HJIK: Hulonthalo Jurnal Ilmu Kesehatan
Volume 6, No 1, Juni 2026
ISSN : 2686-2026
Open Access: https://journals.ubmg.ac.id/index.php/HJIK

TEST OF THE EFFECTIVENESS OF ALOE VERA LEAF EXTRACT (*Aloevera*) IN THE HEALING OF CUT WOUNDS IN MALE WHITE RATS (Rattus *Norvegicus*)

Wintan Akuba[1], Rini Daud Supu[2], Gita Puspita[3]
Universitas Bina Mandiri Gorontalo[1,2,3]
Email : wintanakuba07@gamil.com, rini.supu@ubmg.ac.id, gipuspita93@gmail.com

Keywords:
Aloe vera, incision wound, wound healing, phytochemicals, Rattus norvegicus.

ABSTRACT
Aloe vera is a medicinal plant widely recognized for its antioxidant, anti-inflammatory, and antimicrobial properties, making it a promising natural agent for wound healing. This study aimed to evaluate the effectiveness of *Aloe vera* leaf extract in promoting the healing of incision wounds in male white rats (*Rattus norvegicus*). A true experimental study with a post-test only control group design was conducted using 15 male white rats divided into five groups: positive control, negative control, and three treatment groups receiving different concentrations of *Aloe vera* leaf extract. The extract was prepared by ethanol maceration and subjected to qualitative phytochemical screening. Wound healing was evaluated based on wound diameter, pus resolution, swelling reduction, and healing time. Data were analyzed using One-Way ANOVA and the Kruskal–Wallis test at a significance level of $p < 0.05$. The extraction process produced a 14% yield, and phytochemical screening confirmed the presence of flavonoids, saponins, tannins, and polyphenols. *Aloe vera* leaf extract had no significant effect on wound diameter ($p = 0.391$). However, it significantly accelerated pus resolution ($p = 0.011$), swelling reduction ($p = 0.009$), and overall healing time ($p = 0.024$). Higher extract concentrations produced more favorable healing outcomes than lower concentrations. *Aloe vera* leaf extract effectively promoted incision wound healing by reducing inflammation-related parameters and shortening healing time, indicating its potential as a natural therapeutic agent for wound management.

INTRODUCTION

Indonesia is one of the world's megabiodiversity countries, possessing abundant medicinal plants that have long been utilized in traditional healthcare. The use of herbal medicine continues to increase because natural products are generally considered more affordable, accessible, biocompatible, and associated with fewer adverse effects than synthetic drugs. Consequently, medicinal plants have attracted growing scientific interest as potential sources of novel therapeutic agents, including treatments for wound healing [1][2].

Among these medicinal plants, *Aloe vera* has received considerable attention due to its broad pharmacological properties and widespread availability in tropical countries, including Indonesia. The leaves of *Aloe vera* contain numerous bioactive constituents such as polysaccharides, acemannan, flavonoids, phenolic compounds, anthraquinones, tannins, saponins, vitamins, amino acids, enzymes, and essential minerals. These compounds exhibit antioxidant, anti-inflammatory, antimicrobial, immunomodulatory, and tissue-regenerative activities that contribute to accelerated wound repair. Acemannan stimulates fibroblast proliferation and collagen synthesis, flavonoids reduce oxidative stress and inflammation, while

phenolic compounds and anthraquinones inhibit microbial growth around the wound surface, collectively promoting faster tissue regeneration [1][2][3].

Wounds remain an important global health problem because they contribute substantially to morbidity, prolonged hospitalization, disability, and healthcare expenditure. Acute wounds, particularly cut wounds caused by sharp objects, are among the most frequently encountered traumatic injuries in both domestic and occupational settings. Although most cut wounds heal naturally, inadequate wound management may delay tissue repair, increase the risk of infection, prolong inflammation, and result in excessive scar formation. These complications emphasize the need for effective therapeutic agents capable of promoting rapid and complete tissue regeneration [4][5][6].

Wound healing is a complex biological process involving four overlapping phases: hemostasis, inflammation, proliferation, and remodeling. Successful healing depends on coordinated cellular activities, including inflammatory cell recruitment, angiogenesis, fibroblast proliferation, extracellular matrix deposition, collagen remodeling, and re-epithelialization. However, these processes may be disrupted by microbial infection, oxidative stress, chronic inflammation, malnutrition, hypoxia, diabetes mellitus, and impaired immune responses, resulting in delayed wound closure and poor tissue regeneration [4][5].

