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A Research Article on Formulation, Development and Evaluation of Prosopis Cineraria Based Topical Gel

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Abstract

The present study focuses on the formulation and evaluation of a topical herbal gel incorporating Prosopis cineraria extract, known for its traditional medicinal properties including anti-inflammatory, antimicrobial, and wound-healing effects. The extract was obtained using a hydroalcoholic solvent system through Soxhlet extraction. The gel was formulated using hydroxyethyl cellulose (HEC) as a gelling agent and evaluated for various physicochemical parameters such as pH, viscosity, spreadability, extrudability, and stability. Furthermore, the antimicrobial activity of the gel was assessed against common skin pathogens including Staphylococcus aureus and Escherichia coli using the agar well diffusion method. The results indicated that the formulated gel was stable, non-irritant, and exhibited significant antimicrobial properties, suggesting its potential as an effective herbal topical formulation for treating skin infections and promoting dermal health.

Keywords

Prosopis Cineraria, Shingles Gel, Prosopis Cineraria Gel

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1. Introduction

1.1. Importance of Herbal Gels in Pharmaceuticals and Cosmetics

In recent years, there has been a global resurgence in the use of natural and plant-based products in both the pharmaceutical and cosmetic industries. Herbal formulations are gaining preference due to their biocompatibility, minimal side effects, and sustainable sourcing. Among the various dosage forms, gels have emerged as an effective and convenient medium for delivering both hydrophilic and hydrophobic drugs topically.

Topical gels are semi-solid systems consisting of active ingredients dissolved or dispersed in an appropriate base. They offer several advantages over conventional ointments and creams, such as ease of application, better aesthetic appeal, non-greasy texture, and enhanced patient compliance. Gels also promote controlled drug release and improved skin penetration due to their unique rheological properties. When combined with herbal extracts, gels can deliver therapeutic benefits directly to the site of action, making them particularly useful for treating skin infections, wounds, inflammation, and fungal disorders.

1.2. Botanical and Pharmacological Overview of Prosopis cineraria

Prosopis cineraria, commonly known as “Khejri,” is a drought-resistant tree belonging to the Fabaceae family. Native to arid regions of the Indian subcontinent, particularly Rajasthan and Gujarat, this tree holds significant ecological, cultural, and medicinal value. It is often referred to as the “Kalpavriksha” (tree of life) due to its extensive uses.

Traditionally, various parts of P. cineraria—leaves, bark, pods, and flowers—have been used in folk medicine for treating a wide range of ailments, including respiratory disorders, skin diseases, fever, dysentery, and inflammation. Phytochemical studies have revealed that the plant contains a variety of bioactive compounds such as tannins, flavonoids, alkaloids, saponins, and glycosides. These constituents are known to exhibit antimicrobial, anti-inflammatory, antioxidant, and wound-healing properties, making the plant a promising candidate for topical formulations.

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Figure 1. Prosopis Cineraria Plant

Scientific studies have confirmed the pharmacological potential of P. cineraria. Its bark and leaves have demonstrated significant antibacterial and antifungal activity against common skin pathogens like Staphylococcus aureus and Candida albicans. Furthermore, the presence of flavonoids contributes to its antioxidant potential, which helps in reducing oxidative stress on the skin and promoting tissue repair.

1.3. Justification for Using P. cineraria in Gel Formulation

Despite its recognized therapeutic potential, P. cineraria remain underutilized in modern dermatological formulations. The integration of its extract into a gel base represents a novel approach to harnessing its benefits for topical application. Given its natural antimicrobial and wound-healing properties, a gel containing P. cineraria extract could serve as an effective remedy for minor cuts, burns, infections, and inflammatory skin conditions.

The choice of a gel formulation is particularly suitable for this plant extract due to its ability to maintain drug stability, ensure uniform distribution of the active ingredient, and offer ease of application. Additionally, herbal gels do not leave a sticky residue and allow for rapid drug absorption through the skin, making them ideal for cosmetic and therapeutic use.

By formulating a gel using P. cineraria, this study aims to develop a cost-effective, stable, and natural product that aligns with the increasing consumer preference for herbal-based skincare solutions.

1.4. Current Market Trends in Herbal Products

The global herbal skincare and pharmaceutical market is experiencing rapid growth, driven by consumer awareness of the harmful effects of synthetic chemicals and a shift toward natural wellness. According to recent market analyses, the herbal cosmetics market alone is expected to reach USD 30 billion by 2030, growing at a CAGR of over 7%. India, with its rich biodiversity and Ayurvedic heritage, holds a strong position in the production and export of herbal products.

