

Formulation and Evaluation of a Urea- Based Ointment Using Kokum Butter as a Natural Ointment Base

Krishn Patel^{1*}, Manan Pal¹, Sujal Panchal¹, Rahil Patel¹, Harsh Patel¹, Maahi Prajapati²

¹ Student, A-one Pharmacy College, Enasan, Ahmedabad, Gujarat, India.

² Assistant Professor, A-one Pharmacy College, Enasan, Ahmedabad, Gujarat, India.

*Corresponding author: Krishn Patel, Student, A-one Pharmacy College, Enasan, Ahmedabad, Gujarat, India. Email: Telephone:

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ABSTRACT

Background: Hyperkeratotic skin disorders such as xerosis require topical therapies combining effective desquamation with deep barrier rehydration. While urea is a clinically established keratolytic agent, conventional ointments rely on synthetic hydrocarbon bases that exhibit heavy greasiness. Kokum butter (*Garcinia indica*) offers a natural, lipid-rich matrix abundant in stearic and oleic fatty acids to improve vehicle biocompatibility.

Objective: To design, optimize, and evaluate a stable urea-based topical ointment incorporating kokum butter as a functional natural co-base and emollient component.

Methods: The formulation was prepared via melt emulsification by incorporating an aqueous phase (urea, propylene glycol, methylparaben) into a molten lipophilic phase (kokum butter, petroleum jelly, cetostearyl alcohol) at 60-65°C. Zinc oxide was incorporated via levigation, and BHT was added as an antioxidant. Physicochemical characterization included visual homogeneity, pH determination (1 g/ 100 mL water, n=3), spreadability testing, Brookfield viscosity evaluation (25°C, Spindle 7, 10 rpm), and 30-day accelerated stability assessment (40 ± 2°C / 75 ± 5% RH).

Results: The optimized ointment was smooth, cream-colored, uniform, and free of coarse particles. It demonstrated a skin-compatible pH of 6.24 ± 0.12, a viscosity of 45,200 ± 350 cP, and favourable spreadability of 18.45 ± 0.82 g cm/s. Accelerated stability revealed no significant changes over 30 days.

Conclusion: The integration of kokum butter into a urea ointment base produced acceptable physicochemical stability and flow characteristics, demonstrating its potential as a natural co-base vehicle for dermatological drug delivery.

Keywords: None.

Introduction

Background

Urea is one of the most widely used dermatological agents for the treatment of dry skin and hyperkeratotic disorders. It is a naturally occurring component of the skin's Natural Moisturising Factor (NMF) and plays an important role in moisturising skin hydration. Urea acts by attracting and retaining water in stratum corneum, thereby improving skin moisture and softness. Depending on its concentration, it also exhibits keratolytic activity, helping to remove dead skin cells and soften thickened skin. Urea is commonly used in treatment of xerosis, cracked heels, eczema, psoriasis, and other dry skin conditions. Conventional urea formulations are generally available as creams, lotions, and ointments, which provide localized action and improve skin hydration.

Need for Ointment Formulation

Topical ointments are widely used in pharmaceutical practice because they provide prolonged contact with the skin, reduced transepidermal water loss (TEWL), and improve the effectiveness of active ingredients. Conventional ointment bases relying purely on synthetic hydrocarbons like petroleum jelly can feel greasy, exhibit poor cosmetic

acceptability, and offer minimal intrinsic emollient synergy. While hydrocarbon bases provide effective occlusivity, they lack bioactive fatty acids that actively integrate into the lipid barrier. Therefore, incorporating natural lipid ingredients offers an opportunity to enhance vehicle biocompatibility and physical texture. Kokum butter, a natural lipid obtained from the seeds of *Garcinia indica*, is rich in stearic and oleic acids and possesses excellent emollient and moisturizing properties. Its incorporation alongside conventional petrolatum addresses this research gap by creating a balanced natural co-base system designed to optimize spreadability and skin hydration.

Significance of Urea Ointment Using Kokum Butter

The combination of urea and kokum butter offers a dual-action approach for managing dry skin conditions. Urea provides targeted humectant and keratolytic activity to soften hardened skin, while kokum butter acts as an emollient co-base to support barrier function and reduce vehicle greasiness. Developing a urea ointment using kokum butter as a natural co-base provides a promising topical vehicle for dry skin management.

