



FORMULATION AND EVALUATION OF ANTI-BACTERIAL HERBAL GEL CONTAINING TERMINALIA CATAPPA EXTRACT

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ABSTRACT

The present research work was undertaken to develop and assess a herbal antibacterial gel containing *Terminalia catappa* leaf extract for topical use. The leaf extract was obtained from dried plant material and incorporated into a gel base with appropriate excipients. The formulation was evaluated for various parameters including physical appearance, pH, viscosity, spreadability, skin compatibility, and antibacterial effectiveness. Phytochemical investigation revealed the presence of several active constituents such as alkaloids, flavonoids, tannins, phenolic compounds, steroids, and glycosides. The developed gel showed a smooth texture, acceptable pH, satisfactory spreadability, and suitable viscosity for skin application. No signs of irritation were observed during skin compatibility testing. The formulation also exhibited notable antibacterial activity against selected microorganisms. These findings indicate that *Terminalia catappa* leaf extract can be effectively formulated into a herbal gel and may serve as a potential natural topical treatment for minor skin infections and wound management.

KEYWORDS: Terminalia catappa; herbal gel; antibacterial activity; phytochemical screening; topical application; wound healing; medicinal plants.

INTRODUCTION

The skin functions as the primary protective barrier of the human body and plays an important role in safe guarding internal tissues from microbial invasion, environmental pollutants, and physical damage. Various dermatological disorders, particularly bacterial skin infections, continue to affect a large population and often require effective

therapeutic intervention. Topical drug delivery has emerged as a preferred approach for treating such conditions because it allows direct application of medication at the affected site, resulting in improved therapeutic efficacy and reduced systemic adverse effects.

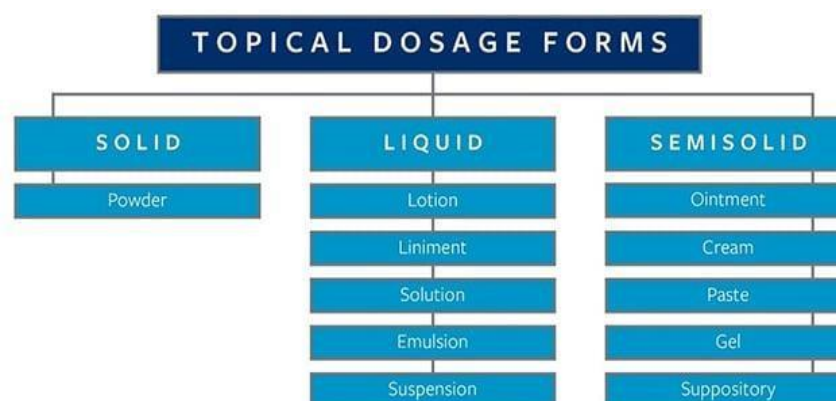


Fig. No. 1: Topical Dosage Form.

Topical pharmaceutical preparations are available in several forms, including ointments, creams, lotions, pastes, patches, and gels. Among these dosage forms, gels have gained considerable popularity due to their ease of application, aesthetic appearance, non-greasy nature, and enhanced patient acceptance. A gel is a semisolid system composed of a three-dimensional polymeric network capable of retaining substantial amounts of liquid, thereby providing suitable consistency and controlled release of active constituents. These characteristics make gels particularly useful for dermatological applications.

Antibacterial gels are topical formulations designed to reduce microbial growth on the skin and assist in the management of infections caused by pathogenic bacteria. They are commonly employed for the treatment of minor wounds, cuts, abrasions, acne, and other bacterial skin disorders. However, the prolonged use of synthetic antimicrobial agents may be associated with adverse reactions and the development of microbial resistance. Consequently, increasing attention has been directed toward natural products as alternative therapeutic agents.

Herbal medicines have been utilized for centuries in traditional healthcare systems and remain an important source of bioactive compounds. Plant-derived formulations are often preferred because of their therapeutic benefits, availability, cost-effectiveness, and comparatively lower incidence of side effects. The incorporation of medicinal plant extracts into topical dosage forms offers an attractive strategy for developing safe and effective products for skin care and infection management.

