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Development of a Topical Antifungal and Antibacterial Preparation Based on Ayurvedic Principles

Pooja Dhakar, Asif Mohd Taufik Khan, Yogendra Nagar, Priyanka Prajapat, Manish, Yogesh Sharma

Department of Pharmacy, Mahatma Gandhi Engineering College, Shivdaspura, Jaipur, Rajasthan, India

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Corresponding author: Pooja Dhakar

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Abstract:

Background: Superficial fungal and bacterial skin infections represent a widespread global public health challenge, exacerbated by environmental humidity, poor hygiene, and mounting resistance to synthetic antimicrobials. Prolonged use of synthetic topical drugs frequently results in adverse cutaneous reactions such as hypersensitivity, localized irritation, and extreme dryness. This study details the formulation and systemic pharmaceutical evaluation of an oil-based, hydrophobic polyherbal topical lotion developed using classical Ayurvedic principles.

Methods & Materials: The lotion was prepared using a lipid base consisting of Coconut Oil (*Cocos nucifera*) and Beeswax, incorporating therapeutically active mineral and herbal constituents: Camphor, Sulphur, Borax, and Turmeric (*Curcuma longa*). Due to its hydrophobic nature and the absolute absence of water, the formulation exhibits inherently high resistance to microbial proliferation. Standard organoleptic, homogeneity, pH compatibility, and rheological parameters were measured.

Results & Conclusion: The developed preparation provides a smooth, yellow, stable semi-solid matrix with a skin-compatible pH range. It offers a synergistic multi-target therapeutic profile, combining potent antifungal, antibacterial, anti-inflammatory, antipruritic, and accelerated wound-healing dynamics with an estimated shelf life of 2 to 3 years without requiring synthetic chemical stabilizers.

Introduction

Topical drug delivery systems are critical interventions for managing localized dermatological disorders, providing targeted action directly at the infection site while eliminating systemic metabolic side effects. Lotions are highly favored among topical dosage forms owing to their excellent skin spreadability, rapid application characteristics, and unique ability to serve as

stable vehicles for both lipophilic and functional active agents [1, 2].

In contemporary pharmaceutical research, an exponential surge of interest is directed toward traditional Ayurvedic systems due to their biocompatibility, low toxicity profiles, and multi-constituent synergistic efficacy [3]. Fungal infections (mycoses) manifest opportunistically across keratinized

superficial structures, including human skin, nails, and mucosal linings, flourishing rapidly under localized thermal and moisture gradients [4, 5].

Classic dermatophytic infections—including *Tinea corporis*, *Tinea pedis*, and *Tinea cruris*—are widely distributed across rural and urban environments [6]. Epidemiological trends indicate that pediatric and adolescent demographics (specifically between 11–15 years of age) show a high susceptibility (~32% prevalence) to superficial mycoses, primarily driven by heightened sebum production, physical outdoor activity, and sweat accumulation [4, 7].

This research highlights the synthesis of traditional knowledge and modern

manufacturing methodologies by formulating a multi-component Ayurvedic lotion to combat pathogenic fungi (e.g., *Candida albicans*, *Trichophyton rubrum*) and bacterial strains (e.g., *Staphylococcus aureus*) without triggering modern synthetic side effects like dry epidermal scaling or chemical dermatitis [8, 9].

Materials and Methods

Composition of the Polyherbal Lotion

The quantitative and categorical composition of the raw materials utilized in the execution of this formulation is systematically outlined below in Table 1:

Table 1: Quantitative composition formula for the Ayurvedic polyherbal lotion.

Sr. No.	Active / Inactive Ingredient	Quantity (g) per 100g	Primary Functional Category
1	Coconut Oil (<i>Cocos nucifera</i>)	63.4375 g	Hydrophobic Emollient Base & Antipruritic Agent
2	Beeswax	9.0625 g	Structural Thickener & Consistency Regulator
3	Camphor (<i>Cinnamomum camphora</i>)	5.0000 g	Active Antifungal & Counter-irritant
4	Sulphur	7.5000 g	Active Antifungal & Keratolytic Agent
5	Borax (Sodium Borate)	7.5000 g	Co-Emulsifier, Buffer, & Structural Stabilizer
6	Turmeric (<i>Curcuma longa</i>)	7.5000 g	Active Antibacterial & Wound Healing Agent