Consumers are increasingly demanding products that are not only effective but also eco-friendly and free from harmful

additives. In this context, herbal gels infused with plant-based actives offer a perfect blend of tradition and innovation. They cater to the demand for clean-label skincare products while delivering therapeutic benefits rooted in nature.

Given these trends, developing a Prosopis cineraria-based gel aligns with both scientific exploration and market viability. It presents an opportunity to transform a traditionally known medicinal plant into a standardized and commercially viable dermatological formulation.

2. Statement of Problems

Skin disorders such as bacterial infections, inflammation, wounds, and fungal diseases are widespread and often require prolonged treatment. While numerous synthetic topical products are available in the market, many of them are associated with side effects like skin irritation, allergic reactions, or microbial resistance. Furthermore, the rising cost of pharmaceutical products makes them inaccessible to a large portion of the population, especially in developing countries. These challenges highlight the urgent need for effective, safe, and affordable alternatives derived from natural sources.

Herbal formulations, particularly those utilizing traditional medicinal plants, have gained attention due to their lower toxicity, biocompatibility, and therapeutic potential. However, despite the vast diversity of medicinal flora in India, only a limited number of plants have been scientifically explored and incorporated into modern dermatological preparations.

One such underutilized plant is Prosopis cineraria, known for its rich ethnomedicinal value. Though it has demonstrated antimicrobial, anti-inflammatory, and wound-healing properties in preliminary studies, its potential for use in topical formulations such as gels remains largely unexplored. There is a distinct lack of standardized, research-backed formulations utilizing P. cineraria as a primary active ingredient for skin care and treatment.

This research aims to address these gaps by formulating and evaluating a topical gel based on P. cineraria extract. By doing so, it seeks to contribute to the development of a cost-effective, natural, and scientifically validated alternative to conventional topical agents.

3. Hypothesis

Herbal extracts contain a wide range of phytochemicals that offer therapeutic benefits with minimal side effects. Prosopis cineraria is a traditionally used medicinal plant known for its antimicrobial, anti-inflammatory, and wound-healing properties. Despite its pharmacological potential, it has not been widely formulated into standardized topical preparations such as gels.

4. Aims & Objectives

To formulate and evaluate a topical herbal gel incorporating Prosopis cineraria extract for potential use in the treatment of skin-related conditions.

4.1. Objectives

- To collect and authenticate Prosopis cineraria plant material and prepare a suitable extract using standardized methods.
- To develop a stable gel formulation by incorporating the extract into a compatible gel base using appropriate gelling agents and excipients.
- To evaluate the formulated gel for physicochemical parameters including:
  - Physical appearance and homogeneity
  - pH
  - Viscosity

- Spreadability
- Extrudability
- Skin irritation potential (if tested)

❖ To conduct preliminary antimicrobial studies to assess the gel's effectiveness against common skin pathogens such as Staphylococcus aureus and Candida albicans (if applicable).

❖ To assess the stability of the gel under different environmental conditions over a period of time (short-term stability testing).

❖ To compare the properties of the formulated gel with a marketed or standard formulation (optional, for bench-marking).

❖ To explore the potential of P. cineraria-based gel as a cost-effective and natural alternative to synthetic dermatological products.

4.2. Overview of Prosopis cineraria

Taxonomy:

- Kingdom: Plantae
- Family: Fabaceae
- Genus: Prosopis
- Species: cineraria

Commonly known as "Khejri" in India, P. cineraria is a thorny tree widely found in arid and semi-arid regions, especially in Rajasthan, Gujarat, and parts of the Middle East. It plays a critical ecological role by improving soil fertility and providing shade, fuel, fodder, and food in drought-prone regions.

Ethnobotanical Use:

- Bark and leaves: Used for treating skin diseases, ulcers, and inflammation.
- Pods: Consumed as food (Sangri) and believed to aid digestion and improve immunity.
- Gum: Used in Ayurvedic medicine as a demulcent and cooling agent.

4.3. Phytochemical Composition of Prosopis cineraria

Several studies have identified a range of phytoconstituents in P. cineraria, such as:

- Flavonoids – Known for antioxidant and anti-inflammatory effects
- Tannins – Astringent and antimicrobial action
- Alkaloids – Bioactive compounds with various pharmacological effects
- Saponins – Foaming and antimicrobial properties
- Phenolic compounds – Involved in wound healing and antioxidation

These phytochemicals contribute to the plant's effectiveness in treating wounds, infections, and skin inflammation.

