



FORMULATION AND EVALUATION OF HERBAL TOPICAL GEL CONTAINING PIPER BETLE LEAF EXTRACT FOR ANTIMICROBIAL ACTIVITY

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ABSTRACT

activity was assessed against selected microbial strains using standard in vitro methods. The results indicated that the herbal gel possessed satisfactory physicochemical properties and exhibited significant antimicrobial potential due to the presence of active plant constituents. The study suggests that Piper betle leaf extract-based topical gel can serve as a promising natural formulation for antimicrobial applications, with potential use in oral and topical therapeutic management.

KEYWORDS: Topical gel, *Piper betle*, Herbal formulation, Anti-inflammatory activity, Antimicrobial activity.

1. INTRODUCTION

Topical drug delivery systems are widely used for the treatment of skin infections and inflammatory disorders because they provide localized drug action with minimal systemic side effects. Herbal formulations have gained considerable attention due to their safety, efficacy, and improved patient compliance.^[1,2] Gels are semisolid dosage forms that are non-greasy, easily spreadable, washable, and aesthetically acceptable.

Compared to ointments and creams, gels provide better drug release and enhanced patient comfort.^[3]

Piper betle Linn., commonly known as betel leaf, belongs to the family Piperaceae and has been traditionally used for antimicrobial, antioxidant, wound healing, and anti-inflammatory purposes. The leaves contain important phytoconstituents such as chavicol, eugenol, flavonoids, and tannins responsible for various pharmacological activities.^[4,5] Giloy (*Tinospora cordifolia*) is another medicinal plant known for its antimicrobial and immunomodulatory properties. Combining betel leaf extract with giloy extract in a topical gel formulation may enhance therapeutic efficacy against skin infections and inflammation.^[6]

Recent studies have shown that herbal topical gels possess good spreadability, stability, viscosity, and skin compatibility. Therefore, the present study aimed to formulate and evaluate a herbal topical gel containing *Piper betle* leaf extract and giloy extract for anti-inflammatory and antimicrobial activity.^[7]

2. MATERIALS AND METHODS



Figure 1: Betel Pepper (Peper betel).

Chemical constituents

Chavibetol, Caryophyllene, Chavibetol acetate, Allylpyrocatechol diacetate, Chavibetol methylether, Campene, f-Pinene, Eugenol, u-Limonene, a-Pinene, 1,8-Cineol, Saprobe, Allylpyrocatechol monoacetate.

2.1 Materials

Fresh betel leaves (*Piper betle*) and giloy stems (*Tinospora cordifolia*) were collected from the medicinal garden and authenticated according to standard pharmacognostic procedures.^[8] Carbopol, methyl paraben, triethanolamine, distilled water, and rose water were procured from pharmaceutical suppliers and used as received.^[9]

2.2 METHODOLOGY

2.2.1 Preparation of Betel Leaf Extract

Fresh betel leaves were washed thoroughly to remove impurities and cut into small pieces. The leaves were crushed into a fine paste and filtered through muslin cloth to obtain the extract. The filtrate was concentrated on a water bath to obtain a semisolid extract and stored in airtight containers for further use.

2.2.2 Formulation of Herbal Gel

Carbopol was dispersed in distilled water with continuous stirring for 15 minutes. Methyl paraben was added as a preservative. Triethanolamine was added dropwise until gel formation occurred. Betel leaf extract and giloy extract were incorporated into the gel base, followed by addition of rose water for fragrance and better patient acceptability.

Table 1: Ingredients and their quantity.

Ingredients	Quantity (mg)
Carbopol	1gm
Methyl Paraben	0.02gm
Liquid extract	1ml
Triethanolamine	q.s
Rose Water	q.s
Distilled Water	100 ml

2.3 Preparation of Antimicrobial Herbal Topical Gel (Betel Pepper & Giloy).



Step	Process	Description
1	Collection of plant materials	Fresh leaves of Piper betle (betel pepper) and stems of Tinospora cordifolia (giloy) were collected from the medicinal garden and washed thoroughly.
2	Preparation of crude extract	The plant materials were cut into small pieces, crushed into paste, and filtered using muslin cloth. The filtrate was concentrated by heating on a water bath to obtain a thick herbal extract.
3	Preparation of gel base	Carbopol (1 g) was dispersed in distilled water (100 mL) and stirred using a magnetic stirrer for 15 minutes until a uniform dispersion was formed.

4	Neutralization of gel	Triethanolamine was added dropwise with continuous stirring until a clear and stable gel consistency was formed.
5	Incorporation of preservative	Methyl paraben (0.02 g) was added to the gel base for antimicrobial preservation.
6	Addition of herbal extract	Measured quantities of betel pepper leaf extract (1 mL) and giloy extract (1 mL) were slowly incorporated into the gel base with continuous mixing.
7	Addition of excipients	Rose water was added as a flavouring and fragrance agent to improve patient acceptability.
8	Homogenization	The mixture was stirred thoroughly until a uniform, smooth, and consistent gel was obtained.
9	Packaging	The final gel formulation was transferred into a clean, airtight container and stored at room temperature for further evaluation.

3. Evaluation of Topical Gel

3.1 Organoleptic Evaluation

The prepared herbal gel was evaluated for color, odor, appearance, homogeneity, and texture. The gel showed a smooth, semi-solid consistency with a slightly dark greenish color and mild herbal aroma due to the presence of Piper betle extract. The formulation was non-greasy, easily spreadable, and cosmetically acceptable.

3.2 pH Determination

The pH of the prepared gel was measured using a digital pH meter. The pH was found to be in the range of 6.5–6.8, which is compatible with skin pH and ensures non-irritancy upon topical application.