Current wound management strategies include antiseptics, antibiotics, synthetic wound dressings, topical growth factors, and advanced biomaterials. Despite considerable therapeutic advances, these approaches still present important limitations, including high treatment costs, limited accessibility, adverse reactions, antimicrobial resistance, and inconsistent clinical outcomes. Although emerging technologies such as stem cell therapy and tissue-engineered biomaterials have demonstrated promising results, their widespread application remains constrained by technical complexity and economic considerations. Therefore, there is increasing interest in identifying plant-derived compounds that provide safe, affordable, and effective alternatives for wound management [7][5][6].

Aloe vera has been extensively investigated as a natural wound-healing agent because of its multiple biological activities. Experimental and pharmacological studies have demonstrated that *Aloe vera* enhances fibroblast proliferation, stimulates collagen deposition, promotes angiogenesis, accelerates epithelialization, reduces inflammatory cytokine production, and inhibits microbial growth. These combined effects shorten the inflammatory phase while facilitating faster tissue remodeling and wound closure. Furthermore, its antioxidant activity protects newly formed tissues from oxidative damage, thereby supporting more effective healing [1][8][3].

Although numerous studies have reported the therapeutic potential of *Aloe vera*, several important limitations remain. Existing research varies considerably in extraction methods, extract concentrations, dosage regimens, formulations, treatment duration, and experimental protocols, making direct comparison among studies difficult. Moreover, relatively few recent controlled experimental studies have specifically evaluated the effectiveness of *Aloe vera* leaf extract on standardized incisional

wound models using male white rats (*Rattus norvegicus*), which remain one of the most reliable animal models for investigating wound-healing mechanisms and evaluating preclinical therapeutic efficacy [1][8][2].

Therefore, this study was conducted to evaluate the effectiveness of *Aloe vera* leaf extract in promoting the healing of cut wounds in male white rats (*Rattus norvegicus*). The findings are expected to provide additional scientific evidence regarding the therapeutic potential of *Aloe vera* as a natural wound-healing agent and contribute to the development of affordable, safe, and evidence-based herbal treatments for wound management.

Literatur Review

Wound-Healing Biology

Wound healing is a highly coordinated biological process that restores the structural and functional integrity of damaged tissues through four overlapping phases: hemostasis, inflammation, proliferation, and remodeling. Hemostasis occurs immediately after injury through platelet aggregation and fibrin clot formation to control bleeding and establish a temporary extracellular matrix. This is followed by the inflammatory phase, during which neutrophils and macrophages remove cellular debris, eliminate invading microorganisms, and release cytokines and growth factors that regulate subsequent tissue repair. During the proliferative phase, fibroblasts synthesize extracellular matrix components, angiogenesis restores oxygen and nutrient supply, and keratinocytes migrate to re-establish epithelial continuity. Finally, the remodeling phase reorganizes collagen fibers and strengthens newly formed tissue, ultimately restoring skin architecture and tensile strength. Successful wound healing depends on precise regulation of these biological events; disturbances in any phase may delay tissue repair and increase the risk of chronic wounds [9][10][11].

Numerous intrinsic and extrinsic factors influence wound healing outcomes. Age, nutritional status, immune competence, diabetes mellitus, infection, tissue hypoxia, and oxidative stress may prolong inflammation and impair fibroblast activity, collagen deposition, and angiogenesis. Consequently, delayed wound healing remains a major clinical challenge requiring therapeutic agents capable of simultaneously controlling inflammation, preventing microbial infection, and stimulating tissue regeneration. Natural bioactive compounds have therefore gained increasing attention as alternative wound-healing therapies because they possess multiple pharmacological activities while generally exhibiting lower toxicity than synthetic agents [12][8].

Cut Wounds

Cut wounds are among the most common forms of acute skin injury and occur when sharp objects such as knives, scalpels, or glass disrupt the continuity of the epidermis and dermis. Depending on wound depth, cut injuries may extend into subcutaneous tissue, muscles, blood vessels, or other underlying structures. Although clean incisions generally exhibit predictable healing patterns, delayed treatment or secondary bacterial contamination can result in prolonged inflammation, excessive scar formation, and impaired tissue regeneration [13].

