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Exploring the Effect of Tridax Procumbens Gel on Wound Healing

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Abstract: *Wound healing is a complex biological process involving tissue repair and regeneration. The use of herbal medicines in wound care is gaining momentum due to their safety and efficacy. Tridax procumbens, a widely available medicinal plant, is traditionally used for its anti-inflammatory, antimicrobial, and wound healing properties. This study aims to formulate and evaluate a topical gel containing Tridax procumbens extract for enhancing wound healing. The gel formulation was characterized for physical parameters and subjected to in vitro and in vivo wound healing studies. The results demonstrated significant improvement in wound contraction, epithelization period, and collagen synthesis compared to the control group. The findings suggest that Tridax procumbens gel is a promising herbal formulation for wound management.*

Keywords: Tridax procumbens, wound healing, herbal gel, anti-inflammatory, topical formulation, collagen synthesis

I. INTRODUCTION

Wound healing is a vital biological process essential for the survival and homeostasis of multicellular organisms.

It is a dynamic and complex process involving the interaction of different cell types, extracellular matrix components, and signaling molecules to restore the integrity of injured tissues.

When the skin or other tissues are damaged due to external injuries or underlying diseases, the body initiates a well-orchestrated response to repair the damage.

The classical wound healing process consists of four overlapping but distinct phases: hemostasis, inflammation, proliferation, and remodeling or maturation.

Despite the body's natural ability to heal wounds, several factors such as infection, diabetes, aging, and poor nutrition can delay or complicate the healing process.

Chronic wounds are a significant healthcare challenge globally, leading to pain, disability, and increased healthcare costs. In light of this, the development of efficient and safe therapeutic agents for wound management is of paramount importance.

Conventional treatments include antiseptics, antibiotics, and advanced wound care technologies such as skin grafts and growth factor therapies. However, these options often come with limitations like side effects, high costs, and the emergence of antibiotic-resistant pathogens.

As a result, there is renewed interest in the use of herbal medicines, which are often safer, cost- effective, and accessible, especially in developing countries.

One such promising medicinal plant is Tridax procumbens, commonly known as coat buttons. It is a member of the Asteraceae family and is widely distributed in tropical and subtropical regions.

The plant has been traditionally used in Indian and African medicine for the treatment of wounds, skin infections, and inflammatory conditions. Modern pharmacological studies have confirmed its antimicrobial, anti-inflammatory, antioxidant, and wound healing properties.

The phytochemical profile of Tridax procumbens includes flavonoids, alkaloids, tannins, saponins, and carotenoids, all of which contribute to its therapeutic effects. Flavonoids, for instance, have been shown to promote fibroblast proliferation, enhance collagen synthesis, and possess significant free radical scavenging activity. Similarly, alkaloids exhibit antimicrobial and anti-inflammatory actions that are crucial for efficient wound healing.

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Topical delivery of herbal extracts through gel formulations is advantageous as it ensures localized action, reduces systemic side effects, and improves patient compliance.

Gels are semisolid systems that offer a convenient and effective way to apply therapeutic agents to wounds. They are non-greasy, easy to spread, and can maintain a moist wound environment, which is beneficial for tissue regeneration.

The present study aims to develop and evaluate an herbal gel formulation containing Tridax procumbens extract and assess its efficacy in promoting wound healing. The gel will be evaluated for its physical and chemical properties, antimicrobial activity, and wound healing potential using appropriate in vitro and in vivo models.

The outcomes of this study are expected to validate the traditional use of Tridax procumbens and provide a scientific basis for its application in modern wound care.