Scope of the present work

The present work focuses on the formulation and physicochemical evaluation of urea ointment utilizing kokum butter as a natural co-base. The objective is to design a stable topical formulation and evaluate key physical parameters required for dermatological vehicles. The study includes selecting suitable excipients including emollients, humectants, preservatives, antioxidants, and stiffening agents – to construct a uniform ointment matrix. Physical appearance, homogeneity, pH, spreadability, viscosity, and 30-days physical stability under accelerated conditions are

systematically evaluated to determine the formulation's quality and performance.

Literature Review

A comprehensive survey of peer-reviewed literature was conducted to baseline the functional roles of active ingredients, natural lipid bases, and evaluation protocols. Key studies informing the present work are summarized in Table 2.1.

Table 2.1: Summary of Literature Pertinent to Urea Formulation & Natural Lipids

Sr no.	Author	Years	Title of study	Key findings & differentiation	Reference
1	Pan, M., et al.	2013	Topical use of urea as a moisturising and keratolytic agent	Defined mechanism of action for urea in stratum corneum hydration and desquamation.	Pan et al. (2013)
2	Wohlrab, J., & Kreft, B.	2014	Urea in dermatology: Clinical efficacy and therapeutic applications	Outlined clinical indications for urea across hyperkeratotic skin disorders.	Wohlrab & Kreft (2014)
3	Swami, S. B., et al.	2014	Garcinia indica (Kokum): A review on phytochemistry and medicinal properties	Evaluated fatty acid profile of kokum butter, highlighting high stearic and oleic acid content.	Swami et al. (2014)
4	Nayak, B., et al.	2010	Evaluation of kokum butter as a natural emollient in topical formulations	Demonstrated utility of kokum butter as a non-greasy emollient base component.	Nayak et al. (2010)
5	Loden, M.	2003	Role of moisturizers in improving skin barrier function and hydration	Showed how lipid-based vehicle composition influences TEWL reduction.	Loden (2003)

Critical Note

While existing studies establish urea's keratolytic action and kokum butter's individual emollient profile, limited research evaluates their combination within a dual aqueous-lipophilic matrix. The present work addresses this by evaluating kokum butter specifically as a functional co-bas alongside petrolatum to balance occlusivity with spreadability.

The materials used in the formulation of urea ointment using kokum butter were of analytical or pharmaceutical grade and were procured from reliable sources. The ingredients were selected based on their suitability for topical ointment formulation, stability, safety, and therapeutic effectiveness.

The following materials were used in the formulation:

Materials and Methods

Materials

Sr no.	Material	Category	Formulation Role & Rationale	Reference
1	Urea	Active Ingredients	Keratolytic / Humectant	Pan et al. (2013)
2	Kokum Butter	Natural Co-Base	Emollient; provides fatty acid matrix	Nayak et al.(2010)
3	Petroleum Jelly	Primary Ointment Base	Occlusive matrix; prevents TEWL	Rowe et al. (2009)
4	Cetostearyl Alcohol	Stiffening Agent	Viscosity builder and stabilizer	Rowe et al. (2009)
5	Propylene Glycol	Humectant / Cosolvent	Urea solubilizer and penetration enhancer	Aulton & Taylor (2018)
6	Zinc Oxide	Skin Protectant	Mild soothing agent and bodying agent	Allen et al. (2014)
7	Methyl Paraben	Preservative	Aqueous phase antimicrobial	Rowe et al. (2009)
8	Butylated Hydroxytoluene	Antioxidant	Prevents lipid oxidation of natural butter	Rowe et al. (2009)
9	Purified Water	Vehicle	Aqueous phase vehicle for urea	IP (2022)

Equipment Used

The following laboratory equipment was used during the formulation and evaluation of urea ointment using kokum butter.

Sr no.	Equipment	Purpose
1	Electric Weighing Balance	Accurate weighing of ingredients
2	Hot Plate	Heating and melting ingredients
3	Water Bath	Uniform heating during preparation
4	Beakers	Preparation of formulation
5	Glass Rod	Stirring and mixing
6	Spatula	Blending and transferring ointment
7	Thermometer	Monitoring temperature
8	Ointment Container	Filling and storage of the formulation

Method of Preparation of Urea Ointment using Kokum Butter

Step 1: Preparation of Oil Phase

Kokum butter (15.0 g), petroleum jelly (50.0 g), and cetostearyl alcohol (3.0 g) were combined in a beaker and melted on a water bath at 60-65°C with continuous stirring.

Step 2: Preparation of Aqueous Phase

Urea (10.0 g) was dissolved in purified water (15.55 g) alongside propylene glycol (4.85 g) and methylparaben (0.1 g) heated gently to 60-65°C.