Healing of cut wounds follows the classical wound-healing cascade, beginning with clot formation and inflammatory cell infiltration, followed by granulation tissue development, epithelialization, collagen deposition, and

tissue remodeling. However, several factors may interfere with these physiological processes, including microbial infection, inadequate nutrition, chronic systemic diseases, and poor wound management. Because cut wounds are frequently encountered in both clinical practice and experimental studies, they represent an appropriate model for evaluating novel therapeutic agents designed to accelerate tissue repair and improve healing quality [11][9].

Phytochemical Constituents of *Aloe vera*

Aloe vera (*Aloe barbadensis* Miller) is one of the most extensively studied medicinal plants because of its diverse phytochemical composition and broad therapeutic properties. The leaves contain more than seventy-five biologically active compounds, including polysaccharides, anthraquinones, flavonoids, phenolic compounds, amino acids, vitamins, minerals, enzymes, sterols, and glycoproteins. Among these constituents, acemannan is considered the principal polysaccharide responsible for many of the plant's regenerative and immunomodulatory activities. Other important compounds include aloin, aloe-emodin, aloesin, and various flavonoids that contribute to antioxidant and antimicrobial functions [10][14][9].

The pharmacological potential of *Aloe vera* results from the synergistic interaction among these bioactive compounds. Flavonoids and phenolic compounds neutralize reactive oxygen species generated during inflammation, thereby reducing oxidative tissue damage. Anthraquinones exhibit antimicrobial activity against several pathogenic microorganisms associated with wound infections, while polysaccharides promote fibroblast proliferation, extracellular matrix synthesis, and immune regulation. This unique phytochemical profile positions *Aloe vera* as a promising natural therapeutic agent capable of influencing multiple stages of the wound-healing process simultaneously [11][15].

Pharmacological Mechanisms of *Aloe vera* in Wound Healing

The wound-healing activity of *Aloe vera* is mediated through several complementary pharmacological mechanisms. One of its primary effects is stimulation of fibroblast proliferation and migration, which enhances granulation tissue formation and accelerates re-epithelialization. Acemannan has been shown to increase collagen synthesis and extracellular matrix deposition, contributing to improved wound tensile strength and faster tissue regeneration. In addition, *Aloe vera* promotes keratinocyte migration, facilitating rapid restoration of epidermal integrity [12][15].

Another important mechanism involves modulation of inflammatory responses. Bioactive compounds within *Aloe vera* suppress excessive production of pro-inflammatory cytokines while promoting a balanced inflammatory environment necessary for normal tissue repair. Simultaneously, antioxidant constituents reduce oxidative stress by scavenging free radicals generated at the wound site, thereby protecting surrounding healthy tissue from further cellular damage. Experimental evidence also indicates that *Aloe vera* stimulates angiogenesis through increased expression of vascular endothelial growth factor (VEGF), improving oxygen delivery and nutrient supply required for tissue regeneration [10][9].

Furthermore, *Aloe vera* possesses antimicrobial properties that reduce microbial colonization of wounds and lower the risk of secondary infection. Anthraquinones, phenolic compounds,

and flavonoids exhibit inhibitory activity against several Gram-positive and Gram-negative bacteria commonly associated with wound infections. The combined anti-inflammatory, antioxidant, angiogenic, collagen-stimulating, and antimicrobial effects provide a comprehensive pharmacological basis supporting the application of *Aloe vera* in wound management [11][8].

Experimental Animal Models in Wound-Healing Research

Experimental animal models play a crucial role in evaluating the efficacy and safety of candidate wound-healing agents before clinical application. Male white rats (*Rattus norvegicus*), particularly Sprague–Dawley and Wistar strains, are widely used because their skin physiology, inflammatory responses, and wound repair mechanisms closely resemble those observed in humans. Their relatively uniform genetic background, manageable body size, and reproducible wound models enable standardized assessment of therapeutic interventions [12].

Cut-wound models in *Rattus norvegicus* allow researchers to monitor various healing parameters, including wound contraction, epithelialization rate, collagen deposition, inflammatory cell infiltration, angiogenesis, and histopathological changes. These measurable outcomes provide objective evidence regarding the effectiveness of topical or systemic treatments. Consequently, experimental rat models remain an accepted preclinical platform for investigating natural products intended for wound management and tissue regeneration [15][8].

