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Original Research Article

Formulation and Evaluation of *Boswellia serrata* Gel for Topical Pain Management

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Abstract: The present study focuses on the formulation and evaluation of a topical herbal gel containing *Boswellia serrata* for effective pain management. Pain associated with conditions such as arthritis, muscle strain, and inflammation is commonly treated with synthetic drugs, which often produce adverse effects on long-term use. Hence, this study aims to develop a safer, natural, and cost-effective alternative using herbal ingredients. *Boswellia serrata*, known for its potent anti-inflammatory and analgesic properties due to boswellic acids, was selected as the primary active ingredient. The gel formulation also incorporated other herbal components such as curcumin, neem extract, menthol, and lavender oil to enhance therapeutic efficacy. The gel was prepared using Carbopol 940 as a gelling agent along with suitable excipients to ensure stability and patient acceptability. The formulated gel was evaluated for various physicochemical parameters including appearance, pH, viscosity, spreadability, homogeneity, washability, and skin irritation. The results indicated that the gel possessed a smooth texture, appropriate pH (5.2–6.1), good spreadability, and optimal viscosity, making it suitable for topical application. No signs of irritation were observed, confirming its safety. Additionally, the formulation demonstrated sustained drug release and significant anti-inflammatory activity, supporting its effectiveness in managing pain and inflammation. The study concludes that the developed *Boswellia serrata* gel is a promising herbal alternative to conventional analgesics, offering localized action with minimal side effects. Further clinical studies are recommended to validate its therapeutic potential and commercial applicability.

Keywords: Boswellia serrate, Herbal gel, Topical drug delivery, Pain management, Anti-inflammatory activity, Boswellic acids, Arthritis, Polyherbal formulation, Skin compatibility, Spreadability and viscosity ,Natural analgesics, Phytoconstituents.

Introduction:

Pain management is a vital component of modern healthcare, especially for individuals suffering from musculoskeletal disorders such as arthritis, sprains, strains, and muscle fatigue. Pain can be broadly classified into physiological pain, which arises from normal nociceptive responses to harmful stimuli, and pathophysiological pain, which results from tissue injury and inflammation. The latter is often chronic in nature and significantly affects the quality of life of patients. Conventional treatment approaches mainly include non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, and synthetic analgesics. Although these drugs are effective in reducing pain and inflammation, their prolonged use is associated with several adverse effects such as gastrointestinal irritation, renal complications, and cardiovascular risks (1).

In recent years, there has been a growing interest in the use of herbal medicines as safer and more effective alternatives for pain management. Herbal formulations are derived from natural sources and are known for their minimal side effects, better patient compliance, and cost-effectiveness. Among various dosage forms, topical drug delivery systems such as gels have gained considerable importance due to their ability to provide localized therapeutic action, bypass

first-pass metabolism, and reduce systemic toxicity. Topical gels are easy to apply, non-greasy, and enhance drug penetration through the skin, making them highly suitable for the treatment of joint and muscle pain (2).

Boswellia serrata, commonly known as Indian frankincense or Salai guggul, is a well-known medicinal plant widely used in traditional systems of medicine such as Ayurveda. The oleo-gum-resin obtained from its bark contains active constituents known as boswellic acids, which exhibit potent anti-inflammatory and analgesic properties. These compounds act by inhibiting key inflammatory pathways, particularly the 5-lipoxygenase (5-LOX) enzyme, thereby reducing the synthesis of leukotrienes responsible for inflammation. Due to this mechanism, *Boswellia serrata* has shown significant therapeutic potential in the management of inflammatory conditions such as osteoarthritis and rheumatoid arthritis (3).

Arthritis is a chronic inflammatory disorder affecting millions of people worldwide and is one of the leading causes of disability. It is characterized by joint pain, stiffness, swelling, and reduced mobility. The increasing prevalence of arthritis, particularly among the elderly population, along with contributing factors such as sedentary lifestyle, obesity, and aging, has created a demand for safer long-term treatment options. Herbal therapies, especially those formulated as topical gels, offer a promising solution by delivering active constituents directly to the affected site, thereby enhancing efficacy and minimizing systemic exposure (4).

In addition to *Boswellia serrata*, other herbal ingredients such as turmeric (*Curcuma longa*), neem, and essential oils like lavender are often incorporated into polyherbal formulations to enhance therapeutic effectiveness. These ingredients possess anti-inflammatory, antioxidant, and antimicrobial properties, which synergistically contribute to pain relief and tissue healing. The use of suitable excipients such as Carbopol, glycerin, and propylene glycol further improves the stability, consistency, and spreadability of the gel formulation (5).

