RESEARCH PAPER

Wound Healing and Antimicrobial Properties of *Pergularia daemia*: A Comprehensive Research

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ABSTRACT:
Wound healing is a highly coordinated physiological process involving hemostasis, inflammation, proliferation, and remodelling. Interruptions due to infection, oxidative stress, or comorbidities may impede restoration, raising the need for effective therapeutic solutions. Plant-based treatments with both regenerative and antimicrobial effects offer promising alternatives. This investigation assessed the wound healing and antimicrobial efficacy of a 5% *Pergularia daemia* ethanolic leaf extract in comparison to povidone-iodine and a paraffin base in a excision wound model. Eighteen male Swiss albino mice were randomly divided into three groups. Full-thickness dorsal excision wounds (~300 mm²) were created under ketamine–xylazine anaesthesia and treated topically once daily for 14 days. Wound contraction was measured at days 0, 4, 8, and 14. Epithelialization time, microbial load (bacterial/fungal CFUs), and histopathological features were also assessed. By Day 14, the P. daemia group achieved 92.1% ± 1.7% contraction, comparable to povidone-iodine (95.4% ± 1.2%), and significantly higher than the control (65.0% ± 4.3%). Epithelialization happened in 10.5 ± 0.3 days (vs. 9.8 ± 0.2 for standard and 14.2 ± 0.5 for control). Microbial analysis revealed a decline from 22×10^3 CFU to 4×10^3 in treated wounds; fungi were eradicated in both P. daemia and standard groups by Day 14. Histo pathological evaluation showed denser collagen deposition, re-epithelialization, and minimal inflammation. The observed healing and antimicrobial activities are likely due to flavonoids, tannins, and saponins inherent to P. daemia[1–10]. These findings support its development as a safe, effective, and affordable topical phytotherapeutic for wound care.

KEYWORDS: *Pergularia daemia*, wound contraction, skin repair, natural antimicrobial, murine model, epithelial regeneration, herbal therapeutics

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INTRODUCTION:

The repair of cutaneous wounds is a staged biological cascade beginning with inflammation and culminating in tissue remodelling. Impediments—such as persistent infection—can hinder this process, leading to chronicity[1]. Synthetic antiseptics like povidone-iodine, while effective, may exert cytotoxic effects upon prolonged exposure[2]. Ethnobotanical practices have long supported the use of plant extracts for wound management[3]. P. daemia, a member of the Asclepiadaceae family, is traditionally employed in South Asia and Africa to treat ulcers, bacterial infections, and inflammation[4–6]. Phytochemical profiling reveals substantial levels of flavonoids, tannins, saponins, alkaloids, and phenolic acids with known antioxidant and antimicrobial capabilities[7–10].

Despite anecdotal validation, research backing the wound healing potential of P. daemia is limited. Prior in vitro studies note fibroblast proliferation and anti-inflammatory responses[11–13]. GC-MS analyses have identified bioactive terpenoids and phenolics, aligning with its therapeutic properties[14–16]. The current study employs a murine excision wound model to systematically evaluate the regenerative and antimicrobial function of this plant extract, targeted for integration into affordable topical formulations.

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A greater understanding of how its bioactive molecules influence cellular and molecular healing responses is crucial in validating traditional claims and guiding further pharmacological development.

MATERIALS AND METHODS:

Plant Collection & Extract Preparation Authentic P. daemia leaves were harvested and verified. After shade-drying and pulverization, 250 g of leaf powder underwent Soxhlet extraction in 90% ethanol for 72 h. The extract was concentrated and formulated as a 5% ointment in a paraffin base[17].

The ointment was prepared under aseptic conditions and stored in amber jars until use to preserve its phytochemical integrity.

Animals & Ethical Approval Eighteen Swiss albino mice (25–30 g) were randomized into three groups (n=6). Protocol approval was obtained from IAEC (IAEC No.: 1877/PO/Re/S/16/CCSEA/2023/007)) following CPCSEA regulations[18].