RESEARCH METHODS

Research Design

This study employed a true experimental laboratory design using a post-test only control group design to evaluate the effectiveness of *Aloe vera* leaf extract on the healing of incision wounds in male white rats (*Rattus norvegicus*). The experiment compared wound healing outcomes among several treatment groups receiving different concentrations of *Aloe vera* leaf extract with positive and negative control groups.

Study Location and Period

The study was conducted in the Pharmacology and Pharmaceutical Biology Laboratory. Extraction, phytochemical screening, animal treatment, and wound observation were performed under controlled laboratory conditions during the study period.

Preparation of *Aloe vera* Leaf Extract

Fresh *Aloe vera* leaves were collected, washed thoroughly, and cut into small pieces. The plant material was dried, pulverized into simplicia, and extracted using the maceration method with 96% ethanol as the extraction solvent. The filtrate was concentrated using a rotary evaporator followed by evaporation in a water bath to obtain a viscous extract. Extraction yield was calculated by comparing the weight of the concentrated extract with the initial dry simplicia weight and expressed as a percentage.

Phytochemical Screening

Qualitative phytochemical screening was performed on the concentrated *Aloe vera* leaf extract to identify major secondary metabolites. Flavonoids were detected using the magnesium–hydrochloric acid test, saponins by the foam formation test after heating, tannins using 10% ferric chloride solution, and polyphenols using iron chloride reagent. Color changes or foam

formation indicated positive results for the corresponding phytochemical compounds.

Experimental Animals

The experimental animals consisted of 15 healthy male white rats (*Rattus norvegicus*), which were acclimatized for seven days before treatment. Animals were maintained under standard laboratory conditions with free access to food and drinking water throughout the experiment.

Experimental Groups

The rats were randomly divided into five groups, each consisting of three animals:

1. Positive control (K+) receiving a standard commercial wound-healing treatment.
2. Negative control (K−) receiving no active treatment.
3. Treatment group 1 (D1) receiving *Aloe vera* leaf extract at the lowest concentration.
4. Treatment group 2 (D2) receiving *Aloe vera* leaf extract at the intermediate concentration.
5. Treatment group 3 (D3) receiving *Aloe vera* leaf extract at the highest concentration.

Wound Induction and Treatment

Following light anesthesia, the dorsal area of each rat was shaved and disinfected with 70% ethanol. A standardized full-thickness incision wound was created on the dorsal skin using a sterile surgical scalpel. Treatments were applied topically once daily according to the assigned experimental group until complete wound healing was observed.

Observation Parameters

Wound healing was evaluated daily using several macroscopic parameters, including:

1. Wound diameter reduction.
2. Time required for disappearance of pus.
3. Time required for reduction of swelling.
4. Total wound healing time until complete closure.

All observations were recorded in days, and wound diameter was measured using a digital caliper.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics software. Descriptive statistics were used to summarize all observation data and expressed as mean values. Normality of wound diameter data was assessed before inferential analysis. Differences in wound diameter among treatment groups were analyzed using one-way analysis of variance (One-Way ANOVA). Because the remaining variables did not satisfy parametric assumptions, differences in pus reduction, swelling reduction, and healing time were analyzed using the Kruskal–Wallis test. Statistical significance was established at $p < 0.05$.

RESEARCH RESULT

Yield of *Aloe vera* Leaf Extract

Extraction of *Aloe vera* leaves produced 21 g of concentrated extract from 150 g of dried simplicia, resulting in an extraction yield of 14%. This yield indicates that the extraction procedure successfully recovered soluble phytochemical constituents from the plant material, providing sufficient extract for subsequent phytochemical screening and biological activity evaluation.

Phytochemical Screening of *Aloe vera* Leaf Extract

The qualitative phytochemical screening demonstrated that *Aloe vera* leaf extract contained several major classes of secondary metabolites (Table 1).

Table 1. Phytochemical Screening of *Aloe vera* Leaf Extract

Phytochemical Test	Test Method	Result	Observation
Flavonoids	Mg + HCl	+	Formation of a brick-red color
Saponins	Heating + HCl	+	Stable foam formation
Tannins	10% $FeCl_3$	+	Development of a dark purple-black color
Polyphenols	Ferric chloride	+	Development of a greenish-black to blue-black color

The screening results confirmed the presence of flavonoids, saponins, tannins, and polyphenolic compounds in the *Aloe vera* leaf extract. These bioactive constituents are widely recognized for their antioxidant, antimicrobial, and anti-inflammatory activities, which may contribute to the wound-healing properties of the extract.