Pharmacological Profiles of Constituents

Coconut Oil: Sourced from the dried kernel of *Cocos nucifera*, it contains high parameters of medium-chain fatty acids like lauric and capric acid, reinforcing the natural skin barrier [2, 10]. Beeswax (melting window 62–64°C) handles consistency regulation and hydration retention [11]. Camphor acts on TRPV3/TRV8 receptors providing deep anti-pruritic activity [12]. Sulphur yields trace hydrogen sulfide (H₂S)

providing exceptional keratolytic, scaling action [13, 14]. Borax controls the baseline pH, while Turmeric yields dynamic curcuminoids to suppress microbial structural proteins and drive localized cellular healing [15, 16].

Compounding and Manufacturing Procedure

The manufacturing was executed using an optimized hot-melt geometric incorporation

methodology: (a) Milling active minerals (Sulphur, Borax, Turmeric) into a mesh No. 80 microfine powder blend; (b) Melting Coconut oil and Beeswax at 70°C–80°C with gradual addition of volatile Camphor crystals; (c) High-velocity incorporation of the microfine blend into the molten lipid phase; and (d) Mechanical homogenization during controlled cooling to room temperature to guarantee long-term uniformity and eliminate crystalline precipitations [1, 17].

Review of Literature

Superficial clinical dermatological mycoses have been treated with mineralized herbal fats for centuries across classic Ayurvedic systems [3, 18]. Up-to-date studies verify that modern chemical azoles are frequently linked to toxic cutaneous resistance [5]. Research by Al-Waili *et al.* proved that lipid blends containing natural waxes and oils effectively stifle multi-drug resistant strains of *Staphylococcus aureus* and *Candida albicans* by breaking down structural cellular wall components [11, 19]. Curcuminoids act as robust secondary tools, suppressing cellular division lines while upregulating structural collagen repair mechanisms across lesion margins [16, 20]. Keratolytic clearing

pathways achieved using trace sulfur combinations accelerate this process by stripping protective bacterial crust profiles [14, 21].

Evaluation and Standardization Parameters

The formulation parameters were systematically mapped against international pharmacopoeial frameworks: Organoleptic consistency (color/odor monitoring); Tactile slide uniformity (grittiness metrics); Glass-electrode potentiometry (pH parameters); Brookfield rheological profiling (viscosity indices); and SDA Agar well bio-assays (Zone of Inhibition metrics) [1, 22].

Results and Discussion

The polyherbal system yields an optimally smooth, structurally uniform, lemon-yellow semi-liquid lotion matrix without any detectable grit or phase separation. Since the preparation is fundamentally anhydrous, it displays zero thermodynamic water activity, which stops standard microbial proliferation lines. As a result, the lotion remains stable for an extended shelf life of 2–3 years without requiring any synthetic preservative chemicals [23, 24]. Physical outcomes are compiled in Table 2.

Table 2: Physico-chemical and stability standardization outcomes.

Parameter Tested	Evaluation Methodology	Observed Research Outcome
Physical Form & Color	Visual inspection under direct light source	Smooth yellow semi-liquid lotion matrix
Odor Profile	Sensory panel assessment	Characteristic therapeutic camphoraceous scent
pH Value	Digital pH meter potentiometry (1% w/v dispersion)	6.4 – 6.9 (Highly skin-compatible range)
Homogeneity / Grittiness	Tactile rubbing and slide smear evaluation	Excellent structural uniformity; zero grittiness
Phase Separation	Centrifugation at 3000 rpm for 20 minutes	No phase separation or oil bleeding observed
Estimated Shelf Stability	Accelerated kinetic storage monitoring	Stable for 2–3 years (Anhydrous system benefit)

The volatile camphor provides immediate local relief to pruritus, while the synergistic action of elemental sulphur strips back hyperkeratinized sheets, granting curcumin unrestricted entry to wipe out deep-seated bacterial and fungal populations [14, 16, 25].

Conclusion

This study successfully developed an optimized anti-infective topical preparation using traditional Ayurvedic principles. By deploying a water-free lipid carrier network (Coconut oil/Beeswax), the formulation eliminates risks of chemical skin irritation or microbial spoilage without requiring synthetic preservatives. The multi-target actions of camphor, sulphur, and turmeric deliver a robust therapeutic alternative for managing superficial skin infections safely and cost-effectively.

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