

## Formulation and Evaluation of Medicated Lotion for Treatment of Rosacea

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**ABSTRACT:** Rosacea is a chronic dermatological condition characterized by persistent erythema, pustules, and inflammation, which disrupts skin homeostasis and exacerbates vascular and immune responses. Chronic inflammation in rosacea leads to increased vascular permeability, immune dysregulation, and oxidative stress, contributing to skin barrier dysfunction and persistent flare-ups. This study focuses on formulating and evaluating a medicated lotion containing metronidazole and niacinamide, two active ingredients known for their anti-inflammatory, antimicrobial, and skin-soothing properties. The formulation is designed to target inflammatory pathways while ensuring compatibility with sensitive skin. A comprehensive evaluation, including physicochemical characterization, stability testing, and both in vitro and in vivo studies, was conducted to assess its therapeutic potential. Results demonstrated a significant reduction in redness and inflammation, enhanced skin hydration, and improved barrier function, with excellent tolerability and minimal adverse effects. This research underscores the importance of targeted topical formulations in controlling inflammation-driven skin damage, paving the way for further optimization and large-scale clinical studies for rosacea management.

**KEYWORDS:** Rosacea, inflammation, erythema, metronidazole, niacinamide, vascular permeability, immune dysregulation, oxidative stress, skin barrier function, topical formulation.

### I. INTRODUCTION

<sup>[1,2]</sup> Rosacea is a common chronic skin condition that primarily affects the face. It causes redness, visible blood vessels, and sometimes pimples. It can occur in individuals of any age but is most common in fair-skinned individuals, especially between the ages of 30 and 60. The condition typically manifests in the central areas of the face, such as the cheeks, nose, chin, and

forehead, and can lead to both physical and psychological distress due to its visible symptoms.

➤ Types of Rosacea:

- Erythematotelangiectatic Rosacea
- Papulopustular Rosacea
- Phymatous Rosacea
- Ocular Rosacea
- Granulomatous Rosacea

➤ Causes of Rosacea:

- Immune Dysregulation
- Microbial Factors
- Neurovascular Dysregulation
- Genetic Susceptibility
- Environmental Triggers
- Systemic Associations

<sup>[3,4]</sup> Lotion is a popular topical dosage form widely used for delivering active pharmaceutical ingredients (APIs) to the skin. It is a liquid or semi-liquid preparation primarily composed of water, emulsifiers, and various excipients such as stabilizers, preservatives, and humectants. The primary purpose of a lotion is to provide hydration, protect the skin, and deliver therapeutic effects in an easily spreadable and non-greasy formulation. Unlike thicker preparations like creams or ointments, lotions typically have a lighter texture, which makes them more suitable for application over large areas of the body, especially in conditions that affect extensive skin regions such as eczema, psoriasis, or rosacea.

➤ Properties of Lotions

- Soothing: Reduces redness and inflammation with calming ingredients like niacinamide, aloe vera, and chamomile.
- Hydrating: Moisturizes dry, sensitive skin with glycerine, hyaluronic acid, or similar agents.
- Non-irritating: Free from fragrances, alcohol, or harsh chemicals that could trigger flare-ups.

- **Anti-inflammatory:** Contains anti-inflammatory ingredients to reduce swelling and redness.
- **Lightweight & Non-greasy:** Easily absorbed without clogging pores or leaving a heavy residue.

<sup>[5,6]</sup>Metronidazole is an antibacterial agent that's FDA-approved for the topical treatment of inflammatory lesions of rosacea. Topical metronidazole, applied to the skin as lotion—can help reduce inflammatory lesions of rosacea and redness, and is generally well-tolerated by patients. Metronidazole operates as an antibiotic, primarily targeting bacteria, its efficacy in rosacea

treatment stems largely from its potent anti-inflammatory properties when applied to the skin. Niacinamide has been shown to have an anti-inflammatory effect, which can help to reduce the redness and swelling associated with rosacea. Some people with rosacea experience an increase in oil production, which can contribute to the development of acne-like bumps. This is due to the fact that people with rosacea tend to have more enlarged oil glands also known as sebaceous hyperplasia. Niacinamide has been shown to regulate oil production helping to prevent these bumps from forming.

