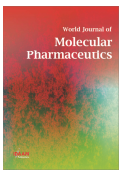

World Journal of
Molecular Pharmaceutics

IDAAM Publications

World J Mol Pharm 2023; 1(1): 34-40

RESEARCH ARTICLE

Formulation and characterization of a topical *Murraya koenigii* gel for antibacterial activity

SONALI N NALAWADE, JAMEEL AHMED S MULLA*, MUKESH VINOD KAPSE

Department of Pharmaceutics, Shree Santkrupa College of Pharmacy, Ghogaon, Karad, Dist: Satara, Maharashtra – 415111

***Author for Correspondence:** *Email:*jameelahmed5@rediffmail.com

ARTICLE DETAILS

Article history:
Received on 13 January 2023
Modified on 24 February 2023
Accepted on 27 February 2023

Keywords:
Murraya koenigii,
Curry Leaves,
Antibacterial Gel,
Topical Application,
Staphylococcus aureus,
In Vitro Drug Release,
Herbal Formulation,
Plant-based Antibacterial Agent.

ABSTRACT

Natural products derived from plants have been extensively researched for their therapeutic potential. This study focuses on the formulation and evaluation of a *Murraya koenigii* leaf extract-based gel for topical application with antibacterial properties. *Murraya koenigii*, also known as curry leaves, is known for its antioxidant, anti-inflammatory, and antimicrobial properties. The formulated gel was characterized through various physical evaluations, including colour, Odor, consistency, pH, viscosity, spreadability, and washability. The gel exhibited good viscosity (6256 cp), excellent spreadability (7.4 gm.cm/sec), and a pH of 6.4, making it suitable for topical application. Antibacterial efficacy was tested against *Staphylococcus aureus*, showing a significant zone of inhibition (19.625 cm). The in vitro drug release study revealed a rapid initial release (40% in 15 minutes), followed by a sustained release over 300 minutes (95% cumulative release). These results suggest that *Murraya koenigii* leaf extract gel has potential as a plant-based antibacterial treatment, providing both immediate and prolonged therapeutic effects for bacterial skin infections.

INTRODUCTION

Natural products derived from plants have long been recognized for their therapeutic potential, especially in treating various skin conditions. Among these, *Murraya koenigii*, commonly known as curry leaves, has been traditionally used in Indian and Southeast Asian medicine due to its wide range of pharmacological activities, including antioxidant, anti-inflammatory, and antimicrobial properties [1]. The plant is rich in alkaloids, flavonoids, and phenolic compounds, all of which contribute to its antibacterial effects [2]. Bacterial skin infections, caused by pathogens like *Staphylococcus aureus* and *Escherichia coli*, remain a significant concern, especially in light of increasing antibiotic resistance [3]. The use of plant-based antimicrobial agents presents a potential solution to this problem. Topical drug delivery systems, particularly gels, offer several advantages for localized treatment, including ease of application, good patient compliance, and the ability to maintain drug concentration at the site of infection for extended periods [4].

Gels typically consist of a liquid phase that has been reinforced with additional elements. Auta et al. noted an increasing demand for medicinal herbs in both developed and developing nations. Gels are defined as semi-rigid systems where a three-dimensional network of interlacing particles or solvated macromolecules of the dispersed phase restricts the movement of the dispersing medium [5].

The formulation of a gel incorporating *Murraya koenigii* leaf extract could provide an effective treatment for bacterial skin infections by utilizing the plant's natural antibacterial properties. This study aims to formulate and evaluate a gel containing *Murraya koenigii* leaf extract for topical application, focusing on its antibacterial efficacy, stability, and physical properties. The gel will be assessed for its ability to inhibit the growth of common skin-infecting bacteria, with the goal of developing an alternative, plant-based antibacterial treatment [6].

MATERIALS AND METHODS

Murraya Koeginii extract collected from local area of Karad, Dist. Satara, India. Carbopol obtained from Molychem, Mumbai, India. Methyl paraben obtained from Research lab fine chem industry, Mumbai, India. Triethanolamine, Propylene glycol and Glycerine was obtained from Loba Chemie, Mumbai, India.