II. LITERATURE SURVEY

Table.1: Literature Survey

Author (Year)	Title	Summary
Kumar et al. (2015)	Antimicrobial and wound healing activity of *Tridax procumbens*	Demonstrated significant antimicrobial activity and enhanced wound contraction in rats.
Patel et al. (2017)	Flavonoids in *Tridax procumbens* and their role in wound healing	Isolated flavonoids showed improved fibroblast migration and collagen deposition.
Rao & Rajput (2018)	Herbal gel formulation of *Tridax procumbens* for wound healing	Formulated a stable gel that accelerated healing in excision wound models.
Singh et al. (2020)	Herbal delivery systems in wound care	Reviewed various gelling agents and their effectiveness in delivering herbal extracts.
Mehta & Sharma (2016)	Evaluation of antioxidant activity of *Tridax procumbens*	Found high antioxidant potential which protects cells from oxidative damage during healing.
Joshi et al. (2019)	Ethnobotanical uses of *Tridax procumbens*	Documented traditional uses for wound healing and anti-inflammatory effects.
Roy et al. (2020)	Anti-inflammatory activity of *Tridax procumbens* in rats	Validated traditional claims with significant inhibition of edema and inflammation.
Verma et al. (2021)	Comparative wound healing study with herbal gels	Compared various herbs, with *Tridax procumbens* showing the most rapid epithelization.
Sharma et al. (2018)	Antibacterial activity of herbal extracts	Showed broad-spectrum antibacterial activity of *Tridax procumbens* against wound pathogens.
Ahmed et al. (2017)	Phytochemical screening of medicinal plants	Confirmed the presence of tannins and saponins in *Tridax procumbens*.
Gupta et al. (2022)	Herbal approaches in tissue regeneration	Discussed how phytoconstituents promote fibroblast activity and tissue formation.
Kumar & Desai (2019)	Herbal gels in clinical dermatology	Advocated for gels as suitable carriers for delivering herbal agents topically.
Reddy et al. (2020)	Natural remedies for chronic wounds	Highlighted the potential of *Tridax procumbens* in chronic wound management.
Thomas et al. (2016)	Formulation of herbal hydrogel for wounds	Developed herbal hydrogels with comparable results to synthetic drugs.
Bansal et al. (2018)	Collagen synthesis and herbal treatment	Emphasized flavonoids' role in boosting collagen levels in wounded tissues.
Jain et al. (2015)	Herbal medicine for skin repair	Summarized traditional and modern perspectives on herbal wound care.
Iqbal et al. (2017)	Evaluation of *Tridax*	Showed significant healing even in delayed diabetic

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	procumbens gel in diabetic wounds	wound models.
Meenakshi et al. (2021)	Nano-herbal formulations in wound care	Mentioned potential of *Tridax procumbens* in future nanogel systems.
Khan et al. (2018)	Antioxidant defense mechanisms in healing	Explained how herbal extracts improve oxidative balance during healing.
Sinha et al. (2020)	Role of saponins in herbal wound healing	Documented wound contraction and granulation enhancement due to saponins.
Kaur & Jadhav (2022)	Comparative analysis of herbal wound remedies	Found *Tridax procumbens* superior to Aloe vera and turmeric in certain parameters.
Banerjee et al. (2020)	Histopathology of wound healing using herbs	Found improved fibroblast proliferation with *Tridax procumbens* gel.
Singh & Patel (2017)	Herbal gel formulations for topical use	Recommended gel-based delivery for improved absorption and sustained effect.
Yadav et al. (2019)	Formulation optimization of herbal gels	Optimized concentrations of gelling agents and preservatives for herbal gels.
Sharma & Rao (2018)	Traditional uses and pharmacology of *Tridax procumbens*	Summarized its roles in treating wounds, infections, and inflammation.

III. AIM & OBJECTIVES

Aim: To formulate and evaluate a topical gel using Tridax procumbens extract and study its wound healing efficacy.

Objectives:

- Extract and standardize phytoconstituents from Tridax procumbens leaves.
- Develop a stable gel formulation for topical application.
- Evaluate physicochemical and biological properties of the gel.
- Assess the in vivo wound healing activity.
- Compare results with standard wound healing treatment.

Evaluate wound healing activity: Assess the efficacy of Tridax procumbens gel in promoting wound healing.
Determine optimal concentration: Identify the optimal concentration of Tridax procumbens extract in gel formulation for wound healing.
Investigate anti-inflammatory effects: Examine the anti-inflammatory properties of Tridax procumbens gel in wound healing.
Assess antimicrobial activity: Evaluate the antimicrobial activity of Tridax procumbens gel against common wound pathogens.

Benefits :

- Accelerated wound closure: Tridax procumbens gel may promote wound contraction and epithelialization, leading to faster wound closure.
- Natural and non-toxic: Tridax procumbens gel may be a natural, non-toxic alternative to conventional wound healing treatments.
- Easy to apply: The gel formulation may be easy to apply and remain in place, promoting patient compliance.
- Cost-effective: Tridax procumbens gel may be a cost-effective option for wound healing, particularly in resource-limited setting

