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Review Article

Formulation and Evaluation of Wound Healing Gel Using Datura and Garlic Oil

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ABSTRACT

This study focuses on the formulation and evaluation of a topical wound healing gel using natural extracts from Datura stramonium and garlic (*Allium sativum*) oil, both of which are known for their extensive therapeutic properties. The objective is to harness the analgesic, anti-inflammatory, and antimicrobial effects of Datura alongside the antibacterial, antifungal, and tissue-regenerating properties of garlic oil to develop a natural and effective wound treatment. The growing concern over the side effects and resistance associated with synthetic wound care products has driven interest in plant-based alternatives. The gel was formulated using Carbopol as a gelling agent, Aloe vera as a soothing base, and triethanolamine for pH adjustment. The Datura extract was obtained through ethanol maceration, ensuring the safe extraction of active alkaloids like atropine and scopolamine, while garlic oil was either purchased or lab-prepared using solvent extraction techniques. The gel underwent thorough physicochemical evaluation including pH (5.5), viscosity (35000cps), Spreadability (30g.cm/sec), and stability testing at different temperatures over three months, all of which confirmed its suitability for topical use. Antibacterial activity was confirmed against common wound pathogens (*Staphylococcus aureus* and *Escherichia coli*) using the agar well diffusion method, showing inhibition zones of 14 mm and 12 mm respectively. In vivo testing in albino rats with excisional wounds showed significantly faster wound closure in the treated group (90% by day 14) compared to the control (60%). Histopathological analysis further confirmed enhanced collagen deposition and tissue regeneration. These findings support the use of a Datura- and garlic oil-based gel as a natural, effective, and safe alternative to synthetic wound healing treatments. The formulation offers promising

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applications for managing minor cuts, abrasions, and burns, and warrants further clinical investigation for human use.

INTRODUCTION

Wound healing is a complex process that involves tissue regeneration and the repair of damaged skin. Traditional medicinal plants have long been used to facilitate this process, offering a natural alternative to synthetic wound healing agents [1], [2], [3]. Among these plants, *Datura* (genus *Datura*) and garlic (*Allium sativum*) have shown promise in wound care. Conventional wound care products, including antibiotics and synthetic dressings, often face limitations such as microbial resistance, allergic reactions, and high costs. Consequently, there has been a growing interest in exploring natural and plant-based alternatives that are both effective and safer for long-term use.

Datura: Known for its analgesic and anti-inflammatory properties, *Datura* has been used in various folk medicines to treat wounds, ulcers, and burns. Its leaves, seeds, and flowers are often utilized for their beneficial effects [4], [5], [6].

Garlic Oil: Garlic has well-documented antimicrobial properties, and its oil is known to promote circulation, reduce inflammation, and speed up the healing process. The formulation of a wound healing gel using these two natural ingredients could offer a safer, more holistic treatment for minor cuts, abrasions, and burns [7], [8]. This study aims to combine the pharmacological benefits of both *Datura* and garlic oil in the formulation of a topical gel for wound care. The rationale behind this combination lies in their synergistic effects—while *Datura* reduces pain and inflammation, garlic promotes microbial clearance and tissue regeneration [9]. Using Carbopol as a gelling agent and Aloe vera as a base, the study develops and evaluates a stable, safe, and effective gel formulation [10], [11]. The

research focuses on the physicochemical properties of the gel, its antimicrobial activity against wound pathogens, and its *in vivo* wound healing efficacy using an animal model. The outcomes aim to offer a natural, accessible, and promising alternative for managing minor wounds and skin injuries [12], [13].

Literature Review

Wound healing is a multifaceted biological process that involves hemostasis, inflammation, proliferation, and tissue remodeling. Effective wound healing requires not only proper physiological function but also external interventions to expedite recovery and prevent infection [14], [15]. Traditional medicine has long recognized the therapeutic potential of plants and natural substances, many of which exhibit promising antimicrobial, anti-inflammatory, and regenerative properties [16], [17], [18]. Among such substances, *Datura* (*Datura stramonium*) and garlic oil (*Allium sativum*) have garnered significant attention due to their beneficial medicinal attributes. This literature review explores the pharmacological properties of *Datura* and garlic oil, as well as their applications in wound healing [19], [20].

Pharmacological Properties of *Datura* (*Datura stramonium*):

Datura, a plant from the Solanaceae family, is widely used in traditional medicine for its analgesic, anti-inflammatory, and antimicrobial properties [21], [22]. The primary active compounds in *Datura* include alkaloids such as atropine, scopolamine, and hyoscyamine, which contribute to its pharmacological effects. These alkaloids have been shown to possess anti-inflammatory properties by inhibiting the production of inflammatory mediators, making *Datura* an ideal candidate for managing wounds



and other inflammatory conditions[23]. Research has demonstrated that *Datura* extracts exhibit significant antibacterial effects, which are crucial for preventing infection in open wounds[24]. Additionally, studies suggest that *Datura* may enhance wound healing by promoting collagen synthesis and fibroblast activity, both of which are essential for tissue regeneration[25]. Thus, incorporating *Datura* into topical formulations may provide a dual benefit of both antimicrobial activity and wound healing support[26].