Collection of Plant Material

The *Murraya koeginii* leaves were gathered from the neighbourhood of Karad in the Satara region of Maharashtra. The gathered leaves were properly cleaned under running water and allowed to air dry and powdered it after drying [7] (Fig. 1).

Figure 1: Dried powdered of *Murraya koeginii* leaves

Maceration of *Murraya Koenigii*

By using maceration process *Murraya koeginii* leaves were initially cleaned with deionized water to eliminate dirt, and then they were dried and processed using a mechanical grinder. After that, a container containing the powder was left at room temperature. Following that, a portion of the leaf powder was weighed, steeped in ethanol, and macerated for around 4-5 days. The extract was concentrated and used for additional formulations after maceration. After that the extract is being concentrated for few hours and then desired extract is obtained [7] (Fig. 2).

Figure 2: Maceration of *Murraya Koenigii* dried powder

Preparation of Herbal Gel

To achieve a uniform dispersion, the needed amount of carbopol-934 was gently added to weighed amounts of water while being continuously stirred. The mixture was then stored overnight for hydration. With steady mechanical stirring, the precisely weighed amounts of the medication and other additives were added to the predetermined amount of hydrated Carbopol.

The following day, to adjust the pH, the mixture made in another beaker with water, propylene glycol, extracts, methyl paraben, and triethanolamine was added to the Carbopol mixture (Table 1). The antibacterial tropical gel is currently ready for additional evaluation criteria [9] (Fig. 3).

Table 1: Formulation Table of *Murraya Koenigii* herbal gel

Sr. No	Ingredients	Quantity
1	*Murraya koenigii* extract	2gm
2	Carbopol	1gm
3	Methylparaben	0.2gm
4	Triethanolamine	q.s
5	Propyleneglycol	1mL
6	Glycerin	1mL
7	Water	15mL

Figure 3: Herbal gel of *Murraya Koenigii*

Evaluations

Physical Tests

Colour: Place a small amount of the gel on a white surface or in a clear glass container. Observe the colour of the gel under natural light to ensure uniformity and record the appearance.

Odour: Take a small amount of gel and smell it directly, ensuring to avoid any strong air currents that could interfere with the perception of the scent. Describe the odour as pleasant, medicinal or any other specific characteristic and record any unusual or undesirable Odours.

Consistency: Place a small amount of gel between your fingers or use a spatula to observe its spreadability and texture. Check for smoothness, uniformity, and ease of application. Describe the consistency of the gel whether it is smooth, lumpy, thick, or thin. Ensure the gel is free from any grittiness or phase separation [10].

Viscosity

Viscosity was determined by using spindle no. 64 of the Brookfield rotating viscometer at 100 revolutions per minute (RPM), the viscosity of herbal gels was measured [11, 12].

Spreadability

The spreadability of herbal gel was measured by taking two glass slides. One slide (the ground slide) was fixed to the wooden block, and it was covered with 1.0 g of the gel sample. Then, these two slides were sandwiched with the 1.0gm gel sample. To remove air bubbles and apply a homogeneous layer of sample gel, place 1.0 kg of weight on the top glass slide for 5 minutes. Then, scrape off any surplus gel from the sides. Use the equation below to get the spreadability [13, 14].

$$Spreadability\ (S) = \frac{Mass\ (M) \times Lengt\ (L)}{Time\ (T)} \quad (1)$$

Washability

After applying the formulation to the skin, the ease of water washing was evaluated. It can be used for a limited amount of time on the skin before being wiped off with water [15].

pH Determination

pH of Herbal gel was determined by using digital pH meter. Take a 1 gm of herbal gel which was dissolve in 10 mL of distilled water and the pH of the formulation was measured [14, 16, 17].

Antibacterial Activity

The agar-well diffusion method was employed for this objective. *Staphylococcus aureus* strains were used for the investigation. Bacterial cultures were poured into the freshly produced nutrient media and mixed correctly so that there would be a uniform dispersion of culture. The media was poured into a sterile petri dish, and the media was allowed to stand still and harden. Then, with the help of sterile cork borer wells, wells were formed in a petri dish in which prepared formulations were added i.e. 50 mg, which allowed the medicine to disseminate in the media. Then it compared with the standard drug gentamicin which was taken 10 mg after that it was incubated for 24 hours at 37°C. Both samples were compared and zone of inhibition is calculated [18-22].