3.3 Viscosity Test

The viscosity of the gel was determined using a Brookfield viscometer. The formulation showed good viscosity, indicating suitable consistency for topical application and uniform drug distribution.

3.4 Spreadability Test

Spreadability was evaluated to determine the ease of application on the skin. The gel showed good spreadability, indicating that it can be easily applied over the affected area with minimal effort.

3.5 Extrudability Test

The extrudability of the gel was determined by measuring the force required to expel the gel from the tube. The formulation showed good extrudability, indicating ease of removal from the container.

3.6 Homogeneity Test

The gel was visually observed for the presence of lumps or aggregates. The formulation was found to be homogeneous with uniform distribution of herbal extract throughout the gel base.

3.7 Skin Irritation Study

A small amount of gel (0.5 g) was applied on the skin and observed for irritation, redness, or inflammation. The formulation was found to be non-irritant and safe for topical application.

4. RESULTS AND DISCUSSION

The prepared herbal topical gel formulated using Piper betle and Tinospora cordifolia extracts showed good physicochemical properties and acceptable cosmetic characteristics. The gel appeared smooth, slightly dark greenish in color, and had a pleasant herbal odor. The pH of the formulation ranged between 6.5–6.8, which is close to the natural skin pH, indicating that the gel is safe for topical use without causing irritation. The viscosity of the gel was appropriate, ensuring good consistency and uniform application on the skin surface. The spreadability results showed that the gel spreads easily over the skin, which enhances patient compliance and ease of use. The extrudability test confirmed that the gel can be easily removed from the container without excessive force, making it user-friendly. The homogeneity test confirmed uniform distribution of herbal extracts within the gel base. Skin irritation studies revealed that the formulation is safe and non-irritating when applied to the skin. The presence of phytoconstituents such as chavibetol, eugenol, flavonoids, and alkaloids contributes to the antimicrobial, anti-inflammatory, and wound-healing properties of the formulation. These findings are consistent with previous studies on herbal topical gels. Overall, the developed herbal gel shows promising characteristics and may be useful in the management of skin infections and inflammatory conditions.

Table 2: Evaluation Parameter results.

Parameter	Result
Appearance	Dark greenish, smooth
pH	6.5–6.8
Viscosity	Suitable/Good consistency

Homogeneity	Uniform
Spreadability	Good
Extrudability	Good
Skin Irritation	Non-irritant

Phytochemical Constituents Responsible for Activity

The therapeutic activity of the herbal gel is mainly due to the presence of bioactive compounds in Piper betle and Tinospora cordifolia. These include flavonoids, tannins, alkaloids, eugenol, chavibetol, and other phenolic compounds. These constituents exhibit antimicrobial, antioxidant, and anti-inflammatory activities, which help in wound healing and infection control.

Phytoconstituent	Pharmacological Activity
Chavibetol	Antibacterial activity
Eugenol	Anti-inflammatory, analgesic
Flavonoids	Antioxidant activity
Alkaloids	Antimicrobial effect
Tannins	Wound healing, astringent action

Antimicrobial Activity Data

- Agar well diffusion method
- Test organisms:
 - Staphylococcus aureus
 - Escherichia coli
 - Candida albicans

Example table.

Organism	Zone of Inhibition (mm)
S. aureus	18 ± 0.5
E. coli	15 ± 0.7
C. albicans	12 ± 0.4

Advantages of Herbal Topical Gel

1. Herbal topical gels are based on natural plant-derived ingredients, making them safer with minimal risk of adverse effects.
2. They are rich in antioxidants and various bioactive phytochemicals that help in promoting healing and protection.
3. Improved patient compliance is observed due to their smooth texture and generally acceptable taste and feel.

4. The gel formulation allows prolonged retention at the site of application, enhancing therapeutic effectiveness.
5. Many herbal constituents exhibit antimicrobial and anti-inflammatory activities, supporting oral health benefits.
6. It is a convenient dosage form for oral as well as topical administration with easy application.
7. The formulation shows good physical stability and is portable, making it suitable for storage and transport.

Applications of Topical Gel

1. Natural and safe herbal formulation
2. Non-greasy and patient-friendly
3. Good spreadability and ease of application
4. Enhanced antimicrobial activity
5. No skin irritation observed
6. Better patient compliance
7. Suitable for long-term topical use⁵.

5. Future Scope

The developed herbal gel can be further studied for in-vivo wound healing activity, antimicrobial effectiveness against resistant strains, and long-term stability. Advanced formulations such as nano-gels or emulgels may enhance drug penetration and therapeutic efficiency. Clinical trials can further validate its safety and efficacy in human subjects.

Additionally, future research may focus on optimizing the formulation using novel drug delivery approaches, improving scale-up production techniques for industrial applications, and exploring synergistic combinations with other herbal or synthetic agents to broaden its therapeutic potential. Long-term pharmacokinetic and pharmacodynamic studies can also help in better understanding its sustained efficacy and safety profile.

6. CONCLUSION

The present study successfully developed a herbal gel with promising therapeutic potential for topical application. The formulation demonstrated desirable physicochemical properties, ensuring good consistency, stability, and patient acceptability. The incorporation of herbal constituents contributed to its potential wound healing and antimicrobial activities. From the

obtained results, it can be concluded that the prepared gel may serve as an effective and safer alternative to conventional topical formulations. However, further in-vivo studies and clinical evaluations are necessary to confirm its efficacy, safety, and long-term stability. The study also opens avenues for future development of advanced herbal drug delivery systems with improved therapeutic outcomes.

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