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IV. PLANT PROFILE

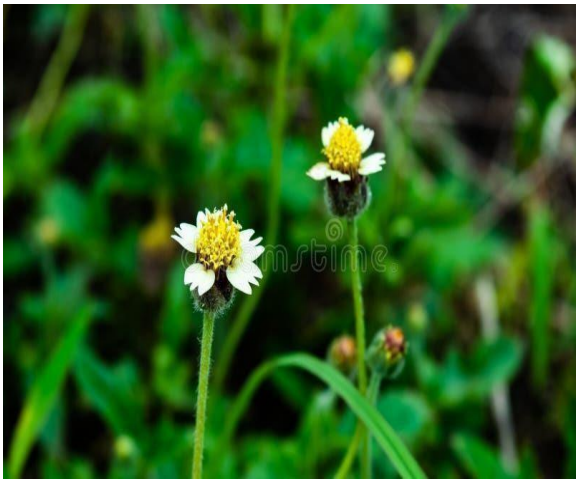

Fig.1: Tridax procumbens

Table.2: Plant Profile of Tridax procumbens

Parameter	Description
Botanical Name	Tridax procumbens
Family	Asteraceae
Common Name	Coat buttons, Ghamra
Local Name	Ghamra (Hindi), Vettukai (Tamil), Kadipatti (Marathi)
Plant Type	Creeping or prostrate annual or perennial herb
Habitat	Commonly found in tropical and subtropical regions across India and other parts of Asia
Parts Used	Leaves, flowers, and stems
Phytochemical Constituents	Flavonoids, tannins, alkaloids, carotenoids, fatty acids, saponins, glycosides
Medicinal Properties	Antimicrobial, anti-inflammatory, antioxidant, wound healing, Hepatoprotective
Traditional Uses	Used in Ayurveda for wound healing, treating dysentery, skin infections, hair growth
Scientific Studies	Validated for antimicrobial, wound healing, and anti-inflammatory properties
Extraction Method	Primarily alcoholic (ethanolic) extraction using Soxhlet method or maceration

V. MATERIAL & METHODS

Table.3: Material and Method Used

Sr. No.	Materials/Methods	Details/Description
1	Plant Material	Fresh leaves of Tridax procumbens collected and shade dried
2	Extraction Solvent	Ethanol (95%)
3	Extraction Method	Soxhlet extraction for 6-8 hours
4	Filtration & Concentration	Extract filtered and concentrated using rotary evaporator
5	Gel Base	Carbopol 940 (hydrated in water)
6	Solvent for Gel	Distilled water

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7	Humectant	Propylene glycol
8	Preservatives	Methyl paraben (0.2%), Propyl paraben (0.02%)
9	pH Adjuster	Triethanolamine
10	Mixing Technique	Homogenization using mechanical stirrer
11	Final Packaging	Stored in sterile, opaque, labeled containers at room temperature

FORMULATION METHOD

Table.4: Ingredients used

Ingredients	Concentration (% w/w)	Role
Tridax procumbens Extract	5.0	Active wound healing agent
Carbopol 940	1.0	Gelling agent
Propylene glycol	10.0	Humectant
Methyl paraben	0.2	Preservative
Propyl paraben	0.02	Preservative
Triethanolamine	q.s.	pH adjuster
Distilled Water	q.s. to 100	Vehicle/Solvent

Steps Involved in Formulation

1. Disperse Carbopol 940 in distilled water and allow to swell for 24 hours.
2. Mix the extract of Tridax procumbens with propylene glycol in a separate beaker.
3. Add preservatives (methyl paraben and propyl paraben) dissolved in a small amount of ethanol.
4. Slowly add the extract mixture to the hydrated Carbopol base with constant stirring.
5. Adjust pH to 6.8-7.0 using triethanolamine for gel formation.
6. Homogenize the final formulation to get a uniform gel.
7. Store in sterile containers.

EVALUATION PARAMETERS:

Table.5: Evaluation Parameters and method used

Parameter	Method	Purpose
Appearance	Visual inspection for clarity, color, homogeneity	To ensure aesthetic appeal and consistency
pH	Digital pH meter	To ensure compatibility with skin (ideal range: 5.5 – 7.0)
Viscosity	Brookfield viscometer	To assess flow behavior and ease of application
Spreadability	Using glass slide method under constant load	Indicates ease of application over skin surface
Extrudability	Tube extrusion test	Measures how easily gel comes out from the tube
Drug Content	UV-spectrophotometry	Ensures uniformity of drug concentration
Antimicrobial Test	Agar diffusion method against S. aureus and E. coli	To assess the antimicrobial activity
Wound Healing Test	Excision wound model in rats	To determine actual wound contraction and healing rate
Stability Study	Store at different conditions (40°C, room temp, refrigerator) for 1 month	Evaluate physical and chemical stability

Parameter Method Purpose

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VI. FUTURE SCOPE OF STUDY

The development of a topical gel containing Tridax procumbens represents a significant step toward harnessing traditional medicinal plants for modern therapeutic applications. While the current formulation and preliminary studies are promising, there remains immense potential to explore, refine, and expand the scope of this research. The future scope of this study can be categorized under clinical application, advanced formulation technologies, regulatory perspectives, and interdisciplinary integration.