In Vitro Drug Release

In vitro drug release was perform by using a Franz diffusion cell where a receptor compartment filled with a suitable dissolution medium (e.g., phosphate buffer, pH 7.4), maintained at 37°C ± 0.5°C to mimic skin conditions. A membrane, such as synthetic cellulose is placed between the donor and receptor compartments. The membrane should be soaked in the dissolution medium prior to the experiment to ensure hydration. Apply a known amount of the herbal gel on the membrane's surface in the donor compartment. Secure the membrane to prevent leakage [23-27]. Withdraw aliquots (e.g., 1 mL) of the dissolution medium from the receptor compartment at specific time intervals (e.g., 0, 15, 30, 60, 120, 180, 240 minutes), and replace with an equal volume of fresh buffer to maintain sink conditions. Analyze the drug content in the collected samples using

UV-visible spectrophotometry or HPLC at the appropriate wavelength [28-32].

RESULTS AND DISCUSSIONS

Physical Test

- ***Colour (Light yellow/green):*** The light yellow/green colour of the gel is likely due to the presence of the *Murraya koenigii* extract, which contains natural pigments. This colour is acceptable for a herbal formulation and indicates the proper incorporation of the plant extract into the gel matrix.
- ***Odour (Good):*** The gel has a pleasant odour, which is crucial for patient acceptability. Unpleasant or strong odours could discourage use, especially for topical formulations intended for regular application.
- ***Consistency (Semi-solid, soft):*** The semi-solid and soft consistency of the gel is ideal for topical application, allowing for smooth and even application on the skin. A good consistency also ensures ease of handling and uniform drug distribution.

Viscosity

The gel exhibits good viscosity i.e. 6256 cp, which is crucial for its stability and application. An optimal viscosity ensures that the gel maintains its form and is easy to apply, while also aiding in the controlled release of the active ingredients.

Spreadability

Spreadability of herbal gel obtains 7.4 gm.cm/sec which shows good spreadability that also indicates that it can be evenly applied over the skin without excessive effort. This property is important for ensuring proper coverage and effectiveness of the active ingredients.

Washability

Good washability suggests that the gel can be easily removed from the skin without leaving any residue. This is important for patient compliance, as patients prefer products that do not leave a sticky or greasy feeling after use.

pH Determination

A pH of 6.4 is within the acceptable range for topical applications, as it is close to the skin's natural pH (4.5–6.5). This ensures that the gel will not disrupt the skin barrier or cause irritation, making it suitable for sensitive skin.

Antibacterial Activity

The gel has shown good antibacterial activity, supporting its intended purpose as an antibacterial topical treatment. This result validates the therapeutic potential of *Murraya koenigii* extract in treating bacterial skin infections. Following Table 2 shows the result of zone of inhibition.

Table 2 : Results of zone of inhibition

Sr No.	Extract and standard drug	Concentration of drug	Zone of inhibition
1	*Murraya koeginii* gel	50µg	11.62mm
2	Gentamicin	10 µg	26.19mm

In Vitro Drug Release

In the first 15 minutes, the formulation releases 40% of the active ingredient, indicating a rapid initial release. This suggests the presence of a burst release phase, which is common in gel formulations when part of the drug is located near the surface or is weakly bound to the gel matrix. By 30 minutes, 61% of the drug is released, and at 60 minutes, 84% is released. This continued rapid release indicates that the formulation is efficiently releasing the active compound during the early stages. The gel appears to be facilitating quick drug diffusion, which is desirable for prompt therapeutic action in topical applications. After 60 minutes, the release rate slows, with only a slight increase to 86% by 120 minutes. This suggests the system is transitioning from the rapid initial release phase to a more controlled, sustained release. After 120 minutes, the drug release plateaus, with only a small increment in release from 86% at 120 minutes to 95% at 300 minutes. This slow and sustained release over time is characteristic of a gel formulation designed to provide prolonged drug exposure at the site of application.

The overall release profile suggests that the formulation is well-suited for topical applications, where both rapid onset and sustained therapeutic effects are required. This release pattern is typical of well-designed topical gels that ensure efficient delivery of the active compound.

