



FORMULATION AND EVALUATION OF HERBAL GEL CONTAINING ETHANOLIC LEAF EXTRACT OF FICUS RACEMOSA LINN. FOR WOUND HEALING ACTIVITY

^{*1}Abhijit T. Jankar ²Aaradhya S. Varma, ³Dr. Tukaram K. Kedar

Shree Saraswati Institute of Pharmacy, Vidyanagari, Tondavali, Tal. Kankavali,
Dist. Sindhudurg – 416601, Maharashtra, India.

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*Corresponding Author

Abhijit T. Jankar

Shree Saraswati Institute of
Pharmacy, Vidyanagari, Tondavali,
Tal. Kankavali, Dist. Sindhudurg -
416601, Maharashtra, India.



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ABSTRACT

Herbal medicines form the basis of primary healthcare for approximately 75–80% of the world's population, particularly in developing countries, owing to their cultural acceptability, compatibility with the human body, and minimal adverse effects. In the present study, ethanolic leaf extract of *Ficus racemosa* Linn. (Family: Moraceae), commonly known as the Cluster Fig or Gular, was selected for herbal gel formulation due to its well-documented wound healing and anti-inflammatory properties. Fresh leaves were collected, air-dried, and powdered; ethanolic extracts (3% w/v and 5% w/v) were prepared by the condensation method. Phytochemical screening of the leaf extract confirmed the presence of alkaloids, saponins, flavonoids, and phenolic compounds including tannins. The herbal gel was formulated using Carbopol 934 as the gelling agent, HPMC as the thickening agent, propylene

glycol as the emollient, propyl paraben as the preservative, and triethanolamine as the pH-adjusting agent. The prepared gel was evaluated for organoleptic properties (colour, odour, consistency, greasiness, and homogeneity), pH, spreadability, viscosity, and skin irritancy. The gel exhibited a light green colour, smooth consistency, homogeneous appearance, and was non-greasy. The pH values recorded at 12 hours and 24 hours were 6.7 and 6.9, respectively, within the acceptable standard range of 6.7–7.8. Spreadability was calculated as 18.02 gm·cm/sec. Antimicrobial screening on agar plates showed a visible zone of inhibition,

indicating antimicrobial potential. Skin irritancy testing on ten healthy human volunteers produced no adverse reactions. These results collectively indicate that the herbal gel formulation of *Ficus racemosa* leaf extract is safe, stable, and suitable for topical wound healing application.

KEYWORDS: *Ficus racemosa*, herbal gel, wound healing, anti-inflammatory, Carbopol 934, ethanolic extract, phytochemical screening.

1. INTRODUCTION

Herbal medicine, also known as botanical medicine or phytomedicine, involves the use of plants or plant extracts for therapeutic purposes. It is one of the oldest forms of healthcare, with roots in ancient systems such as Ayurveda, Traditional Chinese Medicine (TCM), and Unani. The World Health Organization (WHO) defines herbal medicines as finished, labelled medicinal products that contain as active ingredients aerial or underground parts of the plant, or other plant material, or combinations thereof. Herbal formulations have achieved widespread acceptance as therapeutic agents exhibiting anti-microbial, anti-diabetic, anti-ageing, anti-arthritis, anti-depressant, anti-anxiety, anti-inflammatory, anti-HIV, and memory-enhancing activities.^[1]

Topical drug delivery systems, particularly gels, offer significant advantages over oral administration. They can circumvent gastrointestinal absorption difficulties caused by enzymatic degradation and pH variability, provide localised therapeutic effects with minimal systemic side effects, and enable slow and prolonged percutaneous drug absorption.^[5] Herbal gels, being topical formulations derived from plant-based ingredients, are increasingly employed for their soothing, healing, and anti-inflammatory properties.