Animals were housed under standard laboratory conditions with ad libitum access to food and water and monitored daily for signs of stress or infection throughout the experiment.

Excision Wound Model Under anaesthesia (ketamine 80 mg/kg; xylazine 10 mg/kg), full-thickness dorsal

wounds (~300 mm²) were created. Groups: A—paraffin control; B—5% povidone-iodine; C—5% P. daemia ointment. Topical treatment was applied daily for 14 days[19].

Wounds were cleaned using sterile saline before each application. Digital photography and graph paper tracing were used for consistent wound measurement.

PARAMETERS MEASURED:

Wound contraction (%): Planimetric measurements at days 0, 4, 8, 14[20] using transparency sheets.

Epithelialization time: Days until complete scab detachment without residual raw surface.

Microbial load: CFUs on nutrient, MacConkey, and SDA agar[21] obtained by sterile swabbing on Days 4 and 14.

Histology: H&E-stained tissue assessed for collagen, inflammation[22], re-epithelialization, neovascularization, fibroblast density, and collagen architecture.

DATA ANALYSIS:

Mean ± SEM results were analysed via one-way ANOVA and Tukey's post hoc test. Significance was set at $p < 0.05$[23].

Results were tabulated, and graphs plotted to compare the performance of all groups.

RESULTS:

Wound Contraction:

By Day 4, contraction in the P. daemia group reached 38.7% ± 3.0% and rose to 92.1% ± 1.7% by Day 14, surpassing control (65.0% ± 4.3%, $p < 0.05$) but closely matching povidone-iodine (95.4% ± 1.2%)[24,25]. The significant difference between the test and control group highlights the extract's potential in enhancing early wound repair.

Day	Group A (Paraffin)	Group B (Povidone)	Group C (*P. daemia*)
0	100	100	100
4	24.6 ± 2.1	42.3 ± 2.8	38.7 ± 3.0
8	44.2 ± 3.5	71.5 ± 2.4	68.1 ± 2.9
14	65.0 ± 4.3	95.4 ± 1.2	92.1 ± 1.7

Table 1. Wound Contraction (%) Over Time

Epithelialization:

Complete epithelialization averaged 10.5 ± 0.3 days for P. daemia, compared to 14.2 ± 0.5 in control and 9.8 ± 0.2 in standard group[26]. Rapid reformation of the epidermal barrier is critical for preventing wound desiccation and microbial invasion. The treated animals also exhibited minimal scarring at the healing site.

Group	Time (Days)
Control	14.2 ± 0.5
Standard	9.8 ± 0.2*
P. daemia	10.5 ± 0.3*

***Statistical significance relative to control group, $p < 0.05$)**

Table 2. Epithelialization Time (Days)

Microbial Load:

By Day 14, bacterial CFUs dropped from 22×10^3 to 4×10^3 in the test group, aligning with povidone results (3×10^3); fungal CFUs were eliminated in both treatment arms[27,28]. The results confirm the broad-spectrum antimicrobial properties of the phytoconstituents in the extract.

Day	Group	Total Bacteria ($\times10^3$)	Gram-negative ($\times10^3$)	Fungal Load ($\times10^2$)
4	Control	68 ± 4.5	45 ± 3.2	21 ± 1.8
4	Standard	18 ± 2.0	10 ± 1.1	3 ± 0.5
4	*P. daemia*	22 ± 2.4	12 ± 1.3	4 ± 0.6
8	Control	61 ± 3.9	42 ± 2.9	17 ± 1.4
8	Standard	8 ± 0.8	4 ± 0.6	1 ± 0.2
8	*P. daemia*	10 ± 1.1	5 ± 0.7	1 ± 0.2
14	Control	52 ± 3.5	34 ± 2.6	14 ± 1.3
14	Standard	3 ± 0.5	1 ± 0.2	ND
14	*P. daemia*	4 ± 0.6	1 ± 0.3	ND

ND = Not Detectable

Table 3. Microbial Load (CFU/mL)

Histopathology:

Tissues treated with P. daemia showed rich collagen matrix, regenerated epidermis, and minimal inflammatory infiltrate similar to povidone-iodine recipients[29]. Fibroblast proliferation and capillary budding were also observed, indicating active tissue remodelling.