DISCUSSION

The results from the evaluation of the herbal gel demonstrate that the formulation possesses favorable physical and chemical properties, making it a promising candidate for topical

application. The light yellow/green colour, pleasant odour, and good spreadability contribute to the aesthetic and sensory qualities of the product, which are critical for patient compliance.

The gel's semi-solid consistency, good viscosity, and absence of phase separation ensure its stability and usability over time. The pH of 6.4 aligns well with the skin's natural pH, minimizing the risk of irritation, which is further supported by the negative results in the skin irritation test. Homogeneity and solubility results suggest that the active ingredients are uniformly dispersed within the gel, contributing to consistent drug release. The antibacterial test result demonstrates the efficacy of *Murraya koenigii* extract against skin infections, validating its potential as a natural alternative to synthetic antimicrobials. This is especially important in light of the growing concern over antibiotic resistance.

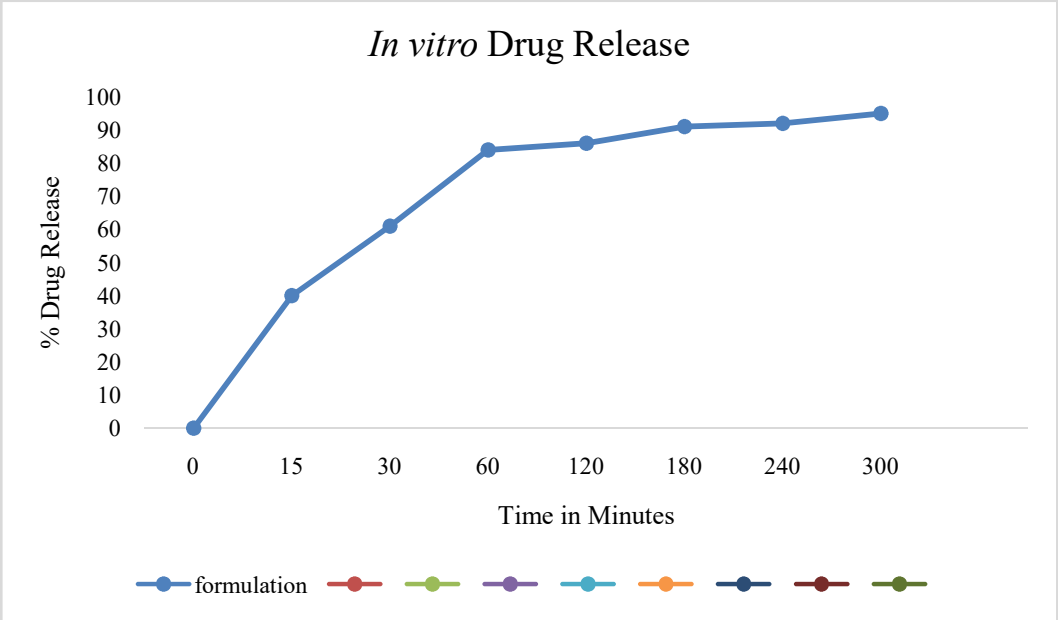

Figure 4: *In vitro* drug release of herbal gel

Overall, the evaluation indicates that the formulated gel is suitable for topical application, possesses good stability, and has potential therapeutic benefits. These findings are in line with other research studies that support the use of herbal extracts in topical gels for their antimicrobial and skin-protective properties.

CONCLUSION

The formulated *Murraya koenigii* leaf extract gel demonstrated promising antibacterial properties and favorable physical characteristics, making it suitable for topical application. The gel exhibited rapid and sustained drug release, providing both immediate and long-lasting effects. Its antibacterial activity against *Staphylococcus aureus* further supports its potential as an effective treatment for bacterial skin infections. The results of this study suggest that *Murraya koenigii* gel can serve as an alternative, plant-based antibacterial agent, offering a natural approach to combating skin infections. Further clinical studies are needed to validate its efficacy *in vivo* and explore its potential for wider therapeutic applications.

REFERENCES

[1] Tiwari. P., Kumar. B., Kaur. M., & Kaur. G. Phytochemical screening and extraction: A review. Internationale Pharmaceutica Sciencia. 2011;1(1):98-106.