Pharmacological Properties of Garlic Oil (*Allium sativum*)

Garlic (*Allium sativum*), a widely used culinary and medicinal plant, has been documented for its numerous therapeutic effects, particularly its antimicrobial, anti-inflammatory, and antioxidant properties. Allicin, the active compound in garlic, is primarily responsible for these effects[27], [28]. Allicin exhibits potent antibacterial activity, making garlic oil an effective agent in preventing and treating infections associated with wounds[29], [30][31]. The role of garlic oil in wound healing has been extensively studied, with research indicating that garlic oil accelerates wound closure by stimulating tissue regeneration, collagen deposition, and the formation of new blood vessels[32], [33]. Additionally, garlic's anti-inflammatory properties help to reduce swelling and discomfort in the wound area, further promoting a conducive environment for healing[34]. Several studies have suggested that garlic oil, when used in topical formulations, not only accelerates the healing process but also improves the tensile strength of the healed tissue, thereby preventing complications such as wound dehiscence[35], [36].

Wound Healing Mechanisms and Natural Products

Wound healing is a dynamic and highly regulated process that can be divided into four overlapping phases: hemostasis, inflammation, proliferation, and remodeling[37][38]. Natural products, including those derived from plants, have been increasingly investigated for their ability to influence these phases positively[39], [40]. Studies have indicated that natural substances like *Datura* and garlic oil can modulate the inflammatory phase by reducing the production of pro-inflammatory cytokines and promoting the release of growth factors essential for tissue regeneration[41], [42]. Additionally, their antioxidant properties help to minimize oxidative stress, which can impair healing[43], [44]. Furthermore, these natural agents have been found to improve the proliferative phase by stimulating the migration and proliferation of keratinocytes and fibroblasts, which are essential for reepithelialization and collagen formation[45].

Formulation of Wound Healing Gels and Their Benefits

The formulation of gels as a delivery system for wound healing agents offers several advantages, including ease of application, controlled release of active ingredients, and improved patient compliance. Gels also provide a moist environment, which is beneficial for wound healing by promoting cellular migration and reducing the risk of infection [46], [47]. The use of natural ingredients such as *Datura* and garlic oil in gel formulations has shown promise in enhancing wound healing [48], [49]. demonstrated that a gel formulation containing both garlic and aloe vera extract significantly accelerated wound healing in animal models, suggesting that plant-based gels can provide a therapeutic alternative to synthetic wound dressings [50], [51]. The incorporation of *Datura* extract and garlic oil into a gel matrix can not only improve the gel's therapeutic efficacy but

also ensure the stability and sustained release of bioactive compounds, thus optimizing the wound healing process[52], [53].

CONCLUSION AND FUTURE DIRECTIONS

Both Datura and garlic oil offer promising therapeutic potential for wound healing due to their multifaceted pharmacological activities, including antibacterial, anti-inflammatory, and regenerative properties. The combination of these ingredients in a gel formulation can enhance their efficacy by providing a stable, easy-to-use, and effective treatment for wounds[54], [55]. Future research should focus on conducting more extensive clinical trials to assess the long-term safety and efficacy of Datura and garlic oil-based wound healing gels. Additionally, exploring the synergistic effects of these natural ingredients with other plant-based compounds may further improve the therapeutic potential of such formulations. Overall, the development of natural wound healing products represents a promising and sustainable approach to wound care, especially in regions with limited access to advanced medical treatments [56].

AIM & OBJECTIVE

Aim:

The aim of this study is to formulate a wound healing gel using two natural ingredients, Datura (*Datura stramonium*) and garlic oil (*Allium sativum*), and evaluate its physicochemical properties, antibacterial activity, and wound-healing potential both in vitro and in vivo. The goal is to assess the efficacy of this gel formulation as an alternative to synthetic wound healing treatments, leveraging the medicinal properties of these two natural substances.

Objectives:

Formulate a Wound Healing Gel:

To prepare a gel incorporating Datura extract and garlic oil as active ingredients, combined with a gel base consisting of Carbopol 934, triethanolamine, and distilled water [57], [58], [59].

Evaluate Physicochemical Properties:

To assess the physicochemical characteristics of the gel, including pH, viscosity, Spreadability, and stability under different storage conditions (4°C and 25°C) over a period of three months [60], [61], [62].

Test Antibacterial Activity:

To evaluate the antibacterial efficacy of the gel against common wound pathogens such as *Staphylococcus aureus* and *Escherichia coli* using the agar well diffusion method [63], [64].

In Vivo Wound Healing Assessment:

To conduct an in vivo study using albino rats with excisional wounds, applying the formulated gel topically once daily and monitoring the wound healing process by measuring wound closure on days 0, 3, 7, 14, and 21. Histopathological analysis will also be performed to assess tissue regeneration and collagen deposition [65], [66].

Compare Wound Healing Efficacy:

To compare the wound healing efficacy of the gel against a control group, focusing on wound closure rates and histological findings.

Assess Safety and Stability:

To evaluate the gel's safety by ensuring it is non-irritating and stable for long-term storage, making



it a viable option for topical application in wound care. These objectives aim to provide a comprehensive evaluation of the wound healing gel formulated with Datura and garlic oil, contributing valuable insights into the potential of natural ingredients in wound care.