Terminalia catappa L., commonly known as Indian almond, is a tropical medicinal plant belonging to the family Combretaceae. Different parts of the plant, especially the leaves, are rich in phytoconstituents such as flavonoids, tannins, phenolic compounds, alkaloids, steroids, and glycosides. Previous investigations have reported a wide range of biological activities including antimicrobial, antioxidant, anti-inflammatory, wound-healing, hepatoprotective, antidiabetic, and cardioprotective effects. Owing to these pharmacological

properties, *Terminalia catappa* has attracted significant interest for the development of herbal therapeutic formulations.

Therefore, the present investigation was undertaken to formulate and evaluate an antibacterial herbal gel containing *Terminalia catappa* leaf extract. The developed formulation was subjected to physicochemical characterization and biological evaluation order to assess its suitability as a topical preparation for the management of bacterial skin infections.

AIM

To develop and evaluate a topical herbal gel incorporating *Terminalia catappa* leaf extract and to investigate its physicochemical characteristics, antibacterial effectiveness, stability, and suitability for skin application.

OBJECTIVES

1. To prepare a herbal gel formulation containing *Terminalia catappa* leaf extract.
2. To characterize the formulated gel by evaluating parameters such as pH, viscosity, spreadability, homogeneity, and appearance.
3. To examine the antibacterial potential of the formulation against selected bacterial strains.
4. To determine the stability of the gel under different storage conditions.
5. To assess the safety and skin compatibility of the developed formulation for topical use.
6. To formulate a non-greasy, smooth, and user-friendly gel with good application properties.

MATERIALS AND METHODS

Plant Material Collection and Identification

Mature leaves of *Terminalia catappa* were collected from the local area of Atpadi, Sangli district, Maharashtra, India. The plant specimen was identified based on its botanical characteristics before experimental use.

The collected plant material was washed thoroughly with water to eliminate adhering dust and foreign particles. After cleaning, the leaves were subjected to drying and utilized for extraction studies.



Fig. No. 2: Photograph Showing *Terminalia catappa*.

Chemicals and Reagent

The formulation ingredients included Terminalia catappa leaf extract, Carbopol 940, polyethylene glycol (PEG), glycerin, triethanolamine, methyl paraben, propyl paraben, rose water, ethanol, and distilled water. All chemicals and reagents employed in the study were of analytical grade and were used without further purification.

Instruments Used

Experimental work and evaluation studies were carried out using standard laboratory equipment such as a digital weighing balance, digital pH meter, Brookfield viscometer, incubator, autoclave, and heating mantle.

Extraction of Plant Material

The collected leaves were dried under shade for several days until complete removal of moisture was achieved. The dried leaves were then ground into coarse powder and stored in airtight containers. Extraction was performed by the maceration technique using ethanol as the extraction solvent. The powdered plant material was immersed in the solvent and allowed to stand for an appropriate period with intermittent stirring to facilitate the extraction of phytochemical constituents. The resulting mixture was filtered, and the filtrate was concentrated to obtain a semisolid extract, which was preserved in a refrigerator for subsequent formulation

studies.



Fig. No. 3: Extraction of Plant Material.

Preliminary Phytochemical Screening

The Terminalia catappa leaf extract was analyzed for its phytochemical composition using standard qualitative screening procedures. The analysis was carried out to identify important bioactive compounds including alkaloids, flavonoids, tannins, saponins, glycosides, phenols, and terpenoids. The presence of these constituents was determined based on observable colour reactions or precipitate formation during the tests. The findings of the phytochemical screening are summarized in Table 1.