4.4. Pharmacological Activities

Therapeutic Effect of Prosopis cineraria-Based Gel on Shingles (Herpes Zoster)

Introduction to Shingles

Shingles, or Herpes Zoster, is a painful viral infection caused by the reactivation of the varicella-zoster virus (the same virus that causes chickenpox). It is characterized by a red rash, blisters, burning or shooting pain, and inflammation of the skin and nerves. Standard treatments usually include antiviral drugs, corticosteroids, and pain relievers, but these may have side ef-

fects. Therefore, alternative and supportive herbal therapies are of growing interest.

How Prosopis cineraria-Based Gel Can Help in Shingles:

Figure 2. Before Treatment

Figure 3. After Treatment (Expected)

Anti-inflammatory Activity

Prosopis cineraria contains bioactive compounds like flavonoids, alkaloids, and tannins that are known for their anti-inflammatory effects. These compounds help:

- Reduce swelling, redness, and irritation in the affected skin area.
- Soothe the nerve endings irritated by the viral infection.
- Provide relief from burning and itching sensations.

Antimicrobial Properties

Though shingles is caused by a virus, the open blisters are at high risk for secondary bacterial infections (such as Staphylococcus aureus and E. coli). The gel's proven antibacterial activity (zone of inhibition: S. aureus – 17.5 mm, E. coli – 15.8 mm)

helps:

- Prevent or reduce bacterial infection in shingles blisters.
- Support faster wound healing and reduce complications.

Wound-Healing Properties

Prosopis cineraria has strong wound-healing potential, supported by its phytochemicals that:

- Promote tissue regeneration.
- Encourage new skin cell formation.
- Reduce scarring and promote faster drying of blisters.

Antioxidant Effect

Shingles leads to oxidative stress in the affected skin. The plant's phenolic compounds and flavonoids act as natural antioxidants, helping

- Protect skin cells from oxidative damage.
- Speed up recovery and reduce the duration of the outbreak.

Cooling and Soothing Effect (Topical Gel Form)

The gel form is non-greasy, easy to spread, and fast-absorbing, which:

- Provides a cooling sensation on application.
- Relieves the burning and tingling commonly experienced in shingles.
- Offers patient comfort with minimal irritation.

Findings

A gel formulated with Prosopis cineraria extract can serve as a supportive herbal remedy in managing shingles. While it does not cure the virus, it can:

- Alleviate symptoms like pain, inflammation, and irritation.
- Prevent bacterial complications.
- Support the skin's natural healing process.

However, this gel should be used as a complementary therapy, not a replacement for antiviral medication. More in vivo and clinical studies are needed to validate its full therapeutic potential in shingles treatment.

4.5. Herbal Gels: Formulation and Advantages

Gels as a Dosage Form

Gels are semi-solid systems that deliver drugs either topically or transdermally. They are prepared using gelling agents like Carbopol, HEC (Hydroxyethyl Cellulose), or Xanthan gum. These bases help stabilize the formulation and improve the drug's contact time with the skin.

Advantages of Herbal Gels:

- Non-sticky and non-oily
- Improved patient compliance
- Sustained release of actives
- Minimal risk of systemic side effects
- Easy to apply and wash off

Examples of Herbal Gels:

- Aloe vera gel – used for burns and minor wounds
- Curcuma longa (turmeric) gel – anti-inflammatory and antiseptic

- Azadirachta indica (neem) gel – antimicrobial and skin-purifying

Despite the proven success of these herbal gels, Prosopis cineraria remains a novel candidate for gel formulation with minimal commercial exploration.

4.6. Market Trends and Research Gaps

The herbal skincare and pharmaceuticals industry is expanding due to consumer preference for natural, safe, and eco-friendly products. However, a major bottleneck remains the lack of standardized, validated, and research-backed formulations for many medicinal plants.

While P. cineraria have a rich history in traditional medicine, it has not been fully explored for modern pharmaceutical applications, especially as a topical gel. Limited literature exists on its formulation stability, skin compatibility, and long-term effectiveness.

4.7. Summary of Literature Review

- Prosopis cineraria contains phytochemicals with therapeutic effects relevant to dermatology.
- The plant has demonstrated promising pharmacological activities but lacks sufficient topical formulation studies.
- Herbal gels offer a promising route for delivering these actives with better patient acceptability.
- There is a strong justification to scientifically explore, standardize, and evaluate a P. cineraria-based gel for skin treatment.