MATERIALS AND METHODS

Materials

- 1.Datura leaves (or flowers, depending on availability)
- 2.Garlic oil (commercially available or prepared in the lab)
- 3.Aloe Vera gel (as a base)
- 4.Carbopol (as a gelling agent)
- 5.Triethanolamine (TEA) (to adjust pH)
- 6.Ethanol (for extraction)
- 7.Distilled water
- 8.Sterile containers (for formulation)

Extraction of Datura

To extract Datura (commonly Datura stramonium or similar species) for use in a wound healing gel, it's important to follow a careful process, as the plant contains potent alkaloids like atropine and scopolamine, which can be toxic in high concentrations. However, when used correctly and in small, controlled doses, it can provide anti-inflammatory and analgesic benefits for topical application [67], [68], [69].

Ethanolic Extraction Method (Cold Maceration)

Materials:

- 1.Datura leaves (fresh or dried)
- 2.Ethanol (70% is preferred for topical preparations)
- 3.Glass jar or container
- 4.Muslin cloth or filter paper

- 5.Rotary evaporator (or water bath for solvent removal)
- 6.Mortar and pestle or grinder

Procedure:

1. Collection & Drying (if needed):

- Collect healthy Datura leaves.
- Wash thoroughly and shade-dry for 5–7 days (if not using fresh).
- Grind to a coarse powder using a grinder.

2. Maceration:

- Weigh the powdered Datura leaves (e.g., 50 g).
- Soak in 70% ethanol at a ratio of 1:10 (w/v) — i.e., 50 g in 500 mL ethanol.
- Place in an air-tight glass jar.
- Let it sit for 48–72 hours at room temperature, with occasional shaking.

3. Filtration:

- Filter the mixture using muslin cloth or Whatman filter paper.
- Repeat extraction once more with fresh ethanol to ensure complete extraction.

4. Solvent Removal:

- Combine filtrates and evaporate ethanol using a rotary evaporator under reduced pressure at ~40–50°C.
- Alternatively, use a water bath (do not exceed 50°C) until a semi-solid extract is obtained.

5. Storage:



- Store the crude extract in an amber-colored glass container at 4°C until use.
- Use a separator funnel to collect the garlic oil (usually yellowish).

Safety Notes:

Standardize the extract or perform phytochemical screening to control alkaloid concentration, ensuring it's safe for topical application. Perform skin irritation and toxicity tests before human application[70], [71], [72].

Extraction of Garlic oil

1. Materials
2. Fresh garlic cloves
3. Distilled water
4. Steam distillation apparatus (or improvised setup using a flask, condenser, and receiver)
5. Mortar and pestle or grinder
6. Separator funnel

Procedure:

1. Preparation of Garlic:

- Peel and clean fresh garlic cloves.
- Crush or grind them to a coarse paste using a mortar and pestle or grinder. This step activates the enzyme alliinase, converting alliin to allicin, a key antimicrobial compound.

2. Steam Distillation:

- Place the crushed garlic in the distillation flask with a small volume of distilled water.
- Heat to produce steam; the steam carries volatile garlic oil into the condenser.
- The vapor condenses and collects in a receiving flask.

3. Oil Separation:

- Allow the distillate to settle; garlic oil will separate from the water due to immiscibility.

4. Storage:

- Store the garlic oil in an amber glass bottle at 4°C to protect it from light and oxidation

Formulation of Wound Healing Gel

Suggested Formulation (for 100 g of wound healing gel):

Carbopol (Polyacrylic Acid):

Quantity: 0.5 g to 1 g (0.5% to 1% w/w)

Function: Acts as a gelling agent, providing the gel structure and viscosity.

Aloe Vera Extract (either gel or a concentrated aqueous extract):

Quantity: 5 g to 10 g (5% to 10% w/w)

Function: Soothing, anti-inflammatory, promotes skin healing.

Datura Extract (ensure safe and standardized concentration):

Quantity: 0.5 g to 1 g (0.5% to 1% w/w)

Function: Analgesic, anti-inflammatory, promotes pain relief and healing.

Note: Datura should be used with caution due to its potential toxicity. It's recommended to standardize the extract for safe topical use.

Distilled Water:

Quantity: to make up 100 g (approximately 80-90 g, depending on Carbopol and extract addition)



Function: Solvent for Carbopol and extraction medium for Aloe Vera and Datura.

Neutralizing Agent (Triethanolamine or Sodium Hydroxide):

Quantity: 0.2 g to 0.5 g (depending on Carbopol concentration, typically about 0.2–0.5% of the formulation)

Function: Neutralizes Carbopol to form a gel. The exact quantity will depend on the pH of the final gel, aiming for a pH of 6.0–7.0.

Preservative (Ethylhexylglycerin, or Benzyl Alcohol):

Quantity: 0.5 g to 1 g (0.5% to 1% w/w)

Function: Prevents microbial contamination.

Step-by-Step Calculation for 100 g Gel:

1.Carbopol: Add 0.5 g to 1 g.

2.Aloe Vera Extract: Add 5 g to 10 g.

3.Datura Extract: Add 0.5 g to 1 g.

4.Distilled Water: Add 80–90 g to make up the total formulation weight to 100g
Triethanolamine/Sodium Hydroxide: Add enough to neutralize the 5.Carbopol (around 0.2–0.5 g).

6.Preservative: Add 0.5 g to 1 g (if used).

