Formulation and Evaluation of Herbal Wound Healing Spray

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Abstract- **Wound healing is a complex biological process that can be significantly impaired by infections and inflammation. Traditional medicinal plants offer a time-tested and scientifically supported approach to accelerate tissue repair. This study presents the formulation and evaluation of a novel herbal wound healing spray composed of standardized extracts of *Aloe vera*, *Curcuma longa* (turmeric), *Azadirachta indica* (neem), and *Calendula officinalis*. These herbs were selected for their well-documented antimicrobial, anti-inflammatory, antioxidant, and regenerative properties.**

A water-based, red-tinted sprayable formulation was developed, incorporating mild preservatives and natural colorants to enhance stability and aesthetics. The product was evaluated for key physicochemical parameters including pH, viscosity, sprayability, and short-term stability. The final formulation demonstrated an ideal pH (5.4 ± 0.2) for topical application, viscosity suitable for smooth atomization (18–22 mPa·s), excellent spray distribution, and no signs of phase separation or degradation over 30 days.

These findings support the potential of this herbal spray as a safe, accessible, and cost-effective alternative to synthetic wound care agents, particularly in resource-limited settings. Further in vivo testing and clinical validation are warranted to fully establish its therapeutic efficacy and commercial viability.

Keywords: **Herbal wound healing spray, *Aloe vera*, *Curcuma longa*, *Azadirachta indica*, *Calendula officinalis*, Polyherbal formulation, Natural wound care.**

I. INTRODUCTION

The skin, the body's largest and most complex organ, serves as a vital barrier against environmental threats—regulating moisture, preventing microbial invasion, and preserving electrolyte balance [1]. When this protective barrier is disrupted due to wounds whether acute or chronic, it compromises both function and integrity, often leading to infections, delayed recovery, and significant patient morbidity [2]. Chronic wounds are a growing concern among elderly and diabetic populations, placing an increasing strain on healthcare systems globally [3].

The economic burden of managing wound-related complications runs into billions annually, largely due to the risk of poor healing, microbial colonization, and the emergence of drug-resistant bacterial strains. Notably, traumatic wounds often affect vulnerable populations at the extremes of age—infants and the elderly—underscoring the need for safe, effective, and affordable therapeutic solutions [4].

While conventional therapies like antibiotics, synthetic dressings, and surgical interventions are widely used, they are often hindered by high costs, limited accessibility, and rising antibiotic resistance. This has sparked renewed interest in phytomedicine as an adjunct or alternative strategy in wound management. Herbal remedies, enriched with bioactive phytochemicals such as flavonoids, alkaloids, tannins, and terpenoids, exhibit a wide range of therapeutic actions—including antimicrobial, antioxidant, anti-inflammatory, and tissue-regenerative properties [5] [6].

The present study explores the formulation and evaluation of a herbal wound healing spray. This formulation is designed to merge time-tested traditional knowledge with modern pharmaceutical practices, offering an accessible therapeutic solution especially valuable for communities with limited access to advanced medical care by synergizing the healing potential of medicinal plants such as *Aloe*

vera, *Curcuma longa* (turmeric), *Azadirachta indica* (neem), and *Calendula officinalis.*

II. MATERIAL AND METHODOLOGY

2.1. Selection of Herbs

The following herbal extracts were chosen based on ethnomedicinal relevance and properties:

- Aloe vera: Hydrating and anti-inflammatory [7].
- Turmeric (*Curcuma longa*): Rich in curcumin; antimicrobial and promotes granulation [8].
- Neem (*Azadirachta indica*): Potent antibacterial and antifungal [9] [10].
- Calendula (*Calendula officinalis*): Stimulates fibroblast proliferation and angiogenesis [11].