Metronidazole and Niacinamide works by stopping the growth of certain bacteria and parasites, and may not only treat the patient's underlying Rosacea, but may also have anti-aging effects.

## II. MATERIALS AND METHOD

**Table 1 List of Materials**

Sr. no.	LIST OF INGREDIENTS	Quantity	ROLE OF INGREDIENTS
1	Metronidazole	0.3gm	API
2	Niacinamide	1gm	API
3	Glycerine	6ml	Humectant
4	Vitamin E	0.15ml	Anti-oxidant
5	Shea Butter	1.5ml	Moisturize and hydrate the skin
6	Ceto stearyl Alcohol	0.9ml	Emulsifier
7	Benzyl Alcohol	0.3ml	Preservative
8	Stearic acid	0.6ml	Thickener
9	Jojoba Oil	1.5ml	Skin Barrier Repair and Strengthening
10	Aloe vera Extract	3ml	Soothing Agent
11	Purified Water	q. s	Solvent

### Method of Preparation<sup>[7]</sup>

There are two methods for preparation of lotion.

- **Oil-in-Water Lotions:** These lotions have oil droplets dispersed in a water-based solution, making them lightweight, non-greasy, and ideal for hydrating the skin.
- **Water-in-Oil Lotions:** In these lotions, water droplets are dispersed in an oil-based solution, creating a thicker, more emollient product that provides enhanced moisturization and forms a protective barrier on the skin.

## III. EXPERIMENTAL WORK:<sup>[8]</sup>

### 1. Pre formulation studies:

- **Organoleptic properties:** Organoleptic studies refer to evaluation of a drug by means of different organs of the human body or by sense, such as appearance of the drug material, its odour and taste.
- **Solubility Studies:** solubility is one of the most important parameter to achieve desired concentration of drug was dissolved in different different solvents.
- **Compatibility study:** To study the compatibility of drug, solid mixtures were prepared by

mixing the drugs and characterised by using FTIR.

## 2. Formulation of Medicated Lotion<sup>[9]</sup>

- Preparation of Oil Phase:  
Heat the oil-soluble ingredients (Vitamin E, Olive Oil, Cocoa Butter, Ceto stearyl Alcohol, Stearic Acid, Jojoba Oil). Stir until all solids melt and the mixture is homogenous.

- Preparation of Water Phase:  
Dissolve the water-soluble ingredients (Glycerine, Niacinamide, Aloe Vera Extract, Benzyl Alcohol, Metronidazole) in Distilled Water. Heat and stir all phase until a homogenous mixture is achieved.

- Emulsification:  
Gradually add the oil phase to the water phase while mixing continuously with a high-shear homogenizer. Maintain stirring until a uniform emulsion forms.

- Cooling Phase:  
After emulsification, cool the mixture to room temperature while stirring gently. During this phase, the lotion stabilizes, and its viscosity increases.

- Packaging:  
Transfer the finished lotion into clean, sterilized containers. Ensure proper sealing to avoid contamination.

## 3. Evaluation of Medicated Lotion

- Visual Appearance<sup>[10]</sup>  
To evaluate a small amount of the lotion is placed in a glass container and examined under normal light conditions for any phase separation, discoloration, or physical instability.

- Organoleptic Properties<sup>[11]</sup>

To evaluate, lotion is applied to the skin, and its odour, texture, and smoothness are recorded.

- Determination of pH<sup>[12]</sup>  
To evaluate, weigh 1 g of lotion and dissolve it in 10 mL of distilled water. Measure pH using a calibrated digital pH meter.

- Viscosity Measurement<sup>[13]</sup>  
To evaluate, viscosity is measured using a Brookfield viscometer at room temperature (25°C). The spindle type and speed are selected based on the lotion's consistency.

- Washability Test<sup>[14]</sup>  
Evaluate, a small amount of lotion is applied to the skin and washed with running water. The ease of removal and residue left is noted.

- Stability Studies<sup>[15]</sup>  
To evaluate formulation samples are stored at 40°C ± 2°C / 75% ± 5% RH, and room temperature for 1–3 months. Physical and chemical stability is analysed at regular intervals.