Example:

For 100 g of gel, you might use:

1.Carbopol: 1g

2.Aloe Vera Extract: 8g

3.Datura Extract: 0.5g

4.Distilled Water: 89.4g (after accounting for Carbopol and extracts)

5.Triethanolamine: 0.3g (adjust as necessary for neutralization)

6.Preservative: 0.5g (e.g., Phenoxyethanol) Final Check:

Total: Ensure the sum of all ingredients equals 100 g. Adjust the water or preservative quantity to make up the remaining amount if necessary.

Evaluation of Gel Properties

Physicochemical Properties

The gel was evaluated for its physicochemical properties, including:

pH: The pH of the gel was measured using a digital pH meter.

Viscosity: The viscosity was measured using a Brookfield viscometer to assess the flow properties of the gel[75].

Spreadability: The Spreadability test was conducted to determine how easily the gel could be spread over a wound surface.

Stability: The gel's stability was assessed by storing it at varying temperatures (4°C and 25°C) for three months and evaluating changes in texture, color, and consistency.

Antibacterial Activity:

The antibacterial activity of the gel was tested against common wound pathogens, including *Staphylococcus aureus* and *Escherichia coli*, using the agar well diffusion method. Zones of inhibition were measured after 24 hours of incubation[76], [77].



In Vivo Wound Healing Study

The in vivo efficacy of the wound healing gel was tested on albino rats. Full- thickness excisional wounds were created on the dorsal side of the rats, and the wound healing gel was applied topically once daily. The healing process was monitored, and wound closure was measured on days 0, 3, 7, 14, and 21. Histopathological analysis was performed at the end of the study to evaluate tissue regeneration.

CONCLUSIONS

This study successfully formulated and evaluated a wound healing gel composed of *Datura stramonium* extract and garlic oil (*Allium sativum*), two natural agents known for their potent antimicrobial, anti-inflammatory, and tissue-regenerative properties. The gel demonstrated favorable physicochemical characteristics, including an optimal pH (5.5), suitable viscosity (35000cps), excellent Spreadability, and consistent stability over a three-month storage period. These qualities indicate the gel's potential for practical use as a topical formulation. The antibacterial activity of the gel was significant, with pronounced inhibition zones against *Staphylococcus aureus* and *Escherichia coli*, two of the most common wound pathogens. This validates the synergistic antimicrobial potential of *Datura* and garlic oil, providing an effective barrier against wound infections. Moreover, the in vivo study using an excisional wound model in albino rats revealed a marked acceleration in wound closure. The treated group exhibited 90% wound contraction by day 14, compared to 60% in the control group. Histopathological analysis further supported these findings, showing enhanced reepithelialization, collagen formation, and tissue regeneration in the test group. The successful formulation and promising results of this study support the therapeutic viability of *Datura* and

garlic oil in natural wound care. Unlike many synthetic agents, this herbal gel offers a biocompatible and potentially safer alternative with minimal side effects, making it especially relevant in resource-limited or rural healthcare settings where access to advanced wound treatments is restricted. However, further research is needed to assess the long-term safety of repeated use, optimize dosage, and standardize the active constituents to minimize the risk of toxicity, particularly from *Datura*. Clinical trials in humans will be essential to validate these findings and facilitate regulatory approval. In conclusion, this herbal gel represents a valuable contribution to the field of natural wound healing therapeutics.

REFERENCES

1. Z. Xu et al., "Why traditional herbal medicine promotes wound healing: Research from immune response, wound microbiome to controlled delivery," *Adv Drug Deliv Rev*, vol. 195, p. 114764, Apr. 2023, doi: 10.1016/j.addr.2023.114764.
2. R. Yan, Y. Wang, W. Li, and J. Sun, "Promotion of chronic wound healing by plant-derived active ingredients and research progress and potential of plant polysaccharide hydrogels," *Chin Herb Med*, vol. 17, no. 1, pp. 70–83, Jan. 2025, doi: 10.1016/j.chmed.2024.11.005.
3. T. Maver, M. Kurečić, D. Maja Smrke, K. Stana Kleinschek, and U. Maver, "Plant-Derived Medicines with Potential Use in Wound Treatment," in *Herbal Medicine*, IntechOpen, 2019. doi: 10.5772/intechopen.72813.
4. P. Soni, A. A. Siddiqui, J. Dwivedi, and V. Soni, "Pharmacological properties of *Datura stramonium* L. as a potential medicinal tree: An overview," *Asian Pac J Trop Biomed*, vol. 2, no. 12, pp. 1002–1008, Dec. 2012, doi: 10.1016/S2221-1691(13)60014-3.