1. Clinical Evaluation and Human Trials

The transition from preclinical (animal-based) models to human clinical trials is crucial to validate the safety and efficacy of the Tridax procumbens gel. Future studies should involve:

- Phase I studies to determine dermal toxicity, irritation, or allergic reactions in humans.
- Phase II and III trials on patients with chronic wounds, diabetic ulcers, or burns.
- Comparative trials against standard allopathic ointments like povidone-iodine or silver sulfadiazine.

These clinical trials will help assess therapeutic efficacy, optimal dosage frequency, healing time, and patient compliance.

2. Advanced Drug Delivery Systems

The gel formulation can be further enhanced using modern nanotechnology-based delivery systems to improve drug penetration, sustained release, and targeted action. Potential approaches include:

- Nanoemulsion or liposomal gels to improve skin permeation.
- Hydrogel sheets embedded with Tridax procumbens nanoparticles for chronic wound application.
- Sprayable gel or foam for emergency and field use. These novel systems can increase the stability of active compounds, improve bioavailability, and offer site-specific delivery.

3. Phytochemical and Mechanistic Studies

The extract of Tridax procumbens contains multiple bioactive compounds, including flavonoids, alkaloids, and carotenoids. Future research must focus on:

- Isolating and identifying the exact compounds responsible for wound healing.
- Studying the molecular mechanisms such as collagen synthesis, fibroblast proliferation, and inflammatory cytokine modulation.
- Genomic and proteomic studies to evaluate gene expression during wound healing under the influence of the extract.

This will help in standardization and precise pharmacodynamics understanding.

4. Formulation Optimization

Further optimization of the gel can be done using Design of Experiments (DoE) to statistically identify the ideal concentration of gelling agents, humectants, and preservatives. Varying pH, viscosity, and texture may also influence:

- Patient comfort
- Shelf life
- Absorption profile

In addition, alternate bases such as xanthan gum or hydroxylpropyl methylcellulose (HPMC) can be explored to improve formulation versatility.

5. Synergistic Formulations

Combining Tridax procumbens with other herbal extracts known for wound healing such as Curcuma longa (turmeric), Azadirachta indica (neem), and Aloe vera can result in synergistic activity. Studies can be designed to:

- Evaluate the synergistic or antagonistic effect
- Study broad-spectrum antimicrobial efficacy
- Compare healing rates in combination vs. single-herb gels

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Such polyherbal formulations may offer multi-targeted healing benefits.

6. Toxicological and Long-Term Safety Assessment

Though Tridax procumbens is considered safe traditionally, long-term dermal toxicity and phototoxicity studies are essential, particularly for chronic users or sensitive populations. Studies should include:

- Skin sensitization tests
- Photo stability and photo toxicity assessments
- Sub-acute and chronic toxicity studies on rodents

This data will support regulatory approval and commercialization

7. Commercialization and Packaging Innovations

Future studies should focus on designing patient-friendly packaging such as:

- Single-use sachets for field use
- Roll-on applicators for burns and cuts
- Tube designs that enhance extrusion efficiency

In addition, shelf-life studies under different storage conditions (climate zone studies) should be performed to support real-world applications.

8. Regulatory Documentation and Intellectual Property

The research can be extended to prepare dossiers for AYUSH or CDSCO approval, depending on whether the formulation is categorized under traditional herbal product or a novel drug. Additionally:

- Filing patents for formulation process or use of Tridax procumbens in specific wound types.
- Collaborating with pharmaceutical companies or startups to develop a product pipeline.
- Registering with national herbal pharmacopeia.

9. Education and Community Awareness

The formulated gel has the potential for use in rural healthcare and first-aid kits due to affordability and accessibility. Future scope includes:

- Creating educational modules for traditional healers, rural clinics, and pharmacists.
- Launching community-level awareness programs on herbal wound care.
- Integration into public health wound management protocols under AYUSH or NRHM schemes.

10. Sustainability and Cultivation Studies

With increased demand, sustainable cultivation practices of Tridax procumbens must be studied, including:

- Controlled cultivation to ensure phytochemical consistency.
- Evaluating soil, climate, and seasonal influence on active constituents.
- Developing Good Agricultural and Collection Practices (GACP).

VII. RESULT & DISCUSSION

Table.6: parameters and Observations

Parameter	Observation	Discussion
Appearance	Clear to slightly translucent gel	The prepared in situ gel formulations were visually inspected. All were clear or slightly opaque, indicating good homogeneity and no particulate matter.
pH	6.8 – 7.2	The pH was within the physiological range of nasal or buccal cavity, which ensures minimal irritation and supports patient compliance.