- Irritancy Test<sup>[16]</sup>  
To evaluate a patch of lotion is applied on the forearm of volunteers and observed for 24 hours for any redness, itching, or swelling.

- Spread ability Test<sup>[17]</sup>  
To evaluate a fixed amount of lotion is placed on a glass slide. Another glass slide is placed over it, and a weight (100g) is applied. Diameter of the spread is measured after 1 minute.

- Microbial Examination<sup>[18]</sup>  
To evaluate the lotion is tested using Total Viable Count (TVC) and Pathogen Detection Tests (E. coli, S. aureus, P. aeruginosa, Candida albicans) as per USP guidelines. Samples are plated on nutrient agar and incubated at 37°C for 24–48 hours to check for microbial growth.

## IV. RESULTS AND DISCUSSION

1. Results of pre-formulation studies
  - Organoleptic Properties of Metronidazole

**Table 2 Organoleptic Properties of Metronidazole**

Property	Description
Appearance	Crystalline powder
Colour	White to pale yellow

Odor	Slight characteristic Odor (some describe it as faintly musty)
Taste	Bitter and metallic

- Organoleptic Properties of Niacinamide

**Table 3 Organoleptic Properties of Niacinamide**

Property	Description
Appearance	Crystalline powder
Colour	White
Odour	Odourless
Taste	Slightly bitter

- Solubility of Metronidazole

**Table 4 Solubility of Metronidazole**

Solvent	Solubility of Metronidazole	Remarks
Water	10 mg/mL (at 25°C)	Slightly soluble
Ethanol (95%)	13 mg/mL (at 25°C)	Moderately soluble
Acetone	Freely soluble	Can dissolve completely
Ethyl Acetate	Soluble	Organic solvent compatibility
Glycerin	Slightly soluble	Used in topical formulations

- Solubility of Niacinamide

**Table 5 Solubility of Niacinamide**

Solvent	Solubility of Niacinamide	Remarks
Water	~500 mg/mL (very soluble)	Highly water-soluble, making it suitable for aqueous formulations
Ethanol (95%)	~10 mg/mL (sparingly soluble)	Limited solubility, requires co-solvents
Acetone	Slightly soluble	Not commonly used
Glycerin	Soluble	Useful for moisturizing formulations