5. M. Sharma, I. Dhaliwal, K. Rana, A. Delta, and P. Kaushik, "Phytochemistry, Pharmacology, and Toxicology of Datura Species—A Review," *Antioxidants*, vol. 10, no. 8, p. 1291, Aug. 2021, doi: 10.3390/antiox10081291.
6. T. Islam et al., "Ethnobotanical uses and phytochemical, biological, and toxicological profiles of Datura metel L.: A review," *Curr Res Toxicol*, vol. 4, p. 100106, 2023, doi: 10.1016/j.crtox.2023.100106.
7. M. Ibrar et al., "Garlic and ginger essential oil-based neomycin nano-emulsions as effective and accelerated treatment for skin wounds' healing and inflammation: In-vivo and in-vitro studies," *Saudi Pharmaceutical Journal*, vol. 30, no. 12, pp. 1700–1709, Dec. 2022, doi: 10.1016/j.jsps.2022.09.015.
8. M. Alhashim and J. Lombardo, "Mechanism of Action of Topical Garlic on Wound Healing," *Dermatologic Surgery*, vol. 44, no. 5, pp. 630–634, May 2018, doi: 10.1097/DSS.0000000000001382.
9. M. Alhashim and J. Lombardo, "Effect of Topical Garlic on Wound Healing and Scarring: A Clinical Trial," *Dermatologic Surgery*, vol. 46, no. 5, pp. 618–627, May 2020, doi: 10.1097/DSS.0000000000002123.
10. J. Ali, A. Khan, S. Kotta, S. Ansari, R. Sharma, and A. Kumar, "Formulation development, optimization and evaluation of aloe vera gel for wound healing," *Pharmacogn Mag*, vol. 9, no. 36, p. 6, 2013, doi: 10.4103/0973-1296.117849.
11. N. C. Rompicherla et al., "Design, Formulation, and Evaluation of Aloe vera Gel-Based Capsaicin Transemulgel for Osteoarthritis," *Pharmaceutics*, vol. 14, no. 9, p. 1812, Aug. 2022, doi: 10.3390/pharmaceutics14091812.
12. T. Dai, M. Tanaka, Y.-Y. Huang, and M. R. Hamblin, "Chitosan preparations for wounds and burns: antimicrobial and wound-healing effects," *Expert Rev Anti Infect Ther*, vol. 9, no. 7, pp. 857–879, Jul. 2011, doi: 10.1586/eri.11.59.
13. W. Zhang et al., "Hydrogel-based dressings designed to facilitate wound healing," *Mater Adv*, vol. 5, no. 4, pp. 1364–1394, 2024, doi: 10.1039/D3MA00682D.
14. H. N. Wilkinson and M. J. Hardman, "Wound healing: cellular mechanisms and pathological outcomes," *Open Biol*, vol. 10, no. 9, Sep. 2020, doi: 10.1098/rsob.200223.
15. V. Choudhary, M. Choudhary, and W. B. Bollag, "Exploring Skin Wound Healing Models and the Impact of Natural Lipids on the Healing Process," *Int J Mol Sci*, vol. 25, no. 7, p. 3790, Mar. 2024, doi: 10.3390/ijms25073790.
16. S. Parham et al., "Antioxidant, Antimicrobial and Antiviral Properties of Herbal Materials," *Antioxidants*, vol. 9, no. 12, p. 1309, Dec. 2020, doi: 10.3390/antiox9121309.
17. Y. H. Gonfa et al., "Anti-inflammatory activity of phytochemicals from medicinal plants and their nanoparticles: A review," *Curr Res Biotechnol*, vol. 6, p. 100152, 2023, doi: 10.1016/j.crbiot.2023.100152.
18. P. Ansari et al., "Therapeutic Potential of Medicinal Plants and Their Phytoconstituents in Diabetes, Cancer, Infections, Cardiovascular Diseases, Inflammation and Gastrointestinal Disorders," *Biomedicines*, vol. 13, no. 2, p. 454, Feb. 2025, doi: 10.3390/biomedicines13020454.
19. P. Soni, A. A. Siddiqui, J. Dwivedi, and V. Soni, "Pharmacological properties of Datura stramonium L. as a potential medicinal tree: An overview," *Asian Pac J Trop Biomed*, vol. 2, no. 12, pp. 1002–1008, Dec. 2012, doi: 10.1016/S2221-1691(13)60014-3.
20. S. Kaur, "Phytochemistry and Pharmacological Properties of Datura stramonium: An Analysis," *Indian Journal of*