2.2. Formulation Composition

A sprayable solution was prepared using:

- Solvent: Distilled water
- Active Extracts: Aloe vera, neem tincture, turmeric extract, calendula tincture.
- Optional Natural Colorants: Turmeric (yellow), madder root or beetroot extract (red tint)
- Preservatives: ethanol (40%)
- Stabilizers- vit E or Citric acid

Sample formulation (Red Tinted Herbal Spray):

Ingredient	Quantity	Function
Distilled water	50 ml	Base solvent for dilution
Vitamin E (Tocopherol)	3 ml	Antioxidant & skin conditioning
Neem tincture	10 ml	Antimicrobial & anti-inflammatory properties
Turmeric extract	5 ml	Antioxidant & skin-brightening agent
Calendula tincture	3 ml	Wound healing & soothing effect
Aloe vera extract	2 ml	Moisturizing & cooling agent

2.3. Evaluation Parameters

- pH: 4.0–6, ideal for skin application [12].
- Stability testing: Observed over 30 days at room temperature.
- Sprayability: Uniform distribution checked visually
- Viscosity: Suitable for atomization.

III. RESULTS AND DISCUSSION

3.1. pH- The pH of the herbal spray formulation was measured at 5.4 ± 0.2, which falls within the physiologically acceptable range for topical skin applications (4–6), ensuring minimal irritation upon application.

3.2. Stability- *Testing over 30 days at room temperature showed no phase separation, color change, or sedimentation, suggesting physical stability and good shelf life potential.*

3.3. Sprayability- Sprayability was assessed by visual observation and user testing using a standard pump-action spray bottle. The formulation exhibited:

- Fine mist formation without clogging.
- Even coverage on the application surface.
- No dripping or residue buildup at the nozzle.

3.4. Viscosity- The viscosity of the formulated herbal spray was measured using a Brookfield viscometer and was found to be approximately 18–22 mPa·s (millipascal-seconds) at 25°C [13]. This viscosity range is ideal for a spray-type wound dressing, ensuring:

- Smooth flow through the spray nozzle.
- Uniform application on the wound site.
- Adequate film formation to prevent contamination and retain moisture.

3.5 Discussion

The formulation of the herbal wound healing spray was successfully developed using Aloe vera, Curcuma longa, Azadirachta indica, and Calendula officinalis—each known for their individual wound healing potential. The combination of these plant-based ingredients resulted in a synergistic formulation that addresses multiple stages of wound healing, including inflammation control, tissue regeneration, and microbial protection.

The physicochemical parameters indicated excellent suitability for topical application. The pH of 5.4 ± 0.2 is skin-friendly and supports the natural acid mantle, thereby minimizing irritation and microbial colonization. The measured viscosity (18–22

mPa·s) ensured smooth atomization, effective coverage, and optimal retention on the skin surface. The sprayability assessment confirmed uniform mist formation without nozzle clogging or dripping, enhancing user convenience, especially for self-application on wounds in hard-to-reach areas.

Stability studies demonstrated the physical robustness of the formulation under ambient storage conditions for 30 days, with no visible signs of degradation or separation. The inclusion of Vitamin E further contributed to antioxidant protection and may improve skin conditioning and formulation longevity.

This polyherbal combination, rich in flavonoids, terpenoids, alkaloids, and polysaccharides, aligns with modern phytotherapeutic approaches and addresses the rising concerns of antimicrobial resistance and cost-effectiveness in wound care management. Despite promising preliminary results, challenges remain, including standardization of extract potency, preservative stability, and long-term storage validation.

IV. CONCLUSION

The present study successfully demonstrates the formulation and preliminary evaluation of a polyherbal wound healing spray, incorporating Aloe vera, Curcuma longa, Azadirachta indica, and Calendula officinalis. The formulation showed optimal pH, suitable viscosity, excellent sprayability, and physical stability—essential parameters for effective topical application. By harnessing the synergistic antimicrobial, anti-inflammatory, and regenerative properties of the selected herbs, the spray offers a safe, accessible, and cost-effective alternative to synthetic wound care agents.

This herbal formulation not only addresses the growing global concern of antimicrobial resistance but also supports the integration of traditional knowledge into modern pharmaceutical innovation. Its potential utility in both clinical and home-based settings, especially in underserved regions, is highly promising. To fully establish its therapeutic value, further in vivo evaluations, clinical trials, and standardization efforts are essential. With appropriate validation, this herbal spray could emerge as a sustainable and scalable solution in the global wound care market.

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