- Compatibility study
- FTIR of Metronidazole

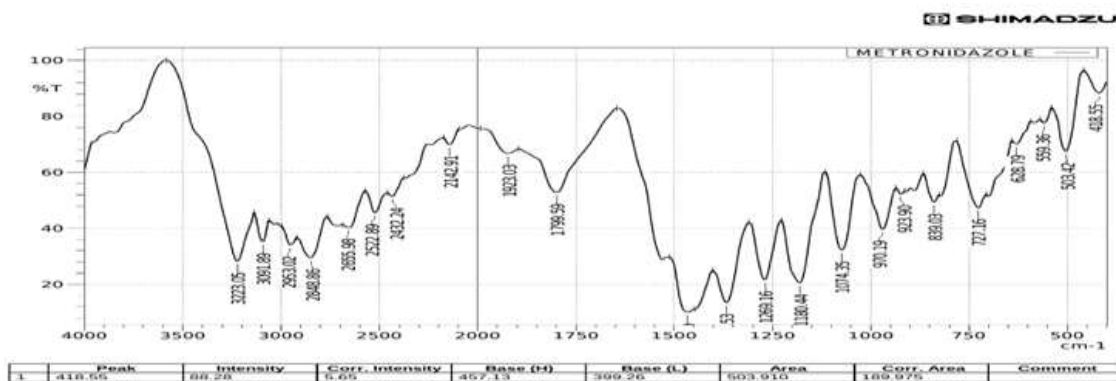


Fig.1 FTIR of Metronidazole

- FTIR of Niacinamide

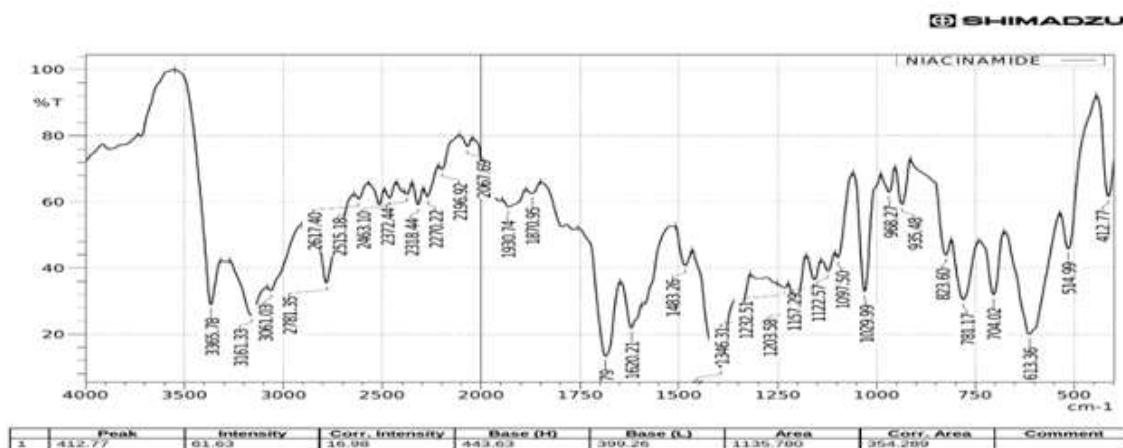


Fig.2 FTIR of Niacinamide

- FTIR of Metronidazole + Niacinamide

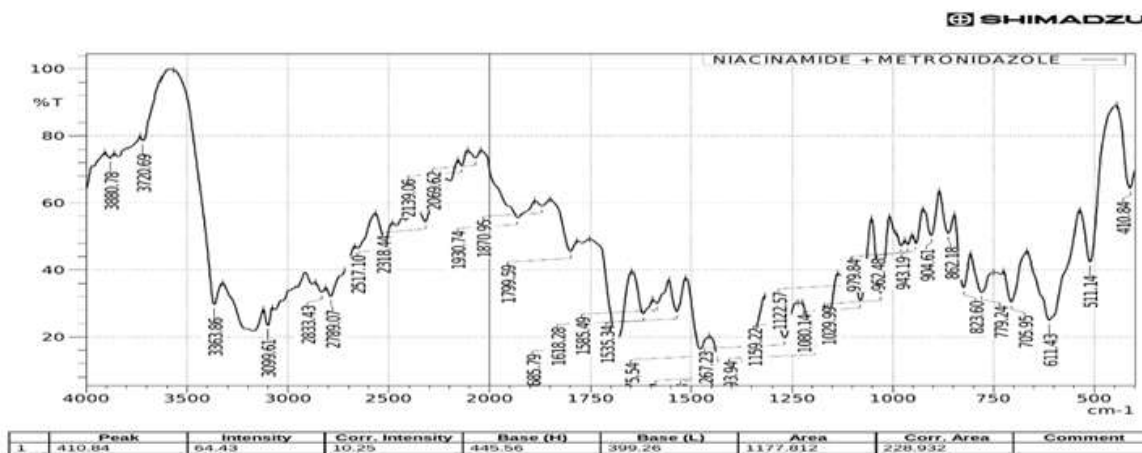


Fig. 3 FTIR of Metronidazole + Niacinamide

2. Evaluation of Medicated Lotion
- Evaluation of Medicated Lotion

**Table 6 Evaluation of Medicated Lotion (Before Stability)**

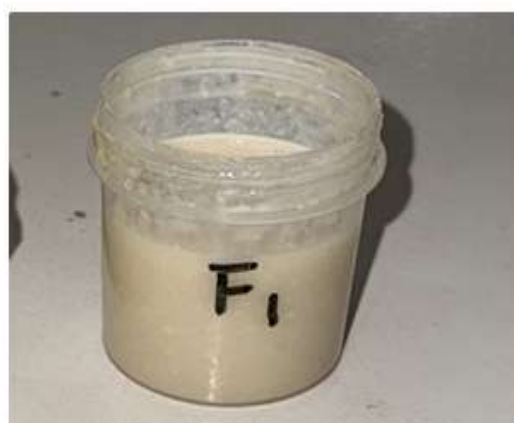
SR. NO.	Evaluation Parameter	F <sub>1</sub> (Before stability studies)	F <sub>2</sub> (Before stability studies)	Result
1	Visual Appearance	Smooth, uniform, white	Smooth, uniform, off-white	F2 has a more aesthetically pleasing off-white appearance.
2	pH Determination	6.5	5.6	F2 has a pH closer to the natural skin pH, making it more preferable.
3	Viscosity Measurement	3200 cP	2500 cP	F2 has better Spreadability due to its slightly lower viscosity.
4	Organoleptic Properties	Mild characteristic odour, non-sticky	Mild characteristic odour, slightly sticky	F2's slight stickiness ensures better adherence to the skin.
5	Washability Test	Easily washable with water	Easily washable with water	Both formulations exhibit good washability.
6	Irritancy Test	No irritation observed	No irritation observed	Both are safe, but F2 provides better skin compatibility.
7	Spreadability Test	6.5 cm	6.8 cm	F2 spreads better on the skin, making it more user-friendly.
8	Microbial Examination	No microbial growth detected	No microbial growth detected	Both formulations meet safety standards.

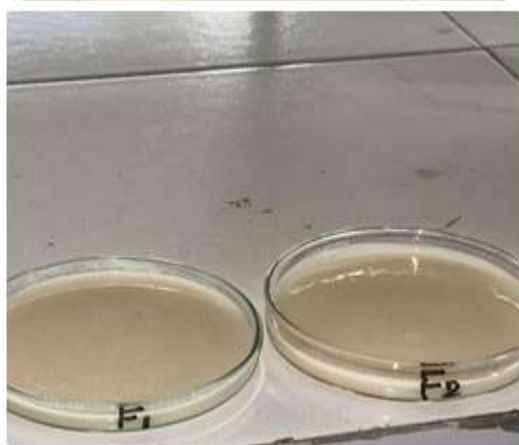
**Table 7 Evaluation of Medicated Lotion (After 1 Month)**

SR. NO.	Evaluation Parameter	F1 (After Stability Study)	F2 (After Stability Study)	Comparative Result
1	Visual Appearance	Slight phase separation observed	Stable, uniform	F2 remains stable, while F1 shows slight instability.
2	pH Determination	6.7	5.5	pH is within the 5.5-6 range for skin compatibility.