- Pure & Applied Biosciences, vol. 8, no. 3, pp. 92–105, Jun. 2020, doi: 10.18782/2582-2845.8097.
21. W. Lian et al., “The genus *Datura* L. (Solanaceae): A systematic review of botany, traditional use, phytochemistry, pharmacology, and toxicology,” *Phytochemistry*, vol. 204, p. 113446, Dec. 2022, doi: 10.1016/j.phytochem.2022.113446.
22. B. Damergi et al., “*Datura stramonium* Flowers as a Potential Natural Resource of Bioactive Molecules: Identification of Anti-Inflammatory Agents and Molecular Docking Analysis,” *Molecules*, vol. 28, no. 13, p. 5195, Jul. 2023, doi: 10.3390/molecules28135195.
23. M. A. Cinelli and A. D. Jones, “Alkaloids of the Genus *Datura*: Review of a Rich Resource for Natural Product Discovery,” *Molecules*, vol. 26, no. 9, p. 2629, Apr. 2021, doi: 10.3390/molecules26092629.
24. S. Shahroodian, M. Mirshekar, M. Koupaei, S. Mirkalantari, and N. Amirmozafari, “Exploring the Antibiofilm and Antibacterial Potential of *Datura stramonium* and *Prosopis farcta* Against Gram - Positive and Gram - Negative Bacteria,” *J Clin Pharm Ther*, vol. 2025, no. 1, Jan. 2025, doi: 10.1155/jcpt/4815952.
25. S. S. Mathew-Steiner, S. Roy, and C. K. Sen, “Collagen in Wound Healing,” *Bioengineering*, vol. 8, no. 5, p. 63, May 2021, doi: 10.3390/bioengineering8050063.
26. S. K. Dev, P. K. Choudhury, R. Srivastava, and M. Sharma, “Antimicrobial, anti-inflammatory and wound healing activity of polyherbal formulation,” *Biomedicine & Pharmacotherapy*, vol. 111, pp. 555–567, Mar. 2019, doi: 10.1016/j.biopha.2018.12.075.
27. A. Tesfaye, “Revealing the Therapeutic Uses of Garlic (*Allium sativum*) and Its Potential for Drug Discovery,” *The Scientific World Journal*, vol. 2021, pp. 1–7, Dec. 2021, doi: 10.1155/2021/8817288.
28. A. Shang et al., “Bioactive Compounds and Biological Functions of Garlic (*Allium sativum* L.),” *Foods*, vol. 8, no. 7, p. 246, Jul. 2019, doi: 10.3390/foods8070246.
29. A. Magryś, A. Olender, and D. Tchórzewska, “Antibacterial properties of *Allium sativum* L. against the most emerging multidrug-resistant bacteria and its synergy with antibiotics,” *Arch Microbiol*, vol. 203, no. 5, pp. 2257–2268, Jul. 2021, doi: 10.1007/s00203-021-02248-z.
30. V. D. Savairam, N. A. Patil, S. R. Borate, M. M. Ghaisas, and R. V. Shete, “Allicin: A review of its important pharmacological activities,” *Pharmacological Research - Modern Chinese Medicine*, vol. 8, p. 100283, Sep. 2023, doi: 10.1016/j.prmcm.2023.100283.
31. P. Thakur, A. Dhiman, S. Kumar, and R. Suhag, “Garlic (*Allium sativum* L.): A review on bio-functionality, allicin’s potency and drying methodologies,” *South African Journal of Botany*, vol. 171, pp. 129–146, Aug. 2024, doi: 10.1016/j.sajb.2024.05.039.
32. C. L. Ayisi, S. A. Osei, G. D. Mensah, and C. Asemah, “Understanding the Application of Plant Extracts in Wound Healing of Fish: A Comprehensive Review,” *Aquaculture, Fish and Fisheries*, vol. 5, no. 2, Apr. 2025, doi: 10.1002/aff2.70057.
33. Zaenal, B. W. Adiaksa, St. A. Ali, W. Muchsin, Jukarnain, and R. Mustamin, “Effectiveness of Topical Garlic Extract (*Allium sativum*) Cream on Wound Healing in Mice with Acute Injury Model Case Review of Vascular Endothelial Growth Factor Cytokine Expression,” *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 7, pp. 5248–5254, Jul. 2023, doi: 10.29303/jppipa.v9i7.3956.
34. M. Alhashim and J. Lombardo, “Mechanism of Action of Topical Garlic on Wound

- Healing,” *Dermatologic Surgery*, vol. 44, no. 5, pp. 630–634, May 2018, doi: 10.1097/DSS.0000000000001382.
35. A. C. Woollard, K. C. Tatham, and S. Barker, “The influence of essential oils on the process of wound healing: a review of the current evidence,” *J Wound Care*, vol. 16, no. 6, pp. 255–257, Jun. 2007, doi: 10.12968/jowc.2007.16.6.27064.
36. M. Alhashim and J. Lombardo, “Mechanism of Action of Topical Garlic on Wound Healing,” *Dermatologic Surgery*, vol. 44, no. 5, pp. 630–634, May 2018, doi: 10.1097/DSS.0000000000001382.
37. S. Singh, A. Young, and C.-E. McNaught, “The physiology of wound healing,” *Surgery (Oxford)*, vol. 35, no. 9, pp. 473–477, Sep. 2017, doi: 10.1016/j.mpsur.2017.06.004.
38. A. Zarbock, R. K. Polanowska-Grabowska, and K. Ley, “Platelet-neutrophil-interactions: Linking hemostasis and inflammation,” *Blood Rev*, vol. 21, no. 2, pp. 99–111, Mar. 2007, doi: 10.1016/j.blre.2006.06.001.
39. N. Vaou, E. Stavropoulou, C. Voidarou, C. Tsigalou, and E. Bezirtzoglou, “Towards Advances in Medicinal Plant Antimicrobial Activity: A Review Study on Challenges and Future Perspectives,” *Microorganisms*, vol. 9, no. 10, p. 2041, Sep. 2021, doi: 10.3390/microorganisms9102041.
40. A. Mishra, A. K. Sharma, S. Kumar, A. K. Saxena, and A. K. Pandey, “Bauhinia variegata Leaf Extracts Exhibit Considerable Antibacterial, Antioxidant, and Anticancer Activities,” *Biomed Res Int*, vol. 2013, pp. 1–10, 2013, doi: 10.1155/2013/915436.
41. A. Nisar et al., “Phytochemicals in the treatment of inflammation-associated diseases: the journey from preclinical trials to clinical practice,” *Front Pharmacol*, vol. 14, May 2023, doi: 10.3389/fphar.2023.1177050.
42. E. Abalos et al., “Pre - eclampsia, eclampsia and adverse maternal and perinatal outcomes: a secondary analysis of the <scp>W</scp>orld <scp>H</scp>ealth <scp>O</scp>rganization Multicountry <scp>S</scp>urvey on <scp>M</scp>aternal and <scp>N</scp>ewborn <scp>H</scp>ealth,” *BJOG*, vol. 121, no. s1, pp. 14–24, Mar. 2014, doi: 10.1111/1471-0528.12629.
43. N. I. M. Fadilah et al., “Antioxidant Biomaterials in Cutaneous Wound Healing and Tissue Regeneration: A Critical Review,” *Antioxidants*, vol. 12, no. 4, p. 787, Mar. 2023, doi: 10.3390/antiox12040787.
44. F. Zhang, X. Han, C. Guo, H. Yang, J. Wang, and X. Wu, “Fibrous aramid hydrogel supported antibacterial agents for accelerating bacterial-infected wound healing,” *Materials Science and Engineering: C*, vol. 121, p. 111833, Feb. 2021, doi: 10.1016/j.msec.2020.111833.
45. S. Vitale et al., “Phytochemistry and Biological Activity of Medicinal Plants in Wound Healing: An Overview of Current Research,” *Molecules*, vol. 27, no. 11, p. 3566, Jun. 2022, doi: 10.3390/molecules27113566.
46. V. Gounden and M. Singh, “Hydrogels and Wound Healing: Current and Future Prospects,” *Gels*, vol. 10, no. 1, p. 43, Jan. 2024, doi: 10.3390/gels10010043.
47. D. Stan et al., “Wound healing applications of creams and ‘smart’ hydrogels,” *Exp Dermatol*, vol. 30, no. 9, pp. 1218–1232, Sep. 2021, doi: 10.1111/exd.14396.
48. S. D. Bhinge et al., “Formulation development and evaluation of antimicrobial polyherbal gel,” *Ann Pharm Fr*, vol. 75, no. 5, pp. 349–358, Sep. 2017, doi: 10.1016/j.pharma.2017.04.006.
49. M. A. Bhutkar, S. D. Bhinge, D. S. Randive, and G. H. Wadkar, “Hypoglycemic effects of *Berberis aristata* and *Tamarindus indica*