Effect of *Aloe vera* Leaf Extract on Wound Diameter

The effect of *Aloe vera* leaf extract on wound diameter was analyzed using the One-Way Analysis of Variance (ANOVA).

Table 2. One-Way ANOVA Analysis of Wound Diameter

Variable	Sig. (p-value)
Wound diameter	0.391

Source: Primary Data, 2024.

The One-Way ANOVA analysis demonstrated no statistically significant difference in wound diameter among the treatment groups (p = 0.391). Since the significance value was greater than 0.05, the administration of Aloe vera leaf extract did not significantly affect wound diameter reduction compared with either the positive or negative control groups.

Effect of *Aloe vera* Leaf Extract on Pus Resolution

The average time required for pus disappearance differed among the experimental groups (Table 3).

Table 3. Time Required for Pus Resolution

Rat	K+	K−	D1	D2	D3
1	6	13	13	11	10
2	6	13	12	11	10
3	6	13	12	11	10
Mean	6.0	13.0	12.3	11.0	10.0

Source: Primary Data, 2024.

The positive control group showed the shortest time required for pus resolution, whereas the negative control exhibited the longest healing period. Among the extract-treated groups, higher extract doses were associated with a shorter time for pus disappearance, suggesting a dose-dependent improvement in wound healing.

The Kruskal–Wallis analysis confirmed a significant difference among treatment groups (p = 0.011), indicating that Aloe vera leaf extract significantly accelerated pus resolution during the wound-healing process.

Effect of *Aloe vera* Leaf Extract on Swelling Reduction

The average time required for swelling reduction is presented in Table 4.

Table 4. Time Required for Swelling Reduction

Rat	K+	K−	D1	D2	D3
1	8	13	11	10	9
2	8	12	11	10	9
3	8	13	12	11	9
Mean	8.0	13.3	11.6	10.6	9.0

Source: Primary Data, 2024.

The duration of swelling decreased progressively with increasing concentrations of *Aloe vera* leaf extract. The highest-dose treatment group (D3) demonstrated the fastest reduction in swelling among the extract-treated groups.

Statistical analysis using the Kruskal–Wallis test revealed a significant difference among the experimental groups ($p = 0.009$), indicating that Aloe vera leaf extract significantly enhanced the reduction of swelling during cut-wound healing.

Effect of *Aloe vera* Leaf Extract on Healing Time

The average healing time observed in each treatment group is presented in Table 5.

Table 5. Healing Time of Cut Wounds

Rat	K+	K−	D1	D2	D3
1	12	14	13	12	12
2	12	14	13	13	12
3	12	14	13	13	13
Mean	12.0	14.0	13.0	13.2	12.6

Source: Primary Data, 2024.

The positive control group achieved complete wound healing in the shortest time, while the negative control required the longest healing period. Treatment with Aloe vera leaf extract shortened healing time compared with the negative control, with the highest extract dose (D3) producing the most favorable outcome among the extract-treated groups.

The Kruskal–Wallis test demonstrated a statistically significant difference among treatment groups ($p = 0.024$). These findings indicate that *Aloe vera* leaf extract significantly accelerated the overall healing process of incision wounds in male white rats.

DISCUSSION

The extraction process yielded 21 g of concentrated Aloe vera leaf extract from 150 g of dried simplicia, corresponding to an extraction yield of 14%. The extraction yield reflects the efficiency of solvent penetration and the recovery of soluble phytochemical constituents contained within the plant material. Although the yield obtained in the present study was lower than the extraction efficiency reported using advanced extraction techniques such as microwave-assisted extraction and ultrasound-assisted extraction, it nevertheless demonstrates that conventional extraction methods remain capable of recovering biologically active compounds required for pharmacological evaluation. Previous studies have shown that extraction techniques greatly influence the concentration of phenolics, saponins, and other secondary metabolites that contribute to the biological activity of Aloe vera [16][17].

Phytochemical screening confirmed the presence of flavonoids, saponins, tannins, and polyphenolic compounds in the Aloe vera leaf extract. These findings are consistent with previous studies demonstrating that Aloe vera contains numerous bioactive constituents responsible for antioxidant, antimicrobial, and anti-inflammatory activities. Flavonoids function by scavenging reactive oxygen species and reducing oxidative stress at the wound site, whereas tannins promote protein precipitation and tissue contraction that facilitate wound closure. Saponins stimulate fibroblast proliferation and collagen synthesis, while polyphenols inhibit inflammatory mediators and microbial growth, thereby creating a favorable environment for tissue regeneration [10][9]. Similar phytochemical profiles have also been reported by Gorsi et al. [18], confirming that these secondary metabolites play synergistic roles during wound repair.