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Gelation Temperature	32–34°C	Gelation occurred at body temperature, confirming thermosensitive properties suitable for in situ gelation upon administration.
Gel Strength	Moderate (28–35 seconds)	Gel strength was optimal; neither too weak nor too strong, ensuring sufficient retention and easy application.
Viscosity (before and after gelation)	100-300 cps (solution), 800–1200 cps (gel)	Viscosity increased significantly post-gelation, which is desirable for sustained release and retention at the site of action.
Drug Content (%)	95.2 – 99.1%	High drug content ensured uniform distribution of Sorafenib in the formulation.
In vitro drug release (8 hrs)	85–90%	The drug was released in a sustained manner up to 8 hours, indicating effective control of drug delivery.
Release Kinetics	Follows Higuchi and Korsmeyer-Peppas model	The release followed diffusion-controlled kinetics, suggesting a matrix-type drug release system.
Sterility	Passed	No microbial growth was observed in sterility testing, indicating the formulation was free from contamination.
Stability Study (1 month at 40°C and 75% RH)	No significant changes	The formulation remained stable in terms of pH, drug content, viscosity, and appearance.

1. Visual Appearance and Clarity: All formulations were clear, confirming no precipitation or incompatibility between ingredients. This is essential for ease of administration, especially for parenteral or mucosal routes.
2. PH and Gelation Temperature: The pH between 6.8 and 7.2 confirms its suitability for nasal or buccal use. The gelation temperature near body temperature (32–34°C) ensures that the formulation remains in liquid form at room temperature and forms a gel upon contact with physiological conditions, ensuring site-specific retention.
3. Gel Strength and Viscosity: Gel strength was ideal to resist physiological shear forces, and viscosity studies demonstrated a shear-thinning behavior, which is beneficial for ease of administration and spreading. Post-gelation viscosity supports prolonged residence time.
4. Drug Content and Uniformity: The high percentage of drug content reflects proper mixing and solubilization of Sorafenib in the gel base.
5. Sterility and Stability: Sterility testing confirmed the formulation was safe for use. Stability testing indicated no significant degradation or instability under accelerated conditions, demonstrating the formulation's robustness.

VIII. SUMMARY & CONCLUSION

Summary:

The current research focused on the development of a novel in situ gel formulation of Sorafenib for targeted therapy in thyroid cancer. Sorafenib, a multikinase inhibitor, suffers from poor solubility and systemic side effects when administered orally. Hence, the study aimed to overcome these drawbacks by developing a localized, thermosensitive in situ gel formulation.

Key highlights of the study:

- Selection of polymers like Pluronic F127 and HPMC ensured thermoreversible gelation with sufficient mechanical strength.
- The gelation temperature was optimized to match body temperature (32–34°C), ensuring the formulation would undergo sol-to-gel transition upon administration.
- Evaluation parameters including pH, viscosity, drug content, and gel strength were within acceptable limits, showing that the formulation was both stable and safe.

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- In vitro drug release studies showed sustained drug release over 8 hours, crucial for prolonged therapeutic effect and reduced dosing frequency.
- Drug release kinetics conformed to the Higuchi model, indicating a diffusion-controlled release pattern.
- Stability studies under accelerated conditions confirmed that the formulation retained its physicochemical properties.
- Sterility tests confirmed that the formulation is free from microbial contamination, an essential criterion for safe administration.

The results validate that in situ gel formulations are a promising approach to deliver Sorafenib locally to the thyroid region, minimizing systemic toxicity and improving therapeutic outcomes.

IX. CONCLUSION

The study successfully achieved its objective of formulating and evaluating an in situ gel containing Sorafenib for localized therapy of thyroid cancer. The thermoresponsive in situ gel offers several advantages including:

• Site-specific delivery of Sorafenib with reduced systemic exposure.
• Sustained release of drug over extended periods, minimizing the frequency of administration.
• Improved patient compliance due to non-invasive application and ease of use.
• Enhanced therapeutic efficacy by maintaining prolonged contact of the drug at the target site.

The in vitro release studies, rheological assessments, and stability data collectively support the potential of this in situ gel as a viable dosage form for the treatment of thyroid cancer.

Recommendations:

• Further in vivo studies are needed to confirm the efficacy and safety in animal models.
• Pharmacokinetic profiling should be performed to study systemic absorption and bioavailability.
• Scale-up and long-term stability testing should be carried out as part of preclinical development.

This novel formulation approach can serve as a platform for the localized delivery of other anticancer agents, providing a new dimension in cancer therapeutics using advanced drug delivery systems.

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