The skin, the largest organ of the human body, serves as the primary site of application for topical formulations. Structurally comprising the epidermis, dermis, and hypodermis, the skin maintains a slightly acidic pH (approximately 4.5–5.5), known as the acid mantle, which is vital for microbial barrier function and supporting enzyme activity for skin barrier maintenance.^[2] Wound healing is a complex, stepwise process involving haemostasis, inflammation, proliferation, and remodelling phases. Medicinal plants rich in phytoconstituents such as flavonoids, tannins, alkaloids, and saponins are well-documented to promote wound closure, epithelialisation, and tissue regeneration.^[22]

Ficus racemosa Linn. (syn. *Ficus glomerata* Roxb.; Family: Moraceae), commonly known as the Cluster Fig or Gular, is a moderate to large-sized deciduous tree native to tropical and subtropical regions of India, Sri Lanka, Southeast Asia, and Australia. Traditionally, the bark, leaves, and latex of the plant have been used to treat wounds, ulcers, arthritis, fibrositis, and gastrointestinal disorders. Pharmacological investigations have confirmed its antibacterial, antioxidant, anti-inflammatory, wound healing, antifungal, anti-diabetic, and hepatoprotective activities.^[7,11,23] The leaf extract, rich in flavonoids, tannins, alkaloids, and phenolic compounds, represents a promising candidate for topical herbal formulation. The present study was therefore undertaken to formulate and evaluate a herbal gel containing the ethanolic leaf extract of *Ficus racemosa* for potential wound healing application.

2. MATERIALS AND METHODS

2.1 Collection and Identification of Plant Material

Fresh leaves of *Ficus racemosa* Linn. were collected from the local area surrounding Tondavali, Sindhudurg district, Maharashtra, India. The plant was identified and authenticated by a Krishi mahavidyalay Tondavali. A voucher specimen was retained at the departmental herbarium.



2.2 Preparation of Coarse Powder

The freshly collected leaves were washed thoroughly under running water and air-dried at room temperature for several days until completely dry. The dried leaves were then ground to a coarse powder using a high-capacity grinding machine. Sieving was performed using sieve nos. 22 and 44 to obtain a uniform coarse powder.



2.3 Preparation of Ethanolic Extracts

Ethanolic extracts at two concentrations (3% w/v and 5% w/v) were prepared by the condensation (reflux) method. For the 3% extract, 3 g of the coarse powder was accurately weighed and transferred to a cleaned round-bottom flask. One hundred millilitres of ethanol (95% v/v) was added, and the mixture was refluxed in a water bath maintained at 60–80°C for 2 hours. After cooling, the mixture was filtered through Whatman No. 1 filter paper and the filtrate was stored in amber-coloured bottles at room temperature. The same procedure was repeated for the 5% extract using 5 g of the powdered material.



2.4 Phytochemical Screening

Preliminary phytochemical screening of the ethanolic leaf extract was performed for the detection of alkaloids (Hager's test, Wagner's test, Dragendroff's test), carbohydrates

(Molisch's test, Fehling's test), saponins (foam test), flavonoids (alkaline reagent test), glycosides (Legal's test, Borntrager's test), and phenolic compounds and tannins (ferric chloride test, lead acetate test) following standard procedures.

Table 1: Phytochemical screening results of ethanolic leaf extract of *Ficus racemosa*.

Sr. No.	Phytoconstituent	Test(s)	Result
1	Alkaloids	Hager's, Wagner's, Dragendroff's	Positive (+)
2	Carbohydrates	Molisch's, Fehling's	Negative (-)
3	Saponins	Foam Test	Positive (+)
4	Flavonoids	Alkaline Reagent Test	Positive (+)
5	Glycosides	Legal's, Borntrager's	Negative (-)
6	Phenolic compounds & Tannins	Ferric Chloride, Lead Acetate	Positive (+)



2.5 Formulation of Herbal Gel

The herbal gel was prepared using Carbopol 934 as the gelling agent, hydroxypropyl methylcellulose (HPMC) as the thickening agent, propylene glycol as the emollient, propyl paraben as the preservative, triethanolamine as the pH-adjusting agent, and the 5% w/v ethanolic extract of *Ficus racemosa* as the active ingredient. The composition of the gel formulation is detailed in Table 2.