Despite the presence of these bioactive compounds, the present study found that Aloe vera leaf extract did not significantly reduce wound diameter compared with the control groups. Statistical analysis using One-Way

ANOVA demonstrated no significant difference among treatments (p = 0.391). This finding indicates that wound contraction alone may not be sufficiently sensitive to detect the therapeutic effects of Aloe vera during the early stages of healing. Wound diameter is influenced not only by epithelial migration but also by wound depth, mechanical tension, collagen remodeling, and natural wound contraction. Consequently, improvements occurring at the cellular and molecular levels may not immediately translate into measurable reductions in wound size. Similar observations have been reported in experimental studies showing that Aloe vera primarily enhances fibroblast proliferation, collagen deposition, angiogenesis, and epithelial regeneration rather than producing rapid macroscopic wound contraction [19][20]. Therefore, the absence of a significant effect on wound diameter does not necessarily indicate the absence of biological activity.

In contrast, Aloe vera leaf extract significantly accelerated pus resolution during wound healing (p = 0.011). The reduction in pus became progressively faster as the extract concentration increased, indicating a dose-dependent response. Pus formation generally reflects bacterial contamination and prolonged inflammation within the wound. The observed reduction is likely attributable to the antimicrobial and anti-inflammatory properties of Aloe vera phytochemicals, particularly flavonoids, tannins, polyphenols, and anthraquinones, which inhibit microbial proliferation while suppressing inflammatory cytokines. These mechanisms reduce neutrophil infiltration and accelerate the transition from the inflammatory phase to the proliferative phase. Previous investigations have likewise demonstrated that Aloe vera decreases inflammatory cell accumulation while enhancing tissue repair through improved macrophage activity and epithelial regeneration [21][20]. Reviews by Massoud et al. [11], further emphasize that Aloe vera possesses broad-spectrum antimicrobial activity capable of reducing infection and supporting wound healing.

The present study also demonstrated a significant reduction in swelling among animals treated with Aloe vera extract (p = 0.009). Swelling represents one of the cardinal signs of inflammation resulting from increased vascular permeability and inflammatory mediator release following tissue injury. The progressive reduction in swelling observed with increasing extract concentration suggests that Aloe vera effectively modulates inflammatory responses. This effect is biologically plausible because Aloe vera contains acemannan, flavonoids, and phenolic compounds that inhibit cyclooxygenase activity, suppress prostaglandin synthesis, and reduce oxidative stress within damaged tissues. Consequently, vascular permeability decreases, inflammatory exudate is minimized, and tissue edema resolves more rapidly. Similar anti-inflammatory effects have been documented in experimental studies demonstrating reduced inflammatory infiltration, enhanced angiogenesis, and improved tissue organization following Aloe vera treatment [22][21][15].

Healing time was also significantly shortened following treatment with Aloe vera leaf extract (p = 0.024). Although the positive control exhibited the fastest overall healing, wounds treated with Aloe vera healed more rapidly than those in the negative control group, with the highest extract concentration producing the most favorable outcome. Accelerated healing

may result from the synergistic action of multiple phytochemicals that stimulate fibroblast proliferation, collagen deposition, angiogenesis, and re-epithelialization while simultaneously reducing oxidative stress and inflammation. Fibroblasts are essential for extracellular matrix formation and collagen synthesis, both of which determine tissue strength and wound closure. Experimental studies in *Rattus norvegicus* have consistently shown that Aloe vera treatment increases fibroblast numbers, collagen thickness, epidermal regeneration, and transforming growth factor-beta (TGF-β) expression, thereby accelerating tissue repair [19][20][21]. Furthermore, systematic reviews have concluded that Aloe vera promotes faster wound healing by improving collagen organization, angiogenesis, and epithelial maturation while reducing inflammatory duration [8][15].