Therefore, the development of a topical herbal gel containing *Boswellia serrata* represents a promising approach for effective and safe pain management. Such formulations not only provide localized relief but also reduce the risk of adverse effects associated with conventional therapies. The present study focuses on the formulation and evaluation of a *Boswellia serrata*-based herbal gel to assess its physicochemical properties, stability, and therapeutic potential in the management of pain and inflammation.

Material And Methods

Table 1: Material

Sr.No	Name of Material	Type
1	Curcumin extract (Turmaric)	Active ingredient
2	Neem Extract	Active ingredient
3	Lavender oil	Active ingredient
4	Glycerine	Excipients
5	Menthol	Active ingredient
6	Carbopol	Excipients
7	Purified water	Vehicle
8	Sodium benzoate	Excipient

Method and Evaluation

A. Methodology

Step 1: Selection of Herbal Ingredients

- Menthol: Known for its counterirritant and cooling effect.
- Curcumin Extract: A powerful antioxidant and anti-inflammatory compound found in turmeric
- Boswellia serrate Extract: Acts as a natural anti-inflammatory agent

- Helps in pain management (arthritis, muscle pain, joint pain)
- Neem Extract: Has anti-inflammatory, antibacterial, and wound-healing activities.
- Lavender Oil: Provides a calming aroma and mild analgesic effect.
- Excipient selection was made to ensure optimal gel texture, stability, and patient acceptability:
- Carbopol: Gelling agent.
- Glycerin: Humectant and skin softener.
- Sodium Benzoate Preservative
- Purified Water: Vehicle

Step 2: Preparation of Herbal Extracts

- Drying and Grinding. Plant materials were cleaned, shade-dried, and powdered. Extraction Method. Cold maceration or Soxhlet extraction using ethanol/water as solvents.
- Filtration. The extracts were filtered using Whatman filter paper
- Concentration: Solvent was evaporated using a rotary evaporator or water bath.
- Storage: Extracts were stored in airtight containers in a cool, dry place

Fig. No. 1 *Drug Extract Filtrate*

- **Extraction Process**

Step 3: Formulation of herbal gel

Step 1: Gel Base Preparation

Dispersion of Carbopol: Carbopol 940 was slowly added to purified water with gentle stirring dallowed to hydrate for 2 hours, 2

Step 2: Drug Phase Preparation

Addition of Glycerin: Glycerin was added to the hydrated Carbopol to improve consistency hydration.

Dissolve Step 3: Incorporation

Incorporation of Extracts Boswellia extract in propylene glycol. Add methyl paraben and propyl paraben.

: Pre-weighed quantities of herbal extracts Add drug phase slowly into hydrated Carbopol gel with continuous stirring.

Step 4: Neutralization

Add triethanolamine drop wise until gel forms.

Addition of Preservative: Sodium benzoate was dissolved in a small amount of water and added to the formulation.Final Mixing: The mixture was stirred until a uniform gel consistency was achieved.

Adjust pH to 6–7.

Step 5: Final Adjustment Make up volume with distilled water.

Stir gently to remove entrapped air.

Formulation Table:

Sr. NO	Ingredient	F1	F2	F3	Role in formulation
1	Boswellia Serrata Extract	1.0 ml	1.09ml	1.15ml	Active anti-inflammatory agent
2	Curcumin Extract	1.0 ml	1.09	1.15ml	anti-inflammatory agent
3	Carbapol 940	0.2 g	0.5 g	1.0 g	Gelling agent
4	Proplyne glycol	2 ml	2 ml	2 ml	Humactant and penetration enhancer
5	Ethanol	2 ml	2 ml	2 ml	Solvent
6	Methyl paraben	0.04 g	0.04 g	0.04 g	Preservative
7	Trietholamine	q.s.	q.s	q.s	Nutralizer
8	Distilled water	q.s	q.s	q.s	Vehicle
9	Glycerin	2.0 ml	2.0 ml	2.0 ml	Humactant Moisturizer

Evaluation

1.Appearance Test

- The appearance of the herbal analgesic gel is one of the primary evaluation parameters as it reflects the physical quality and acceptability of the formulation. This test involves a visual spection of the gel to assess
- Color uniform and appropriate based on the ingredients used. Herbal gels often exhibit greenish, yellowish, or light brown hues depending on the plant extracts.
- Clarity/Opacity formulation, the gel can be transparent, translucent, or opaque, but it should be consistent throughout the sample
- Homogeneity: The gel is appear smooth, without any visible lumps, phase separation, or air bubbles.
- Texture: When observed or touched, it feel smooth and non-gritty

2.Odour Test

- The odour test is a sensory evaluation performed to assess the smell or fragrance of the gel.This characteristic plays a vital role in patient compliance, especially for topical products like herbal analgesic gels that are used multiple times a day

❖ **Purpose**

To ensure the gel has a pleasant or acceptable smell.

To check for any unpleasant, strong, or irritating odours that might discourage use.