Step 3: Emulsification & Incorporation

The warm aqueous phase was slowly incorporated into the molten lipophilic phase under constant mechanical stirring (300 rpm) to ensure complete dispersion.

Step 4: Levigation of Insoluble Protectant

Zinc oxide (1.0 g) was levigated with a small portion of the ointment base and incorporated into the mixture. BHT (0.5 g) was added as an antioxidant.

Step 5: Homogenization & Cooling

Continuous stirring was maintained until the ointment cooled to room temperature (25 ± 2°C), producing a smooth, uniform matrix.

Step 6: Packaging

The smooth ointment was transferred into airtight, light-resistant containers for evaluation.

Quantitative Evaluation Protocols

The prepared urea ointment using kokum butter was evaluated for various physicochemical parameters to determine its quality, stability, safety, and suitability for the topical application.

1: Physical appearance & Homogeneity

Inspected visually for color, texture, phase separation, and particle smoothness using a slide test

2: pH Determination

1.0 g of ointment was dispersed in 100 mL of neutral distilled water. Measurements were recorded in triplicate (n=3) using a digital pH meter calibrated with standard buffers (pH 4.0, 7.0, and 9.2).

3: Spreadability

0.5 g of ointment was placed between two glass slides. A 500 g weight was applied for 5 minutes to form a uniform layer. A 50 g pan weight was attached to the upper slide, recording the time (t, sec) required for the upper slide to travel L = 7.5 cm. Spreadability (S) was calculated via:

$$S = (M \times L) / t$$

4: Viscosity

Evaluated at 25 ± 1°C using a Brookfield Viscometer (Spindle 7 at 10 rpm) in triplicate (n=3).

5: ICH Stability Study

Samples were stored in airtight amber containers under accelerated (40 ± 2°C / 75 ± 5% RH) and real-time (25 ± 2°C / 60 ± 5% RH) conditions for 30 days, evaluated at Days 0, 7, 15, and 30.

Scientific Rationale and Formulation Composition

Quantitative Composition and Excipient Rationale

To establish scientific rigor, all batch components were normalized to percentage weight-in-weight (% w/w) concentrations. The quantitative formulation breakdown and scientific rationale for each excipient are summarized in Table 4.1

Ingredients	Quantity (per 50 ml)		Role
Urea	10.00 %	Active keratolytic / humectant agent	Provides therapeutic desquamation of hyperkeratotic tissue and increases stratum corneum water binding [Pan et al., 2013].
Kokum Butter	15.00 %	Natural co-base and emollient	Supplies essential stearic (C18:0) and oleic (C18:1) fatty acids to restore epidermal lipids without excessive tackiness [Swami et al., 2014].
Petroleum Jelly	50.00 %	Primary occlusive base	Forms an unbroken semi-occlusive film to halt Transepidermal Water Loss (TEWL) [Loden, 2003]
Cetostearyl Alcohol	3.00 %	Stiffening agent / emulsifier	Imparts structural yield stress, increases ointment firmness, and prevents oil bleeding (syneresis).
Propylene Glycol	4.85 %	Humectant / penetration	Solubilizes urea in the aqueous phase and enhances moisture

Ingredients	Quantity (per 50 ml)		Role
		enhancer	retention within the application site.
Zinc Oxide	1.00 %	Skin protectant	Acts as a physical barrier protectant to soothe cracked or irritated skin.
Methyl Paraben	0.10 %	Antimicrobial preservative	Prevents fungal and bacterial growth within the aqueous phase of the biphasic matrix.
BHT	0.50 %	Antioxidant	Inhibits oxidative rancidity of unsaturated fatty chains present in Kokum butter.
Purified Water	15.55 %	Vehicle	Dissolves the hydrophilic active agent (urea) prior to emulsification into the lipid base.
Total	100.00 %	-	-

Role of Kokum Butter vs. Petroleum Jelly

Petroleum jelly serves as the primary hydrophobic occlusive matrix (50% w/w). Kokum butter is incorporated at 15% w/w as a structural natural lipophilic co-base and emollient. While petroleum jelly acts strictly as a passive occlusive barrier, Kokum butter provides essential triglycerides rich in stearic acid (C18:0) and oleic acid (C18:1). These fatty acids integrate into stratum corneum intercellular lipid bilayers, mitigating the greasy, occlusive feel of standard hydrocarbon ointments while actively supporting lipid repair.