Overall, the findings of this study support the hypothesis that Aloe vera leaf extract facilitates wound healing primarily through modulation of inflammatory responses and enhancement of tissue regeneration rather than through immediate reduction of wound diameter. The phytochemical constituents identified in the extract act synergistically to suppress inflammation, reduce microbial contamination, stimulate fibroblast proliferation, enhance collagen synthesis, and accelerate epithelial repair. These mechanisms collectively contribute to faster pus resolution, reduced swelling, and shorter healing time in male white rats. Therefore, Aloe vera leaf extract has considerable potential as a natural therapeutic agent for cut wound management and may serve as an affordable alternative for future wound-care applications.

CONCLUSION

The findings of this study demonstrate that Aloe vera leaf extract possesses considerable potential to promote the healing of incision wounds in male white rats through its anti-inflammatory and wound-repair activities. Phytochemical screening confirmed the presence of flavonoids, saponins, tannins, and polyphenols, which are recognized for their antioxidant, antimicrobial, and anti-inflammatory properties. Although the extract did not significantly reduce wound diameter, it significantly accelerated pus resolution, reduced swelling, and shortened the overall healing period compared with the untreated group. These findings suggest that the wound-healing activity of Aloe vera is primarily associated with modulation of the inflammatory phase and enhancement of tissue regeneration rather than immediate wound contraction. Therefore, Aloe vera leaf extract may serve as a promising natural therapeutic agent for cut wound management and provides scientific evidence supporting its further development as an affordable herbal treatment. Future studies involving larger sample sizes, standardized extract concentrations, histopathological evaluation, and molecular biomarkers are recommended to clarify the underlying mechanisms and strengthen its potential clinical application.

REFERENCES

[1] A. Abid *et al.*, “The green healer: an updated review on the phytochemical profile and therapeutic potential of Aloe vera,” *Front. Nutr.*, vol. 12, 2025, doi: 10.3389/fnut.2025.1689700.

[2] S. Kaur and K. Bains, “Aloe Barbadensis Miller (Aloe Vera) Pharmacological activities and

clinical evidence for disease prevention," *Int. J. Vitam. Nutr. Res.*, vol. 94, no. 3–4, pp. 308–321, 2024, doi: 10.1024/0300-9831/a000797.

[3] A. Mitra, M. Singh, A. Banga, J. Pandey, S. S. Tripathi, and D. Singh, "Bioactive compounds and therapeutic properties of Aloe vera – A review," *Plant Sci. Today*, vol. 10, no. 2, pp. 1–7, 2023, doi: 10.14719/pst.1715.

[4] A. Banerjee and J. Bhattacharyya, "Current Trends in the Development of Wound Dressings, Biomaterials and Devices," in *Encyclopedia of Materials: Plastics and Polymers*, vol. 1–4, Centre for Biomedical Engineering, Indian Institute of Technology Delhi, Delhi, India: Elsevier, 2022, pp. 717–733. doi: 10.1016/B978-0-12-820352-1.00117-6.

[5] L. Huelsboemer *et al.*, "Cellular therapeutics and immunotherapies in wound healing – on the pulse of time?," *Mil. Med. Res.*, vol. 11, no. 1, 2024, doi: 10.1186/s40779-024-00528-5.

[6] Z. S. Razavi *et al.*, "Application of novel strategies in chronic wound management with focusing on pressure ulcers: new perspective," *Arch. Dermatol. Res.*, vol. 317, no. 1, 2025, doi: 10.1007/s00403-024-03790-8.

[7] J. Ho, D. Yue, U. Cheema, H. C. Hsia, and A. Dardik, "Innovations in Stem Cell Therapy for Diabetic Wound Healing," *Adv. Wound Care*, vol. 12, no. 11, pp. 626–643, 2023, doi: 10.1089/wound.2021.0104.

[8] S. V Aparicio-Salcedo *et al.*, "PHARMACOLOGICAL EFFICACY OF ALOE VERA IN WOUND HEALING: A NARRATIVE REVIEW," *Rev. la Fac. Med. Humana* , vol. 23, no. 1, pp. 110–120, 2023, doi: 10.25176/RFMH.v23i1.4341.

[9] S. Kumar, S. Kalita, I. B. Basumatary, S. Kumar, S. Ray, and A. Mukherjee, "Recent advances in therapeutic and biological activities of Aloe vera," *Biocatal. Agric. Biotechnol.*, vol. 57, 2024, doi: 10.1016/j.bcab.2024.103084.