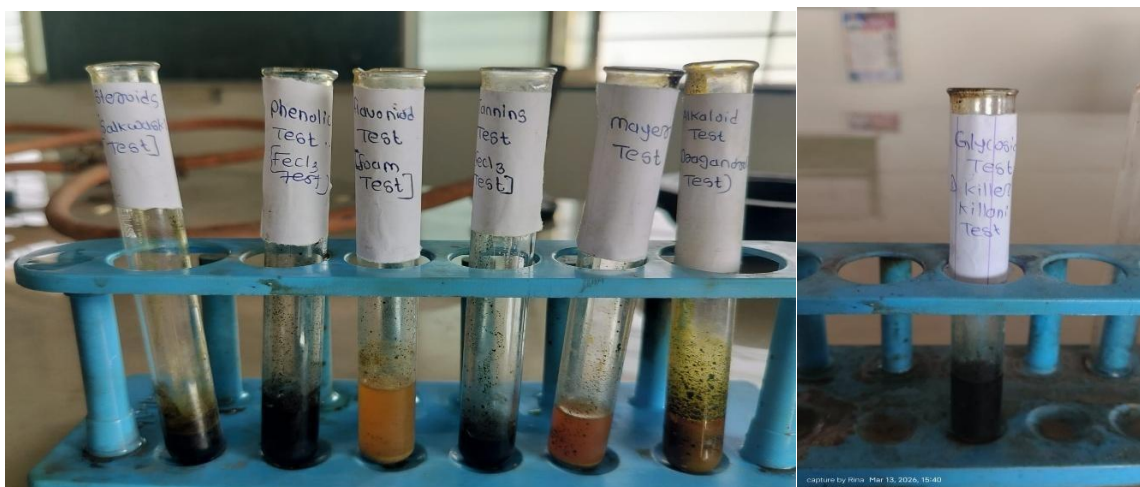


Fig. No. 4: Phytochemical Test.

Preparation of Herbal Gel

The herbal gel was formulated by first heating distilled water and transferring it into a beaker. Carbopol 934 was gradually dispersed into the warm water under constant stirring to ensure uniform mixing and to avoid clumping. The mixture was then allowed to stand for approximately 30–60 minutes to allow complete hydration and swelling of the polymer. After swelling, the hydrated dispersion was transferred to a mortar for further mixing. A preservative blend containing alcohol, methyl paraben, and propyl paraben was prepared separately. In another container, polyethylene glycol and glycerin were mixed to prepare the humectant phase.

Both the preservative solution and humectant mixture were slowly added to the hydrated polymer base with continuous trituration until a smooth and homogeneous consistency was obtained. Triethanolamine was then added dropwise to adjust the pH and convert the dispersion into gel form. The Terminalia catappa leaf extract, dissolved in a suitable solvent, was incorporated into the gel with thorough mixing. Rose water was added to improve the fragrance, and the final volume was made up with distilled water. Any entrapped air was removed, and the finished gel was transferred into suitable containers, sealed, and stored for further evaluation.



Fig. N0-5: Preparation of Herbal Gel.

Evaluation of the Formulated Gel

The prepared *Terminalia catappa* herbal gel was evaluated for its physicochemical properties and biological performance. Parameters such as appearance, colour, odour, pH, viscosity, and spreadability were assessed to determine formulation quality. Phytochemical screening was carried out to identify the major bioactive constituents present in the extract. Antibacterial activity was examined using the agar well diffusion method, while skin compatibility was evaluated by observing the treated area for any signs of irritation. The results confirmed that the gel possessed suitable physical characteristics, antibacterial potential, and good compatibility for topical application.

1. Organoleptic Evaluation

The prepared *Terminalia catappa* herbal gel was evaluated for colour, appearance, texture, odour, and homogeneity. It showed a uniform light-brown colour, smooth semisolid texture, pleasant odour, and good consistency without lumps or phase separation.

2. pH Determination

The pH of the gel was measured using a digital pH meter and was found to range from 5.49 to 6.43. This range is close to the normal pH of human skin, indicating suitability for topical application without causing irritation.

3. Viscosity Analysis

The rheological behaviour of the gel was evaluated using a Brookfield viscometer under controlled laboratory conditions. The viscosity values obtained ranged from 11,420 to 13,520 cP. The observed viscosity was adequate to maintain the formulation at the application site while allowing convenient dispensing and application. Such rheological properties are desirable for topical gel formulations.

4. Spreadability Assessment

Spreadability was determined to evaluate the ease with which the gel could be distributed over the skin surface. The formulation exhibited uniform spreading

characteristics and required minimal force for application. Efficient spreadability enhances patient convenience and promotes even distribution of active constituents across the treated area.

5. Antibacterial Assay

The antibacterial efficacy of the *Terminalia catappa* leaf extract was assessed against *Escherichia coli* using the agar well diffusion technique. A fresh bacterial suspension was prepared by inoculating *E. coli* into nutrient broth and incubating it at 37°C for 24 h. Subsequently, 0.2 mL of the bacterial culture was evenly spread over sterile nutrient agar plates with the aid of a sterile cotton swab to obtain a uniform microbial lawn. The inoculated plates were allowed to stand for approximately 1 h to facilitate proper absorption of the culture.