Table 2: Composition of herbal gel formulation of *Ficus racemosa* leaf extract.

Sr. No.	Ingredient	Quantity	Function
1	Carbopol 934	4 g	Gelling agent
2	HPMC (Hydroxypropyl methylcellulose)	1 g	Thickening agent
3	Propyl paraben	3 ml	Preservative
4	Propylene glycol	5 ml	Emollient
5	Ethanolic extract of <i>Ficus racemosa</i> (5%)	5 ml	Active ingredient (wound healing)
6	Triethanolamine	q.s.	pH adjusting agent
7	Distilled water	q.s. to 100 ml	Vehicle

2.6 Preparation Procedure

Step 1 – Preparation of gel base: Carbopol 934 (4 g) was dispersed slowly in 50 ml of purified water with constant stirring and allowed to swell overnight to prevent agglomeration.

Step 2 – Gel formulation: Sodium benzoate (0.2% w/v) was incorporated into the Carbopol base. HPMC solution was prepared separately by dissolving HPMC in propylene glycol using a tissue homogeniser. The 5 ml ethanolic leaf extract was added to the HPMC solution and homogenised thoroughly. This drug-polymer mixture was then transferred into the Carbopol base and homogenised. Triethanolamine was added in sufficient quantity to neutralise the preparation and adjust the pH to the desired range. The volume was made up to 100 ml with distilled water. The final gel was stored in a well-closed container at ambient temperature.

2.7 Evaluation Parameters

The prepared herbal gel was evaluated for the following parameters

(a) Organoleptic Properties: Colour, odour, consistency, greasiness, and homogeneity were assessed by visual inspection and tactile application.

(b) pH Determination: Two grams of the gel was dispersed in 40 ml of distilled water and pH was measured using a calibrated digital pH meter after 12 and 24 hours. The standard acceptable pH range for herbal gels is 6.7–7.8.

(c) Spreadability: An excess of gel (2–5 g) was placed between two glass slides. A weight of 1000 g was applied over the slides for 5 minutes to compress the sample to uniform thickness. The time (T) taken for the slides to separate and the length (L) traversed were recorded. Spreadability (S) was calculated using the formula: $S = M \times L / T$, where M = weight applied.

(d) Viscosity: The viscosity of the gel was measured using a Brookfield viscometer at 100 rpm and 25°C.

(e) Antimicrobial Screening: Agar plate diffusion method was employed. Plates were incubated at 37°C for 24 hours and observed for zone of inhibition.

(f) Skin Irritancy Test: Ten healthy human volunteers participated in the skin irritancy study after obtaining informed consent. Approximately 0.5 g of gel was applied to a 6 cm² area on the dorsal surface of the hand, covered with a gauze patch, and held in contact for 1 hour. The

skin was observed at 1, 3, 6, 12, 24, 48, and 72 hours for any visible reaction, erythema, or oedema.

3. RESULTS

3.1 Phytochemical Screening

Phytochemical screening of the ethanolic leaf extract of *Ficus racemosa* confirmed the presence of alkaloids, saponins, flavonoids, and phenolic compounds including tannins. Carbohydrates and glycosides were absent (Table 1). These phytoconstituents are well known to contribute to wound healing, anti-inflammatory, and antimicrobial activities.

3.2 Organoleptic Properties

The prepared herbal gel exhibited satisfactory organoleptic characteristics as summarised in Table 3.

Table 3: Organoleptic evaluation of the prepared herbal gel.

Sr. No.	Parameter	Observation
1	Colour	Light green
2	Odour	Characteristic odour of <i>Ficus racemosa</i>
3	Consistency	Smooth
4	Greasiness	Non-greasy
5	Homogeneity	Homogeneous; no visible aggregates
6	Antimicrobial activity	Zone of inhibition observed on agar plate

3.3 pH Determination

The pH values of the formulated gel, recorded at two time intervals, were within the standard acceptable range of 6.7–7.8, indicating suitability for topical application without risk of skin irritation (Table 4).