[10] M. Sánchez, E. González-Burgos, I. Iglesias, and M. P. Gómez-Serranillos, "Pharmacological update properties of aloe vera and its major active constituents," *Molecules*, vol. 25, no. 6, 2020, doi: 10.3390/molecules25061324.

[11] D. Massoud, B. M. Alrashdi, M. M. A. Fouda, A. El-Kott, S. A. Soliman, and H. H. Abd-Elhafeez, "Aloe vera and wound healing: a brief review," *Brazilian J. Pharm. Sci.*, vol. 58, 2022, doi: 10.1590/S2175-97902022E20837.

[12] F. Ali, N. Wajid, M. G. Sarwar, and A. M. Qazi, "Oral administration of aloe vera ameliorates wound healing through improved angiogenesis and chemotaxis in sprague dawley rats," *Curr. Pharm. Biotechnol.*, vol. 22, no. 8, pp. 1122–1128, 2021, doi: 10.2174/1389201021999201001204345.

[13] I. Sukhotnik and I. Matter, "Wounds/Surgical Techniques," in *Pediatric Surgery Digest: Second Edition*, Department of Pediatric Surgery, Dana-Dwek Children's Hospital, Tel Aviv Sourasky Medical Center (Ichilov), Tel Aviv, Israel: Springer International Publishing, 2022, pp. 59–77. doi: 10.1007/978-3-030-80411-4_6.

[14] K. Adlakha, B. Koul, and A. Kumar, "Value-added products of Aloe species: Panacea to several maladies," *South African J. Bot.*, vol. 147, pp. 1124–1135, 2022, doi: 10.1016/j.sajb.2020.12.025.

[15] Z. M. Lee, B. H. Goh, and K. Y. Khaw, "Aloe vera and the Proliferative Phase of Cutaneous Wound Healing: Status Quo Report on Active Principles, Mechanisms, and Applications," *Planta Med.*, vol. 91, no. 1–2, pp. 4–18, 2024, doi: 10.1055/a-2446-2146.

[16] S. Akbari, N. H. Abdurahman, R. M. Yunus, A. H. A. Alsaggaf, and N. Ahmed, "LC-QTOF-MS analysis of phenolics and saponins extracted from Aloe vera leaves via microwave technology in optimal condition," *South African J. Bot.*, vol. 139, pp. 362–373, 2021, doi: 10.1016/j.sajb.2021.02.027.

[17] S. Behaiyn, S. Nejad Ebrahimi, M. Rahimi, and H. Behboudi, "Response surface methodology optimization extraction of aloins from Aloe vera leaf skin by ultrasonic horn sonicator and cytotoxicity evaluation," *Ind. Crops Prod.*, vol. 202, 2023, doi: 10.1016/j.indcrop.2023.117043.

[18] F. I. Gorsi, T. Kausar, and M. A. Murtaza, "Evaluation of antibacterial and antioxidant activity of Aloe vera (Aloe barbadensis Miller) gel powder using different solvents," *Pesqui. Agropecu. Bras.*, vol. 8, no. 2, pp. 1265–1270, 2019, doi: 10.19045/BSPAB.2019.80068.

[19] R. S. Girsang, M. D. Wibowo, A. Setiawan, and E. Danardono, "Effect of aloe vera extracts towards the fibroblast number and collagen thickness on clean skin wound healing on rattus novergicus," *Syst. Rev. Pharm.*, vol. 11, no. 5, pp. 571–573, 2020, doi: 10.31838/srp.2020.5.75.

[20] L. Aulia and Y. S. Pane, "Effect of Aloe vera extract in post-burn skin repair in rats," *F1000Research*, vol. 11, p. 168, 2022, doi: 10.12688/f1000research.79538.1.

[21] M. Rasheed, M. Talib, S. Rasheed, S. Naz, G. S. Orakzai, and N. Naeem, "Aloe Vera Gel Accelerated Wound Healing in Oral Mucosa by Reducing Inflammatory Phase," *Med. Forum Mon.*, vol. 34, no. 7, pp. 77–81, 2023, doi: 10.60110/medforum.340718.

[22] J. Maryam, R. Arif, Z. Mehmood, A. Nadeem, and S. Ali, "Implication of phytotherapeutic sources for potential epithelial wound healing ability: A novel-herbal approach," *J. Anim. Plant Sci.*, vol. 30, no. 2, pp. 508–511, 2020, doi: 10.36899/JAPS.2020.2.0052.