolic extract of *Ixora chinensis* was found to contain alkaloids, glycosides, carbohydrates, proteins/amino acids, flavonoids, and tannins/phenolic compounds, while saponins, triterpenoids, and steroids were absent (Table 5). In the methanolic extract of *Murraya paniculata*, alkaloids, carbohydrates, flavonoids, tannins/phenolics, saponins, and triterpenoids/steroids were present, but glycosides and proteins were absent (Table 6).

Table 5: Phytochemical screening of *Ixora chinensis* methanolic extract

Phytoconstituent	Test	Result
Alkaloids	Dragendorff's / Mayer's / Wagner's / Hager's	Present (+ve)
Glycosides	Bontrager's / Legal's / Keller-Killiani	Present (+ve)
Carbohydrates	Molisch's / Fehling's / Benedict's / Barfoed's	Present (+ve)
Proteins and amino acids	Biuret / Ninhydrin	Present (+ve)
Flavonoids	Alkaline reagent / Lead acetate	Present (+ve)
Tannins and phenolics	Ferric chloride	Present (+ve)
Saponins	Foam test	Absent (–ve)
Triterpenoids and steroids	Salkowski's / Libermann-Burchard's	Absent (–ve)

Table 6: Phytochemical screening of *Murraya paniculata* methanolic extract

Phytoconstituent	Test	Result
Alkaloids	Dragendorff's / Mayer's / Wagner's / Hager's	Present (+ve)
Glycosides	Bontrager's / Legal's / Keller-Killiani	Absent (–ve)
Carbohydrates	Molisch's / Fehling's / Benedict's / Barfoed's	Present (+ve)
Proteins and amino acids	Biuret / Ninhydrin	Absent (–ve)
Flavonoids	Alkaline reagent / Lead acetate	Present (+ve)
Tannins and phenolics	Ferric chloride	Present (+ve)

Phytoconstituent	Test	Result
Saponins	Foam test	Present (+ve)
Triterpenoids and steroids	Salkowski's	Present (+ve)

Total Phenolic Content (TPC) aur Total Flavonoid Content (TFC)

Using the gallic acid standard curve ($R^2 = 0.9922$), the TPC for *Ixora chinensis* was calculated to be 18.70 mg/g GAE, while in *Murraya paniculata* it was significantly higher — 24.55 mg/g GAE (Table 7). Similarly, using the rutin standard curve ($R^2 = 0.9997$), the TFC was 21.60 mg/g RE for *Ixora chinensis* and 29.17 mg/g RE for *Murraya paniculata* (Table 7). These results consistently show that *Murraya paniculata* is a richer source of phenolic and flavonoid compounds, which supports its stronger antioxidant potential.

Table 7: Total Phenolic Content (TPC) and Total Flavonoid Content (TFC) of plant extracts

Plant Extract	TPC (mg/gm GAE)	TFC (mg/gm RE)
<i>Ixora chinensis</i>	18.70	21.60
<i>Murraya paniculata</i>	24.55	29.17

Evaluation of polyherbal gel formulation

The prepared gels had a smooth, semi-solid consistency, a light to dark brown color (depending on the extract concentration), and were homogeneous (no lumps or phase separation). The pH ranged from 6.3 to 6.7, which is skin-compatible. Viscosity was in the range of 5455–5691 cps, and spreadability was between 11.19–13.20 gm.cm/sec. In skin irritation studies, no irritation, redness, or swelling was observed in any formulation (Table 8).

Table 8: pH, viscosity, spreadability, and skin irritation results of formulations

Formulation	pH	Viscosity (cps)	Spreadability (gm.cm/sec)	Skin Irritation
Formulation I	6.3	5455 ± 0.71	11.99	Not observed
Formulation II	6.5	5509 ± 0.56	11.19	Not observed
Polyherbal formulation	6.7	5691 ± 0.82	13.20	Not observed

In vitro antimicrobial activity

In the well diffusion assay, all formulations showed inhibitory activity against *E. coli*, but to different degrees. Formulation I showed the smallest zone of inhibition (6 mm), Formulation II showed moderate activity (8 mm), while the polyherbal formulation showed the largest zone of inhibition (11 mm) — this indicates a synergistic interaction of bioactive phytoconstituents from both extracts (Table 9).