[2] Deval. R. K., & Wanjari. B. E. Antibacterial activity of Murraya koenigii (curry leaves). Journal of Pharmacognosy and Phytochemistry. 2014;3(4):92-96.

[3] Behera. S. S., & Patra. J. K. Murraya koenigii (L.) Spreng: An overview on its nutritional, therapeutic, and industrial application. Journal of Ethnopharmacology. 2020;248:112-128.

[4] Panche. A. N., Diwan. A. D., & Chandra. S. R. Flavonoids: An overview. Journal of Nutritional Science. 2016;5(e47):1-15.

[5] Thombre P.K, Sharma D, Lanjewar M.A. Formulation and evaluation of Pharmaceutical aqueous gel of powdered

cordiadichotoma leaves with guava leaves. American journal of pharmtech research.2018; 8(2):2249-3387.

[6] Kalia. S., & Sharma. R. Gel-based topical formulations: An overview. International Journal of Pharmaceutical Sciences Review and Research. 2015;32(2): 28-35.

[7] Banker M.A, Dole N.M. Formulation and evaluation of herbal antimicrobial gel containingmusa acuminate leaves extract. Journal of pharmacognosy and photochemistry.2016;5(1): 01-03.

[8] Nayak P, Jose J. Formulation and Evaluation of Antibacterial Herbal gels of Murraya koeginii Leaves Extract. Research J. Pharm. and Tech.2017;10(6):0974-3618.

[9] Paliwal V.A, Dole M. Formulation and Evaluation of Herbal Gel Containing Extract of *Calotropis gigantea* Leaves. International journal of science and research. 2017;79(57):296.

[10] Gyawali R, Gupta R.K, Shrestha S, Joshi R, Paudel P.N. Formulation and evaluation of polyherbal cream containing Cinnamomum zeylanicum blume, Glycyrrhiza glabra L. and Azadirachta indica A. Juss. extract to topical use. Journal of institute of science and technology. 2020;25(2):61-71.

[11] Chejara DR, Mabrouk M, Badhe RV, Mulla JA, Kumar P, Choonara YE, du Toit LC, Pillay V. A bio-injectable algin-aminocaproic acid thixogel with tri-stimuli responsiveness. Carbohydrate polymers. 2016 Jan 1;135:324-33.

[12] Nikhil. Navindgikar N, Kamalapurkar K.A, Chanvan S.C. Formulation and evaluation of multipurpose herbal cream. International journal of current pharmaceutical research. 2020;12(3),25-30.

[13] Jameel Ahmed S Mulla, Pratiksha Mahendra Chalke, Shreya Pravin Londhe, Monika Arjun Patil, Sonali Narayan Nalawade, Rutuja Rajaram Sawant. Design and Optimization of Nanosponges of Poorly Soluble Voriconazole Using Central Composite Design. Indian Journal of Novel Drug Delivery, 2023; 15(4): 189-199.

[14] Sundar M, Sundan S, Lingakumar K. Preparation and optimization of medicated cold cream using caralluma adscendens var. attenuata for the treatment of candida skin infection. Journal of biotechnology, computational biology and bionanotechnology. 2022;103(3):249-260.

[15] Matangi P.S, Aruna S, Mamidi, Gulshan M.D, Raghavamma, Nadendla R.R. Formulation and evaluation of anti-aging polyherbal cream. International journal of pharmacy science and technology. 2014; 24 (2):133-136.

[16] Mabrouk M, Mulla JA, Kumar P, Chejara DR, Badhe RV, Choonara YE, du Toit LC, Pillay V. Intestinal targeting of ganciclovir release employing a novel HEC-PAA blended lyomatrix. Aaps Pharmscitech. 2016 Oct;17(5):1120-30.

[17] Snehal Shashaikant Chakorkar, Jameel Ahmed S. Mulla. A novel corticosteroid cubosomes – for ocular drug delivery. Indo American Journal of Pharmaceutical Research, 2020; 10(6): 775-784.