Group	Epidermal Integrity	Collagen Density	Inflammatory Cells
Control	Incomplete	Sparse	High
Standard	Fully restored	Dense and organized	Minimal
P. daemia	Well-formed epithelium	Abundant and structured	Mild

Table 4. Histological Features on Day 14

DISCUSSION:

The synthesis of antimicrobial and regenerative actions underscores the therapeutic merit of P. daemia. Flavonoids and phenolics enhance fibroblast migration and angiogenesis[30],[31], while tannins offer antimicrobial capacity[12],[14],[32]. GC-MS data confirm terpenoids that reduce inflammation[33]. The comparable efficacy to povidone-iodine suggests that P. daemia ointment can serve as a safe, cost-effective alternative with reduced cytotoxicity[34–36]. Further research is needed on isolation, dose optimization, and safety profiling before clinical translation[37–40].

The findings from this study provide compelling evidence for the wound healing efficacy of *Pergularia daemia* leaf extract. The improved rate of wound contraction, along with shorter epithelialization duration, indicates that the extract plays an active role in accelerating the repair process. One of the key aspects of effective wound management is rapid closure, which prevents secondary infections and limits fluid loss; this was efficiently demonstrated by the treated group. The microbial load assessment further emphasizes the extract's dual functionality—not only aiding in tissue regeneration but also effectively reducing pathogenic colonization on the wound surface.

The identified benefits may stem from the accumulative activity of flavonoids, tannins, alkaloids, and saponins in the extract. These bioactive molecules are known to possess anti-inflammatory and antioxidative properties, both of which are critical in moderating the healing environment. Furthermore, the phytochemicals present may modulate cytokine activity and support extracellular matrix production, ultimately contributing to better collagen alignment and tissue organization. Histological analyses supported these effects by revealing well-defined epidermal layers and dense fibroblast populations, reflecting active proliferation and tissue remodeling.

The test group's performance was nearly equivalent to that of povidone-iodine, a recognized topical antiseptic. However, the extract may offer advantages such as reduced cytotoxicity and lower potential for irritation, which are often concerns with chemical antiseptics. These findings are significant for communities relying on traditional medicine or those with limited access to advanced wound care products. Given the consistent improvement in multiple wound healing indicators, P. daemia holds promise as a cost-effective phytotherapeutic agent. Additional pharmacological and molecular studies are warranted to isolate specific active principles and confirm their mechanistic pathways.

CONCLUSION:

Pergularia daemia ethanolic extract significantly accelerates wound closure, decreases infection risk, and enhances tissue regeneration in mice. Comparable to povidone-iodine, it presents an efficacious, locally sourced topical therapy suitable for wound care.

In conclusion, this research highlights the therapeutic potential of *Pergularia daemia* ethanolic extract in promoting efficient wound healing. The formulation demonstrated enhanced wound contraction, accelerated epithelialization, and a substantial reduction in microbial contamination. The histopathological evidence further reinforces its regenerative and protective roles at the wound site. This dual action of antimicrobial and regenerative support sets P. daemia apart as a potential natural alternative to standard wound care treatments.

With the increasing need for sustainable and plant-based medical solutions, especially in rural and resource-constrained settings, this extract offers a promising and accessible therapeutic route. Future research should be directed toward formulating more advanced delivery systems such as hydrogels or biofilms incorporating P. daemia, as well as conducting clinical trials to validate these outcomes in human subjects. By merging traditional knowledge with modern scientific methodologies, P. daemia can be positioned as a viable component in evidence-based wound care regimens.

CONFLICT OF INTEREST:

The authors have no conflicts of interest regarding this investigation.

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