Sterile wells of 8 mm diameter were then punched into the agar medium using a cork borer. Each well was loaded with 0.5 mL of the prepared *T. catappa* leaf extract, while Ciprofloxacin served as the reference antibacterial standard. The plates were incubated at 37°C for an additional 24 h. Following incubation, antibacterial activity was evaluated by measuring the diameter of the clear inhibitory zones surrounding the wells. The extent of the zone of inhibition was considered an indicator of the antimicrobial potential of the plant extract against the test organism.

6. Skin Compatibility Study

The safety of the prepared gel was examined through a skin compatibility assessment. The formulation was applied to a selected area of skin and observed for 24 hours for any adverse reactions. No signs of erythema, oedema, itching, burning sensation, or other irritation responses were detected, confirming good dermal compatibility and safety for external application.

RESULTS AND DISCUSSION

The phytochemical investigation demonstrated the presence of several bioactive compounds, including flavonoids, alkaloids, tannins, saponins, glycosides, phenolic compounds, and Glycoside. These constituents are known for their antimicrobial, antioxidant, and anti-inflammatory properties and may contribute to the therapeutic potential and antibacterial activity of the formulated herbal gel.

Table 1: Preliminary Phytochemical Screening of *Terminalia catappa* Leaf Extra.

Sr. No.	Phytochemical Constituent	Result
1	Alkaloids	Present (+)
2	Tannins	Present (+)
3	Flavonoids	Present (+)
4	Steroids	Present (+)
6	Phenolic Compounds	Present (+)
7	Glycoside	Present (+)

The formulated *Terminalia catappa* herbal gel was successfully prepared and evaluated for various physicochemical and biological parameters. The formulations exhibited satisfactory appearance, texture,

pH, viscosity, spreadability, homogeneity, skin compatibility, and antibacterial activity. The results obtained indicate that the prepared gel possesses desirable characteristics for topical application.

Table No. 2: Evaluation Parameter of formulated herbal gel.

Parameter	F1	F2	F3
Colour	Light brown	Light brown	Light brown
Appearance	Smooth gel	Smooth gel	Smooth gel
Odour	Characteristic	Characteristic	Characteristic
pH	5.49	6.12	6.43
Viscosity	11420 cP	12450 cP	13520 Cp
Spreadability	19.56 cm/sec	18.18 cm/sec	20.83 cm/sec
Skin irritation	Not irritant	Not irritant	Not irritant
Homogeneity	Uniform	Uniform	Uniform
Antibacterial activity (Zone of inhibition)	12 mm	10 mm	15 mm

The developed herbal gel exhibited considerable antibacterial activity against *Escherichia coli*, producing a zone of inhibition comparable to the standard Ciprofloxacin drug. The antimicrobial action is likely associated with the presence of flavonoids, tannins, phenolic compounds, alkaloids, and other secondary metabolites present in *Terminalia catappa* leaves. These bioactive compounds are known to interfere with bacterial growth and cellular functions, thereby contributing to the observed antibacterial effect.

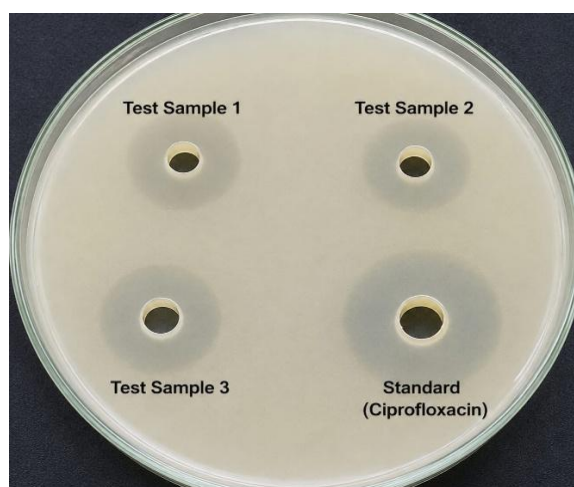


Fig No. 5: Antibacterial assay.

Table 3: Antibacterial Activity of Gel.