[18] JS Mulla, AY Khan, SI Panchamukhi, MA Khazi, MB Kalashetti, IM Khazi. Synthesis and Antitubercular Activity of Mannich bases of imidazo[2,1-*b*][1,3,4]thiadiazoles. Indian Journal of Novel Drug delivery. 3(4), Oct-Dec, 2011, 289-295.

[19] K.H. Kumar Naik, B. Ashok, Nagaraja Naik, Jameel Ahmed S. Mulla, AvinashPrakasha. DNA binding, anti-inflammatory and analgesic evaluation of metal complexes of N/S/O donor ligands; Synthesis, spectral characterization. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 2015; 141: 88-93.

[20] Ukey S, Ingole A, Kamble M, Dhabarde D, Baheti J. Formulation and Evaluation of Anti-bacterial Herbal gel Containing Terminalia catappa Extract. International Journal of Pharmaceutical Sciences Review and Research. 2021;67(1):131-134.

[21] Mulla JA, Palkar MB, Maddi VS, Khazi IA. Rational design of antibacterial thienopyrimidines by 2D-QSAR study. J. Drug Delivery Ther. 2012;2(2).55-66.

[22] Panchamukhi SI, Mulla JA, Shetty NS, Khazi MI, Khan AY, Kalashetti MB, Khazi IA. Benzothieno [3, 2-e][1, 2, 4] triazolo [4, 3-c] pyrimidines: Synthesis, Characterization, Antimicrobial Activity, and Incorporation into Solid Lipid Nanoparticles. Archiv der Pharmazie. 2011 Jun;344(6):358-65.

[23] Mulla JA, Dasankoppa FS, Vilas GJ, Sholapur HP. Fast dissolving tablets of promethazine: A novel oral formulation for the treatment of fractionated radiotherapy-induced nausea and emesis. Indian Drugs. 2008; 45(4):314.

[24] Mulla JAS, Hiremath SP, Sharma NK. Repaglinide loaded solid lipid

nanoparticles: design and characterization. RGUHS J Pharm Sci. 2 (4), 41-9.

[25] Mulla JAS, Shetty NS, Panchamukhi SI, Khazi IAM. Formulation, Characterization and *in vitro* Evaluation of Novel Thienopyrimidines and Triazolo thienopyrimidines Loaded Solid Lipid Nanoparticles. International Journal of Research in Ayurveda & Pharmacy. 2010; 1(1): 192-200.

[26] Mulla JA, Khazi MI, Khan AY, Gong YD, Khazi IA. Design, Characterization and *In vitro* Evaluation of Imidazo [2, 1-b][1, 3, 4] thiadiazole Derivative Loaded Solid Lipid Nanoparticles. Drug Invention Today. 2012; 4(8): 420-423.

[27] Balakrishnan. A., Thomas. D. S., & Madhavan. V. *In vitro* drug release studies of transdermal drug delivery system of theophylline using Franz diffusion cell. Journal of Pharmaceutical Sciences and Research. 2013;5(6):143-146.

[28] Mulla JAS, Aralelimath VR, Tipugade O, Shinde SS, Tetgure NG, Mulla AA, Gavali DD. Formulation and Evaluation of Teneligliptin-Loaded Mucoadhesive Microspheres. Indian Journal of Novel Drug Delivery. 2020 Oct-Dec;12(4): 222-227.

[29] Mulla JAS, Chopade UA, Kumbhar SA, Marathe PA, Ware PV. Formulation and Evaluation of Fast Dissolving Oral Films of Domperidone. Indian Journal of Novel Drug Delivery 10 (2), 68-75.

[30] Hiremath SP, Dasankoppa FS, Nadaf A, Jamakandi VG, Mulla JS, Sholapur HN. Formulation and evaluation of a novel in situ gum based ophthalmic drug delivery system of linezolid. Scientia Pharmaceutica. 2028; 76 (3): 515-532.

[31] Mulla JA, Suresh S, Khazi IA. Formulation, characterization and in vitro evaluation of methotrexate solid lipid nanoparticles. Research J. Pharm. and Tech. 2009 Oct;2(4):685-689.

[32] Rathod, S., & Mehta, D. *In vitro* release study of herbal topical gel for the treatment of arthritis using Franz diffusion cell. International Journal of Pharmaceutical Sciences and Research. 2015: 6(9): 3836-3841.