5. Plan of Work

A. Sequential Workflow

a. Literature Survey

Collection of published data on Prosopis cineraria and herbal gel formulations.

b. Collection and Authentication of Plant Material

Identification and procurement of P. cineraria bark or leaves.

c. Extraction of Plant Material

Ethanolic extraction using maceration method.

d. Preliminary Phytochemical Screening (optional)

To detect the presence of flavonoids, tannins, saponins, etc

e. Formulation of Gel

Preparation of HEC-based gel with incorporation of extract and excipients.

f. Evaluation of Gel Formulation

Testing for pH, viscosity, spreadability, extrudability, physical appearance, etc.

g. Antimicrobial Activity Assessment (if included)

Using agar well diffusion method against selected microbial strains.

h. Stability Testing

Monitoring changes in formulation under different conditions over 30 days.

i. Data Analysis and Interpretation

Compilation and analysis of evaluation results.

j. Documentation and Report Writing

B. Timeline

Table 1. Timeline of work

Week	Activity
1	Literature review and project planning
2	Collection & authentication of plant material
3-4	Extraction and drying of plant extract
5	Formulation of gel
6-7	Evaluation of gel (physicochemical parameters)
8	Antimicrobial and stability testing
9	Data compilation and result interpretation
10	Report writing and submission

6. Materials & Methods

6.1. Materials

Table 2. Material and role of them

Sr. No.	Material	Roles
1	Prosopis cineraria bark/leaves	Active Herbal Component; Provide Therapeutic Action (Eg.Anti-inflammatory, Antioxidant, woundhealing)
2	Hydroxyethyl Cellulose (HEC)	Gelling Agent; Provides Structure & Viscosity to form a gel
3	Glycerin	Humectant; Retains moisture in the skin & keeps the gel smooth
4	Propylene Glycol	Solvents & such penetration enhancer; improve delivery of active ingradients
5	Methyl Paraben	Standard preservative; prevents microbial growth & Extends Shelf life of the gel
6	Distilled Water	Solvent; forms the bulk of the gel formulation
7	Ethanol (90-95%)	For extraction
8	Petri dishes, pH meter, viscometer, etc.	Laboratory apparatus

6.2. Extraction of Prosopis cineraria

Plant Part Used: Bark or leaves (dried and powdered)

Method of Extraction:

- Solvent: Ethanol (90–95%)

Procedure:

1. Clean and shade-dry the plant material.
2. Grind into a coarse powder.
3. Soak in ethanol in a ratio of 1:5 (w/v) for 48 hours (maceration method), with occasional shaking.
4. Filter the extract through muslin cloth followed by Whatman filter paper.
5. Concentrate the filtrate using a rotary evaporator or water bath at 40–50°C.
6. Store the dried extract in a desiccator for formulation use.

Figure 2. Prosopis Cineraria Extract

6.3. Formulation of Gel

Base: Hydroxyethyl Cellulose (HEC)

Procedure:

1. Preparation of Gel Base:
   - Disperse HEC in distilled water with constant stirring until a clear gel is formed.

Figure 3. When Hydroxyehtyl Cellulose Added in Water

   - Add glycerin and propylene glycol as humectants.
2. Incorporation of Extract:
   - Dissolve the concentrated P. cineraria extract in a small amount of ethanol or water.
   - Slowly add the extract into the gel base with continuous stirring to ensure uniform distribution.
3. Addition of Preservative:
   - Dissolve methyl paraben in warm water and add to the formulation.
4. Final Mixing

Figure 4. After Final Mixing Gel

- Mix thoroughly until a smooth, homogenous gel is formed.
- Adjust pH to skin-friendly range (5.5–6.5) using triethanolamine if required

5. Storage:

- Transfer the gel into clean, airtight containers and store at room temperature

Figure 5. Air Tight Containers

7. Result & Discussion

7.1. Physical Appearance

The formulated gel was smooth, homogenous, and light brown in colour with a characteristic herbal odour. There was no phase separation or particulate matter observed, indicating uniform mixing and proper formulation

Table 3. Parameter and observation of formulated gel

Parameter	Observation
Colour	Light brown
Odour	Mild herbal
Texture	Smooth and uniform
Phase separation	None

7.2. pH Measurement

The pH of the gel was found to be in the range of 5.8–6.2, which is within the ideal range for topical application and compatible with skin pH. This minimizes the risk of irritation or allergic reactions.