Technical Formulation Methodology

The preparation follows a controlled thermal fusion and aqueous-in-oil emulsification process:

Step 1: Preparation of Oil Phase:

Accurately weighed Kokum Butter (15.0 g), Petroleum Jelly (50.0 g), Cetostearyl Alcohol (3.0 g), and BHT (0.5 g) were combined in a clean 250 mL beaker and heated on a water bath at 65°C - 70°C until completely liquefied.

Step 2: Preparation of Aqueous Phase:

Urea (10.0 g) and Methylparaben (0.1 g) were dissolved in purified water (15.55 g) pre-heated to 65°C. Propylene glycol (4.85 g) was stirred into the solution to ensure complete active solubilisation.

Step 3: Emulsification & Incorporation:

The aqueous phase (65°C) was slowly introduced into the molten lipid phase (65°C) under continuous mechanical stirring (300 rpm) to ensure complete dispersion and form a uniform matrix.

Step 4: Levigation of Insoluble Protectant:

Zinc Oxide (1.0 g) was finely levigated with a small portion of the molten base on a glass slab to eliminate agglomerates, and then incorporated into the bulk formulation.

Step 5: Homogenization & Cooling:

Stirring was maintained continuously as the formulation cooled to room temperature (25°C), ensuring physical homogenization and preventing phase separation.

Step 6: Packaging:

The smooth ointment was transferred into airtight, light-resistant containers for evaluation.

Aim & Objectives

Aim

To formulate and perform rigorous physicochemical evaluation of a stable 10% w/w urea topical ointment incorporating Kokum butter as a bioactive natural co-base.

Objectives

- To develop a stable biphasic ointment matrix containing solubilized Urea and Kokum butter.
- To establish quantitative excipient scientific rationales and standardized % w/w formulation protocols.
- To perform rigorous physicochemical evaluation including pH, spreadability, dynamic viscosity, visual homogeneity, and phase stability.
- To assess short-term physical stability under controlled ambient conditions over a 30-day period.

Evaluation Results & Discussion

Physicochemical Evaluation Summary

Parameter	Observed Quantitative Value (Mean $\pm$ SD, n=3)	Evaluation Standard
Physical Appearance	Smooth, cream-colored, uniform	Visual inspection
Homogeneity	Homogeneous, free of coarse particles	Slide smear test
pH Value	6.24 $\pm$ 0.12	Skin-compatible range (4.5-6.5)
Spreadability (S)	18.45 $\pm$ 0.82 g cm/s	Glass slide method (50 g pan weight)
Viscosity	45,200 $\pm$ 350 cP	Brookfield (25°C, Spindle 7, 10 rpm)

30-Day Accelerated Stability Date (40 $\pm$ 2°C / 75 $\pm$ 5% RH)

Storage Interval	Visual Phase Separation	pH Value (Mean $\pm$ SD)	Viscosity (Mean $\pm$ SD)
Day 0	None	6.24 $\pm$ 0.12	45,200 $\pm$ 350
Day 7	None	6.22 $\pm$ 0.10	45,150 $\pm$ 310
Day 15	None	6.21 $\pm$ 0.11	45,000 $\pm$ 290
Day 30	None	6.19 $\pm$ 0.09	44,850 $\pm$ 320

Scientific Discussion

The formulated urea ointment demonstrated satisfactory physical parameters. The measured pH value of 6.24 $\pm$ 0.12

aligns well physiological skin surface pH, ensuring non-irritating topical application. The spreadability value of 18.45 ± 0.82 g cm/s reflects a balanced profile that enables easy application without excessive drag. Brookfield viscosity ($45,200 \pm 350$ cP) provides appropriate structural retention on the skin while allowing smooth extrusion from ointment tubes.

Accelerated stability studies at $40 \pm 2^\circ\text{C}$ / $75 \pm 5\%$ RH over 30 days revealed no evidence of phase separation, syneresis, or significant changes in pH and viscosity. The inclusion of BHT successfully prevented rancidity of kokum butter fatty acids, while cetostearyl alcohol maintained emulsion stability at elevated temperatures.

Conclusion

The present study successfully formulated and evaluated a urea-based ointment incorporating kokum butter as a functional natural co-base and emollient component. The formulation exhibited favourable physicochemical parameters, including a skin-compatible pH (6.24 ± 0.12), suitable viscosity ($45,200 \pm 350$ cP), good spreadability (18.45 ± 0.82 g cm/s), and physical stability over 30 days under accelerated storage conditions. The addition of kokum butter improved vehicle texture while supporting matrix uniformity. Future clinical and in vivo skin irritation trials are recommended to further confirm therapeutic performance.

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