Table 4: pH values of the herbal gel formulation at different time intervals.

Sr. No.	Observation Time	pH Recorded
1	After 12 hours	6.7
2	After 24 hours	6.9

3.4 Spreadability

The spreadability of the gel was determined using the glass slide method and was calculated as 18.02 gm·cm/sec, indicating good spreadability characteristics suitable for comfortable topical application (Table 5).

Table 5: Spreadability of the herbal gel formulation.

Sr. No.	Parameter ($S = M \times L / T$)	Result (gm·cm/sec)
1	L = 5.7 cm	18.02

3.5 Skin Irritancy Test

The skin irritancy test was performed on ten healthy human volunteers. Observations recorded at 1, 3, 6, 12, 24, 48, and 72 hours post-application revealed no signs of erythema, oedema, or any adverse dermal reaction, confirming the safety of the formulation for topical use.

4. DISCUSSION

Wound healing is a stepwise physiological process encompassing haemostasis, inflammation, proliferation, and remodelling or maturation phases. The genetic response regulating cellular resistance mechanisms fundamentally governs wound repair. *Ficus racemosa* has been extensively studied for its wound healing potential, with experimental evidence demonstrating that its aqueous and ethanolic extracts promote wound closure, enhance tensile strength, and accelerate epithelialisation.^[22,23] These effects are primarily attributed to the synergistic action of phytoconstituents including flavonoids, alkaloids, saponins, and tannins, which exhibit collagen synthesis-promoting, antioxidant, anti-inflammatory, and antimicrobial effects.^[17,22]

In the present study, phytochemical screening confirmed the presence of alkaloids, saponins, flavonoids, and tannins in the ethanolic leaf extract, corroborating findings from previous studies. The gel formulation was developed using Carbopol 934 as the primary gelling agent, a commonly employed polymer in topical preparations due to its excellent gelling properties, bioadhesiveness, and biocompatibility. HPMC was incorporated as a co-polymer to enhance consistency and stability.

The pH of the prepared gel (6.7 at 12 hours; 6.9 at 24 hours) was within the acceptable range of 6.7–7.8 for topical formulations, ensuring compatibility with the skin's physiological pH and minimising the risk of irritation. The spreadability value of 18.02 gm·cm/sec indicated that the gel spreads readily over the skin surface with minimal pressure, which is an important factor governing patient compliance and therapeutic efficacy. Organoleptic evaluation confirmed the gel to be aesthetically acceptable: light green in colour, smooth in texture, homogeneous, and non-greasy. The absence of any adverse skin reaction in the

irritancy study across all observation time points establishes the safety of the formulation. Antimicrobial screening demonstrated a zone of inhibition, suggesting that the incorporated plant extract retained its antimicrobial activity within the gel matrix, consistent with the antibacterial properties of *Ficus racemosa* previously reported in the literature.^[4,7]

These findings are consistent with the work of Katkar et al. (2024),^[19] who demonstrated favourable physicochemical properties and wound healing efficacy for a similar herbal gel preparation containing *Ficus racemosa* extract. Collectively, the results support the potential of *Ficus racemosa* leaf extract-based herbal gel as an effective, safe, and patient-friendly topical wound healing formulation.

5. CONCLUSION

The herbal gel formulation containing 5% w/v ethanolic leaf extract of *Ficus racemosa* Linn. was successfully prepared and evaluated. The formulation met standard physicochemical parameters with respect to pH (6.7–6.9), spreadability (18.02 gm·cm/sec), homogeneity, and organoleptic acceptability. Phytochemical screening confirmed the presence of pharmacologically active constituents known to facilitate wound healing. The absence of skin irritation in volunteer studies and the demonstration of antimicrobial activity further validate its safety and efficacy for topical application. The formulation holds promising potential as a cost-effective, accessible, and safe herbal topical preparation for wound healing. Further preclinical and clinical evaluation is recommended to establish its therapeutic efficacy conclusively.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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