Table 9: Zone of inhibition of antimicrobial activity against *E. coli*

S. No.	Sample	Zone of Inhibition (mm)
1.	Formulation I	6
2.	Formulation II	8
3.	Polyherbal formulation	11

Excision wound healing activity

Wound contraction data shows a progressive increase in all treatment groups over the 21-day observation period (Table 10). The negative control group showed minimal natural healing (from 6.20% to 13.10%, day 4 to day 21). Formulation I showed moderate activity, reaching 62.80% wound closure by day 21. Formulation II showed comparatively better healing, reaching up to 67.00%.

The most important finding was that the polyherbal formulation showed 76.30% wound closure on day 21 — which was significantly better than the individual formulations, suggesting a synergistic effect. The standard drug Gentamicin gel showed

the highest activity (91.50% closure), confirming its well-established efficacy. The performance of the polyherbal formulation, although lower than the standard drug, was clearly superior to the individual herbal formulations, supporting the idea that the combined phytoconstituents enhance collagen synthesis, epithelialization, and antimicrobial action.

Table 10: Percentage wound closure in various treatment groups (mean $\pm$ SD, n=6)

Group	4 days	8 days	12 days	16 days	21 days
Control	6.20 $\pm$ 0.32	8.75 $\pm$ 0.40	11.20 $\pm$ 0.45	12.35 $\pm$ 0.48	13.10 $\pm$ 0.50
Formulation I	17.00 $\pm$ 0.50	22.80 $\pm$ 0.64	35.60 $\pm$ 0.57	50.20 $\pm$ 0.60	62.80 $\pm$ 0.54
Formulation II	9.10 $\pm$ 0.60	19.20 $\pm$ 0.52	40.10 $\pm$ 0.59	55.40 $\pm$ 0.53	67.00 $\pm$ 0.53
Polyherbal formulation	10.20 $\pm$ 0.52	24.50 $\pm$ 0.72	47.80 $\pm$ 0.55	67.20 $\pm$ 0.51	76.30 $\pm$ 0.46
Reference standard (Gentamicin gel)	11.00 $\pm$ 0.62	28.10 $\pm$ 0.65	57.00 $\pm$ 0.58	82.00 $\pm$ 0.48	91.50 $\pm$ 0.51

DISCUSSION

The primary aim of the present study was to develop a polyherbal gel formulation combining *Ixora chinensis* and *Murraya paniculata* extracts, and to establish their wound healing potential through systematic *in vivo* evaluation. The extraction yield results (*Ixora chinensis* 7.90%, *Murraya paniculata* 8.57%) were within a reasonable range, indicating that methanol is a suitable solvent for extracting the bioactive constituents of both plants.

The phytochemical screening results make it clear that both plants have overlapping yet distinct phytochemical profiles. *Ixora chinensis* had proteins/amino acids and glycosides which were absent in *Murraya paniculata*, while *Murraya paniculata* had saponins and triterpenoids/steroids which were not present in *Ixora chinensis*. This complementary phytochemical diversity could possibly be the reason behind the enhanced biological activity of the polyherbal combination — because different classes of phytoconstituents can target wound healing pathways through different mechanisms.

In quantitative estimation, *Murraya paniculata* has a higher TPC (24.55 mg/gm GAE) and TFC (29.17 mg/gm RE) compared to *Ixora chinensis* (18.70 mg/gm GAE and 21.60 mg/gm RE respectively), which clearly indicates that *Murraya paniculata* has a stronger antioxidant potential. Phenolic and flavonoid compounds reduce oxidative stress at the wound site through their free-radical scavenging ability, which plays a crucial role in accelerating the healing process — this observation is also consistent with earlier reports by Olayé et al. (2025) and Sraboni et al. (2025), who reported rich phenolic profiles of *Murraya paniculata* and *Ixora chinensis*, respectively.

Formulation evaluation parameters — pH (6.3–6.7), viscosity, and spreadability — were all within the acceptable range, making it suitable for topical application, and the absence of skin irritation also confirms the formulation's safety. These findings are consistent with published reports that establish the physicochemical stability and dermal compatibility of herbal gel formulations.