To verify the consistency of fragrance in all batches.

Procedure:

1. A small amount of gel is taken on a elean spatula or directly from the container

2. The odour is gently inhaled by evaluators (usually 2-3 individuals).

3. Evaluators record whether the smell is Pleasant/Acceptable Strong Irritating Medicinal/Herbal/Aromatic

3. pH Determination:

The pH of a topical gel is a critical parameter that ensures the product is compatible with the skin and does not cause irritation. Human skin typically has a pH around 5.5, so the pH of the herbal analgesic gel should ideally be in the range of 5.0 to 6.5.

Procedure

A small amount of gel (about 1 gram) is dispersed in 10 mL of distilled water.

The mixture is stirred thoroughly to form a uniform dispersion.

The pH is measured using a digital pH meter that has been calibrated with standard buffer solutions (usually pH 4 and pH 7). This test ensures that the gel is compatible with skin pH and minimizes irritation. A slightly acidic pH (4.5–6.0) is ideal for maintaining the natural skin barrier.

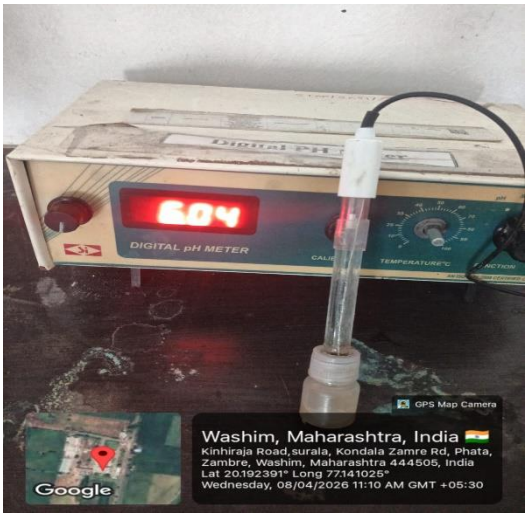


Fig. No. 2 *pH test*

1.pH Test

Importance:

Skin compatibility: A gel with appropriate pH prevents skin irritation or allergic reactions.

Stability: pH can influence the chemical stability of herbal extracts and other ingredients.

Preservative effectiveness: Many preservatives (like sodium benzoate) are only effective within a certain pH range

4. Spreadbility Test

Spreadability is an important evaluation test that determines how easily the gel can be spread on the skin. It reflects the application comfort and uniformity of dosing, both of which affect user satisfaction and therapeutic effectiveness.

- **Purpose**

To ensure the gel can be smoothly and evenly applied over the affected area without requiring excessive effort.

Better spreadability promotes better absorption and coverage.

Fig.No. 3 Spredablity test

Spreadability Test

Procedure (Slip and Drag Method)

1. A fixed amount of gel (usually 1 gram) is placed between two glass slides.

2. A weight (commonly 500 g) is placed on the top slide for 5 minutes to compress the gel mto a thin layer.

1. The weight is then removed and the distance the top slide moves under its own weight or with a light force is measured.

M= mass tied to upper slide

L= length of glass slide

T= time in seconds

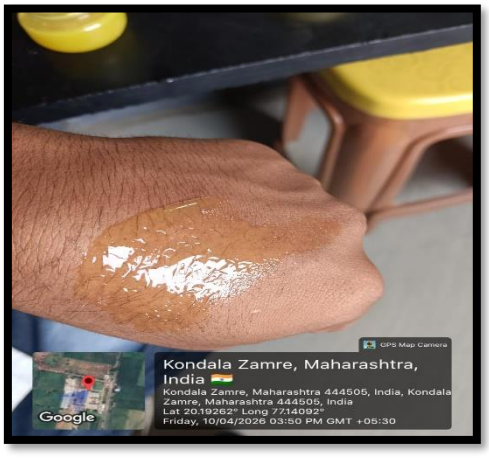
5. Washability Test

Washability refers to how easily the gel can be removed from the skin using water. This is mportant for user convenience and hygiene, especially for products used multiple times a day or over large skin areas

Purpose

To ensure that the gel does not leave a sticky or greasy residue after use

To confirm that it can be easily cleaned from the skin without requiring soap or vigorous scrubbing.



Before wash

After wash

1.Procedure

1. A small quantity of the gel is applied to a marked area on the skin.

2. It is allowed to sit for a few minutes (usually 5-10 minutes).

3. The area is then rinsed with plain water.

6.Libermann – Burchard Test (For Terpenoid)

The Liebermann–Burchard Test is commonly

Purpose:

to detect triterpenoids, which includes boswellic acids present in Boswellia serrata.

Fig.No. 4. *Libermann – Burchard Test*

- **Procedure**

Take a small quantity of Boswellia serrata extract (in chloroform or suitable solvent).

Add 2–3 mL of acetic anhydride .Mix well.