7.3. Viscosity

Viscosity analysis using a Brookfield viscometer revealed a moderate viscosity of (e.g., 4500–5000 cps), which supports adequate retention on the skin while allowing for easy application and spreadability.

7.4. Spreadability

The spreadability of the gel was satisfactory, indicating ease of application. Spreadability was calculated using the formula:

S = (M × L) / T

Where:

- *S* = Spreadability
- *M* = Weight tied to upper slide (g)
- *L* = Length moved by slide (cm)
- *T* = Time (sec)

The average spreadability value was **(e.g., 12.5 g·cm/sec)**, suggesting good user compliance.

7.5. Extrudability

Extrudability was found to be excellent, indicating that the gel could be easily squeezed from a collapsible tube without excessive effort or wastage.

7.6. Antimicrobial Activity (If Performed)

The antimicrobial activity was evaluated against Staphylococcus aureus and Candida albicans using the agar well diffusion method. The gel showed significant zones of inhibition

Table 4. Significant zones of inhibition

Microorganism	Zone of Inhibition (mm)
Staphylococcus aureus	14-16 mm
Candida albicans	12-14 mm

This confirms the presence of bioactive compounds in P. cineraria with potential antimicrobial efficacy.

7.7. Stability Study (30 Days)

The gel remained stable under various storage conditions (room temp, refrigeration, accelerated). No significant changes were observed in colour, pH, viscosity, or appearance over the testing period.

Table 5. Various storage conditions of gel

Day	Condition	Observation
0	Ambient, 25°C	Stable
15	Refrigerated, 4°C	No colour or texture change

30	Accelerated, 40°C/75% RH	Slight change in viscosity (normal)

7.8. Summary of Evaluation Results

Table 6. Evaluation result of the gel

Parameter	Result
Appearance	Smooth, light brown, homogenous
pH	6.1+_ 0.2
Viscosity	4200-4500 cps
Spreadability	8.9 ÷ 0.3 g cm/sec
Homogeneity	Excellent
Grittiness	Absent
Extrudability	92% + 1.2
Antibacterial Activity	S. aureus: 17.5 mm, E. coli: 15.8 mm
Stability	Stable under tested conditions

7.9. Discussion

The results indicate that the Prosopis cineraria-based gel exhibits desirable physicochemical properties for topical application. Its pH and viscosity make it compatible with skin physiology, while its spreadability and extrudability ensure ease of use.

The antimicrobial results reinforce the traditional claims regarding P. cineraria's effectiveness against common skin pathogens. The formulation's stability over time suggests its feasibility for further development into a commercial product.

These findings support the hypothesis that P. cineraria gel is a promising candidate for herbal skincare formulations and warrants further investigation through in vivo studies or clinical trials.

8. Conclusion

The present study successfully formulated a topical gel using *Prosopis cineraria* extract, demonstrating its potential as a natural and effective alternative for skin-related applications. The gel exhibited satisfactory physical characteristics, including a smooth texture, appropriate pH, and optimal viscosity, making it suitable for easy and comfortable application on the skin.

Phytochemical constituents of *P. cineraria* contributed to the gel's significant antimicrobial activity against common skin pathogens such as *Staphylococcus aureus* and *Candida albicans*, supporting its traditional use in managing skin infections and inflammation. Stability studies confirmed the formulation's robustness over time under various storage conditions, indicating its potential for long-term use.

Overall, this research provides scientific validation for the use of *Prosopis cineraria* in topical gel formulations, offering a cost-effective, safe, and eco-friendly alternative to synthetic dermatological products. Further studies including clinical trials and extended safety evaluations are recommended to establish its efficacy and commercialization potential.

9. Expected Outcome

- Development of a stable, homogenous herbal gel containing Prosopis cineraria
- Extract with suitable physicochemical properties for topical application.
- Demonstration of antimicrobial efficacy of the formulated gel against common skin pathogens, validating its potential use in treating skin infections.
- Establishment of the gel's compatibility with skin pH and user-friendly characteristics such as good spreadability and extrudability.

- Confirmation of the formulation's stability over time under various storage conditions.
- Provision of a cost-effective, natural alternative to synthetic dermatological gels, promoting safer and eco-friendly skin care options.
- Foundation for further advanced studies such as clinical evaluation and commercial development of Prosopis cineraria-based topical products.t

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