The result of the *in vitro* antimicrobial study is particularly noteworthy: the polyherbal formulation (11 mm ZOI) showed clearly superior antibacterial activity against *E. coli* compared to the individual formulations (6 mm and 8 mm). This enhancement is likely due to the synergistic interaction of combined flavonoids, phenolics, and alkaloids, which become more effective in disrupting bacterial cell membrane integrity and inhibiting biofilm formation when combined. Reduced microbial load at the wound site lowers the risk of secondary infections and allows the natural healing process to continue unhindered.

The results from the *in vivo* excision wound model provide the most compelling evidence for the superiority of the polyherbal formulation. By day 21, the polyherbal group achieved 76.30% wound closure, which was considerably better than both individual formulations — *Ixora chinensis* gel (62.80%) and *Murraya paniculata* gel (67.00%). This improvement can be explained by multiple mechanisms: first, the combined antioxidant activity minimizes oxidative damage that usually impairs fibroblast proliferation and collagen synthesis at the wound margins; second, enhanced antimicrobial action (as shown in the *in vitro* study) prevents infection-related delays; and third, the complementary anti-inflammatory phytoconstituents from both plants (alkaloids, flavonoids, tannins) regulate the inflammatory phase to an optimal duration, allowing a timely transition to the proliferative and remodeling phases.

This wound contraction pattern — where the polyherbal formulation outperforms individual extracts — is similar to recent literature where Bharathy et al. (2025) showed enhanced wound closure with combined extracts of *Ixora coccinea* and

Rhododendron arboreum, and Dev et al. (2019) reported superior wound contraction and anti-inflammatory effects of polyherbal carbopol-940 gels. This consistent pattern strongly supports that rationally selected plant combinations can provide more effective therapeutic outcomes than single-plant therapies.

The standard drug Gentamicin gel showed the highest wound healing activity (91.50% closure), which is expected since it is a well-established, clinically validated antimicrobial agent with strong bactericidal action. Although the polyherbal formulation's activity was a bit lower than the standard drug, the gap was fairly small (15.2 percentage points), and the additional benefits of the polyherbal formulation — like being natural, cheaper, having minimal side effects, and no worries about antimicrobial resistance — make it an attractive alternative, especially in places where synthetic antibiotics are hard to access or antibiotic resistance is a growing issue.

Overall, the present findings strongly support that a rational combination of *Ixora chinensis* and *Murraya paniculata*, in the form of a properly formulated polyherbal gel, provides better wound healing effectiveness than individual plant extracts, thanks to their complementary phytochemical profiles and synergistic antioxidant, antimicrobial, and anti-inflammatory actions.

CONCLUSION

The present study suggests that the polyherbal gel formulation of *Ixora chinensis* and *Murraya paniculata* extracts has significant wound healing potential. Both plants contain diverse bioactive phytoconstituents — phenolics, flavonoids, alkaloids, and tannins — which contribute to antioxidant, antimicrobial, and anti-inflammatory activities, playing a critical role in accelerating the wound healing process. The polyherbal gel formulation showed better efficacy than individual plant extract formulations (76.30% vs 62.80% and 67.00% wound closure on day 21), confirming that there is a synergistic interaction between the combined bioactive compounds.

Although this activity was slightly less than the standard drug Gentamicin (91.50% closure), the formulation showed substantial healing effects, along with the additional benefits of being natural, safe, and non-irritant. Therefore, the developed polyherbal gel could be a promising alternative for wound management and a potential candidate for further clinical studies. Future research should focus on isolating the active constituents, detailed mechanism studies, and clinical evaluation in human subjects, so that the therapeutic efficacy and safety of the formulation can be fully established.

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AUTHOR CONTRIBUTIONS

Sourav Mishra did the research design, experimental work, plant extraction, phytochemical analysis, formulation development, in vivo pharmacological studies, data collection, statistical interpretation, and complete manuscript drafting. The author also reviewed and approved the final manuscript.

CONFLICTS OF INTEREST

The author declares that there is no conflict of interest regarding the publication of this manuscript.

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