3	Viscosity Measurement	3100 cP	2650 cP	F2 retains better Spreadability post-stability study.
4	Organoleptic Properties	Mild odour change detected	No change	F2 remains more stable in terms of odour and consistency.
5	Washability Test	No change	No change	Both formulations exhibit good washability.
6	Stability Studies	Slight phase separation at high temp	Fully stable	F2 shows better stability under stress conditions.
7	Irritancy Test	No irritation observed	No irritation observed	Both are safe, but F2 remains more consistent.
8	Spreadability Test	5.4 cm	6.7 cm	appropriate thickness for easy application and absorption.
9	Microbial Examination	No microbial growth	No microbial growth d	Both formulations meet safety standards.

The comparative analysis after stability testing confirms that F<sub>2</sub> remains the preferable formulation. F<sub>1</sub> showed minor phase separation and slight changes in viscosity and odour, indicating reduced stability over time. In contrast, F<sub>2</sub> retained its physical and chemical properties with minimal deviation. The optimized pH, better Spreadability, and enhanced stability of F<sub>2</sub> further support its selection as the superior formulation for rosacea treatment. These findings reinforce F<sub>2</sub> as the ideal choice for clinical and consumer applications, ensuring long-term efficacy and consistency.





**Fig. 4 Medicated Lotion**

## V. CONCLUSION

The formulated pharmaceutical lotion for rosacea demonstrated excellent stability, safety, and therapeutic efficacy. The optimized formulation (F<sub>2</sub>) showed superior Spreadability, a balanced pH, and effective anti-inflammatory and antimicrobial properties due to Metronidazole and Niacinamide. The inclusion of moisturizing and soothing excipients enhanced skin hydration and barrier repair. Overall, the lotion presents a promising topical treatment for rosacea, warranting further clinical evaluation for broader application

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