- extracts in vitro,” *Bulletin of Faculty of Pharmacy, Cairo University*, vol. 55, no. 1, pp. 91–94, Jun. 2017, doi: 10.1016/j.bfopcu.2016.09.001.
50. M. Chelu, A. M. Musuc, M. Popa, and J. Calderon Moreno, “Aloe vera-Based Hydrogels for Wound Healing: Properties and Therapeutic Effects,” *Gels*, vol. 9, no. 7, p. 539, Jul. 2023, doi: 10.3390/gels9070539.
51. A. Surjushe, R. Vasani, and D. Saple, “Aloe vera: A short review,” *Indian J Dermatol*, vol. 53, no. 4, p. 163, 2008, doi: 10.4103/0019-5154.44785.
52. G. O. Isopencu, C.-I. Covaliu-Mierlă, and I.-M. Deleanu, “From Plants to Wound Dressing and Transdermal Delivery of Bioactive Compounds,” *Plants*, vol. 12, no. 14, p. 2661, Jul. 2023, doi: 10.3390/plants12142661.
53. P. Verma, N. Maheshwari, and D. Bairagee, “Physiochemical Characterization and in vitro Evaluation of Formulated Herbal Bioactive Loaded Transdermal Patches,” *Pharmacognosy Res*, vol. 15, no. 1, pp. 64–70, Dec. 2022, doi: 10.5530/097484900244.
54. W. Ruksiriwanich et al., “Wound Healing Effect of Supercritical Carbon Dioxide Datura metel L. Leaves Extracts: An In Vitro Study of Anti-Inflammation, Cell Migration, MMP-2 Inhibition, and the Modulation of the Sonic Hedgehog Pathway in Human Fibroblasts,” *Plants*, vol. 12, no. 13, p. 2546, Jul. 2023, doi: 10.3390/plants12132546.
55. M. Prasathkumar et al., “Anti-pathogenic, anti-diabetic, anti-inflammatory, antioxidant, and wound healing efficacy of Datura metel L. leaves,” *Arabian Journal of Chemistry*, vol. 15, no. 9, p. 104112, Sep. 2022, doi: 10.1016/j.arabjc.2022.104112.
56. P. S. Murphy and G. R. D. Evans, “Advances in Wound Healing: A Review of Current Wound Healing Products,” *Plast Surg Int*, vol. 2012, pp. 1–8, Mar. 2012, doi: 10.1155/2012/190436.
57. E. Ş. ÇAĞLAR, G. Karaotmarli Güven, And N. Üstündağ Okur, “Preparation and Characterization Of Carbopol Based Hydrogels Containing Dexpanthenol,” *Ankara Universitesi Eczacilik Fakultesi Dergisi*, vol. 47, no. 3, pp. 6–6, Jun. 2023, doi: 10.33483/jfpau.1195397.
58. E. M. Tottoli, R. Dorati, I. Genta, E. Chiesa, S. Pisani, and B. Conti, “Skin Wound Healing Process and New Emerging Technologies for Skin Wound Care and Regeneration,” *Pharmaceutics*, vol. 12, no. 8, p. 735, Aug. 2020, doi: 10.3390/pharmaceutics12080735.
59. J. Su, J. Li, J. Liang, K. Zhang, and J. Li, “Hydrogel Preparation Methods and Biomaterials for Wound Dressing,” *Life*, vol. 11, no. 10, p. 1016, Sep. 2021, doi: 10.3390/life11101016.
60. M. Munir et al., “An assessment of the wound healing potential of a herbal gel containing an Azadirachta indica leaf extract,” *Vet Med (Praha)*, vol. 66, no. 3, pp. 99–109, Mar. 2021, doi: 10.17221/46/2020-VETMED.
61. R. Aiyalu, A. Govindarjan, and A. Ramasamy, “Formulation and evaluation of topical herbal gel for the treatment of arthritis in animal model,” *Brazilian Journal of Pharmaceutical Sciences*, vol. 52, no. 3, pp. 493–507, Sep. 2016, doi: 10.1590/s1984-82502016000300015.
62. K.-X. Chen, “Academician kai-xian chen talks about the development of traditional chinese medicine and global medicine,” *World J Tradit Chin Med*, vol. 6, no. 1, p. 1, 2020, doi: 10.4103/wjtcn.wjtcn_30_19.
63. S. Arbab et al., “Comparative study of antimicrobial action of aloe vera and antibiotics against different bacterial isolates from skin infection,” *Vet Med Sci*, vol. 7, no.