Test Sample	Zone of Inhibition (mm)
Leaf Extrac F1	12 mm
F2	10 mm
F3	15 mm
Standard (Ciprofloxacin)	22 mm

CONCLUSION

The present study was successfully carried out to formulate and evaluate a herbal gel containing *Terminalia catappa* leaf extract for antibacterial activity against *Escherichia coli*. The plant extract has been reported in

the literature to possess significant antibacterial, antioxidant, and anti-inflammatory properties. Different gel formulations (F1, F2, and F3) were prepared using varying concentrations of the extract and evaluated for physicochemical parameters such as appearance, pH, viscosity, spreadability, homogeneity, washability, and skin irritation.

The antibacterial activity of all formulations was assessed using the agar well diffusion method. Among the prepared formulations, formulation F3 exhibited the highest zone of inhibition against *E. coli*, indicating superior antibacterial activity. The formulations showed good physical stability, acceptable consistency, and no signs of skin irritation. Based on the evaluation results and antibacterial efficacy, formulation F3 was found to be the optimized formulation and demonstrated better performance compared to F1 and F2.

Therefore, it can be concluded that the herbal gel containing *Terminalia catappa* leaf extract is a safe, stable, and effective topical formulation with promising antibacterial potential. The developed formulation may serve as a natural alternative for the management of bacterial skin infections and warrants further clinical investigation.

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FINAL REFERENCE LIST

1. Cock, I. E. The medicinal properties and photochemistry of *Terminalia catappa* L. *Asian Pacific Journal of Tropical Medicine*, 2015; 8(10): 761–769.
2. World Health Organization. (2013). WHO traditional medicine strategy 2014–2023. World Health Organization.
3. Mali, A. D., Bathe, R. S., & Patil, M. V. An updated review on topical drug delivery system. *International Journal of Advances in Scientific Research*, 2015; 1(6): 244–254.
4. Fan, Y. M., Xu, L. Z., Gao, J., Wang, Y., Tang, X. H., Zhao, X. N., & Zhang, Z. X. Phytochemical and anti-inflammatory studies on *Terminalia catappa*. *Fitoterapia*, 2004; 75(3–4): 253–260.
5. Singh, M., Govindarajan, R., Nath, V., Rawat, A. K. S., & Mehrotra, S. Antimicrobial, wound healing and antioxidant activity of *Terminalia catappa*. *Journal of Herbal Pharmacotherapy*, 2006; 6(3–4): 45–56.
6. Khandelwal, K. R. (2008). *Practical pharmacognosy: Techniques and experiments* (19th ed.). Nirali Prakashan.
7. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2010). *Pharmacognosy* (46th ed.). Nirali Prakashan.
8. Harborne, J. B. (1998). *Phytochemical methods: A guide to modern techniques of plant analysis* (3rd ed.). Springer.
9. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2010). *Pharmacognosy* (46th ed.). Nirali Prakashan.
10. Gupta, P., & Birdi, T. J. Development and evaluation of herbal topical gel formulations: A review. *International Journal of Pharmaceutical Sciences and Research*, 2017; 8(10): 4135–4145.
11. Mali, A. D., Bathe, R. S., & Patil, M. V. An updated review on topical drug delivery system. *International Journal of Advances in Scientific Research*, 2015; 1(6): 244–254.
12. Gupta, P., & Birdi, T. J. Development and evaluation of herbal topical gel formulations: A review. *International Journal of Pharmaceutical Sciences and Research*, 2017; 8(10): 4135–4145.
13. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2010). *Pharmacognosy* (46th ed.). Nirali Prakashan.
14. Singh, M., Govindarajan, R., Nath, V., Rawat, A. K. S., & Mehrotra, S. Antimicrobial, wound healing and antioxidant activity of *Terminalia catappa*. *Journal of Herbal Pharmacotherapy*, 2006; 6(3–4): 45–56.
15. Cock, I. E. The medicinal properties and phytochemistry of *Terminalia catappa* L. *Asian Pacific Journal of Tropical Medicine*, 2015; 8(10): 761–769.
16. World Health Organization. (2013). WHO traditional medicine strategy 2014–2023. World Health Organization.
17. Cock, I. E. The medicinal properties and phytochemistry of *Terminalia catappa* L. *Asian Pacific Journal of Tropical Medicine*, 2015; 8(10): 761–769.