Carefully add 1–2 drops of concentrated sulfuric acid (H_2SO_4) along the side of the test tube.

Observe the color change.

Observation

Formation of: Blue-green color

Result and Discussion

Result

The formulated Boswellia serrata topical gel was evaluated for its physicochemical properties and topical performance. The results obtained are summarized below:

1. Physical Evaluation

Appearance: Smooth, homogeneous gel with no lumps

Color: Pale yellow to light brown

Odour: Characteristic aromatic (due to resin extract)

Texture: Non-greasy and smooth

2. pH Determination

Observed pH: 5.2 – 6.1

This pH range is suitable for skin application and does not cause irritation.

3. Spreadability

The gel showed good spreadability, indicating easy application over the skin surface.

Spreadability value: ~ 6–8 g·cm/sec (approx.)

4. Viscosity

The gel exhibited optimum viscosity, ensuring proper retention at the application site without runoff.

5. Washability

The formulation was easily washable with water, indicating user convenience.

6. Homogeneity

No aggregates or phase separation observed → uniform distribution of drug

7. Skin Irritation Test

No redness, itching, or irritation observed → safe for topical use

8. Drug Release (if included in your project)

The gel showed sustained release of Boswellia extract over time.Indicates prolonged anti-inflammatory action.

9. Anti-inflammatory Activity (if evaluated) Significant reduction in inflammation (e.g., erythema or edema model) Comparable to standard topical NSAID (if used)

Discussion

The present study successfully formulated a Boswellia serrata gel for topical pain management, demonstrating acceptable pharmaceutical properties and therapeutic potential.Boswellia serrata contains boswellic acids, especially acetyl-11-keto-β-boswellic acid (AKBA), which are known to inhibit the 5-lipoxygenase (5-LOX) enzyme, thereby reducing leukotriene synthesis and inflammation . This mechanism explains the observed anti-inflammatory activity of the formulated gel.

PMC The pH of the gel (5.2–5.8) was found to be within the normal skin pH range, indicating compatibility and minimizing irritation risk. Good spreadability and viscosity suggest that the gel can be easily applied and retained on the skin for sufficient time, enhancing drug absorption. The absence of skin irritation confirms that the formulation is safe for topical application, which is a major advantage over conventional NSAIDs that often cause adverse effects.

The sustained drug release observed from the gel indicates that the formulation can provide prolonged therapeutic action, reducing the need for frequent application. This is beneficial in chronic pain conditions such as arthritis Previous studies have also reported that Boswellia-based topical formulations exhibit anti-inflammatory effects and improve conditions like arthritis and localized pain. Additionally, Boswellia has been traditionally used in Ayurveda for treating pain and inflammatory disorders .The gel formulation enhances permeation of active constituents through the skin, leading to faster onset of action compared to oral formulations. Moreover, topical delivery avoids first-pass metabolism and systemic side effects.

Overall, the results indicate that the developed Boswellia gel :Is stable and pharmaceutically acceptable Shows good topical properties Provides effective anti-inflammatory and analgesic action Can be considered a safe herbal alternative for pain management

SUMMARY

The present study was carried out to formulate and evaluate a topical gel containing Boswellia serrata for pain management. Boswellia serrata is a medicinal plant known for its potent anti-inflammatory and analgesic properties due to the presence of boswellic acids. The gel formulation was prepared using an appropriate gelling agent along with necessary excipients to obtain a stable and effective product. The prepared gel was evaluated for various physicochemical parameters such as appearance, pH, spreadability, viscosity, and homogeneity. The formulation showed a smooth texture, good consistency, and uniform distribution of the drug. The pH of the gel was found to be within the acceptable range for skin application, indicating good compatibility. The gel exhibited satisfactory spreadability and viscosity, ensuring ease of application and proper retention at the site. The washability test confirmed that the gel could be easily removed from the skin. The skin irritation study showed no signs of redness or irritation, confirming its safety for topical use. Overall, the formulation demonstrated good stability and acceptable pharmaceutical characteristics. The presence of boswellic acids contributed to the anti-inflammatory activity of the gel, supporting its role in pain management.

The study concluded that the formulated Boswellia serrata gel is a safe and effective topical preparation for pain management. The gel exhibited desirable physicochemical properties and good patient acceptability. The anti-inflammatory activity of Boswellia serrata makes it a suitable herbal alternative to conventional synthetic drugs. The topical delivery system enhances localized drug action and minimizes systemic side effects. The formulation showed no skin irritation, indicating its safety for regular use. The gel can be effectively used in the management of pain and inflammation associated with various conditions. Thus, Boswellia serrata gel has significant potential as a natural and effective topical therapeutic agent. Further studies, including clinical trials and long-term stability studies, are recommended to confirm its efficacy and commercial applicability.

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