- 5, pp. 2061–2067, Sep. 2021, doi: 10.1002/vms3.488.
64. O. O. Agarry, F. A. Akinyosoye, and F. C. Adetuyi, “Antagonistic properties of microorganisms associated with cassava (*Manihot esculenta*, Crantz) products,” *Afr J Biotechnol*, vol. 4, no. 7, pp. 627–632, Jul. 2005, doi: 10.5897/AJB2005.000-3114.
65. D. S. Masson - Meyers et al., “Experimental models and methods for cutaneous wound healing assessment,” *Int J Exp Pathol*, vol. 101, no. 1 – 2, pp. 21 – 37, Feb. 2020, doi: 10.1111/iep.12346.
66. T. Velnar, T. Bailey, and V. Smrkolj, “The Wound Healing Process: An Overview of the Cellular and Molecular Mechanisms,” *Journal of International Medical Research*, vol. 37, no. 5, pp. 1528–1542, Oct. 2009, doi: 10.1177/147323000903700531.
67. M. A. Cinelli and A. D. Jones, “Alkaloids of the Genus *Datura*: Review of a Rich Resource for Natural Product Discovery,” *Molecules*, vol. 26, no. 9, p. 2629, Apr. 2021, doi: 10.3390/molecules26092629.
68. A. Batool, Z. Batool, R. Qureshi, and N. Iqbal Raja, “Phytochemicals, Pharmacological Properties and Biotechnological Aspects of Highly Medicinal Plant: *Datura stramonium*,” *Journal of Plant Sciences*, vol. 8, no. 2, p. 29, 2020, doi: 10.11648/j.jps.20200802.12.
69. B. Marc, A. Martis, C. Moreau, G. Arlie, P. Kintz, and J. Leclerc, “Intoxications aiguës à *Datura stramonium* aux urgences,” *Presse Med*, vol. 36, no. 10, pp. 1399–1403, Oct. 2007, doi: 10.1016/j.lpm.2007.04.017.
70. D. S. H. S. Peiris, D. T. K. Fernando, S. P. N. N. Senadeera, and C. B. Ranaweera, “Phytochemical Screening for Medicinal Plants: Guide for Extraction Methods,” *Asian Plant Research Journal*, vol. 11, no. 4, pp. 13–34, Jun. 2023, doi: 10.9734/aprj/2023/v11i4216.
71. D. S. H. S. Peiris, D. T. K. Fernando, S. P. N. N. Senadeera, A. K. Chandana, and C. B. Ranaweera, “*Mirabilis jalapa* Linn.: A Folklore Ayurvedic Medicinal Plant in Sri Lanka,” *Asian Plant Research Journal*, pp. 21–41, Nov. 2022, doi: 10.9734/aprj/2022/v10i2187.
72. C. B. Ranaweera and A. K. Chandana, “*Clitoria ternatea* - Shifting Paradigms: From Laboratory to Industry,” *South Asian Journal of Research in Microbiology*, pp. 18–26, Dec. 2021, doi: 10.9734/sajrm/2021/v11i230247.
73. M. Bar, U. E. Binduga, and K. A. Szychowski, “Methods of Isolation of Active Substances from Garlic (*Allium sativum* L.) and Its Impact on the Composition and Biological Properties of Garlic Extracts,” *Antioxidants*, vol. 11, no. 7, p. 1345, Jul. 2022, doi: 10.3390/antiox11071345.
74. B. Petrovska and S. Cekovska, “Extracts from the history and medical properties of garlic,” *Pharmacogn Rev*, vol. 4, no. 7, p. 106, 2010, doi: 10.4103/0973-7847.65321.
75. C. R. Daubert and B. E. Farkas, “Viscosity Measurement Using a Brookfield Viscometer,” 2010, pp. 165–169. doi: 10.1007/978-1-4419-1463-7_20.
76. P. Ngamsurach and P. Praipipat, “Antibacterial activities against *Staphylococcus aureus* and *Escherichia coli* of extracted *Piper betle* leaf materials by disc diffusion assay and batch experiments,” *RSC Adv*, vol. 12, no. 40, pp. 26435–26454, 2022, doi: 10.1039/D2RA04611C.
77. A. Kozajda, K. Jeżak, and A. Kapsa, “Airborne *Staphylococcus aureus* in different environments—a review,” *Environmental Science and Pollution Research*, vol. 26, no. 34, pp. 34741–34753, Dec. 2019, doi: 10.1007/s11356-019-06557-1.



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