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Review Paper

Herbo-Dual Therapy: A Synergistic Action of Alli-Neem in the Management of Tenia Pedis

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ABSTRACT

The present study aims to formulate and evaluate an herbal antifungal and analgesic foot mask using natural and safe bioactive ingredients to maintain foot hygiene, relieve pain, and prevent fungal infections. The key active components Tea Tree Oil and Garlic Extract are well recognized for their strong antifungal, antibacterial, and anti-inflammatory properties. Supporting ingredients such as Neem Oil, Clove Oil, and Peppermint Oil enhance antimicrobial action, provide deodorizing effects, and impart soothing and analgesic properties to tired or inflamed feet. Additionally, Glycolic Acid and Salicylic Acid function as mild exfoliating and keratolytic agents, assisting in the removal of dead skin cells and improving absorption of actives. Linoleic Acid, Aloe Vera, and Urea contribute to moisturization, skin repair, and softening, restoring the natural elasticity and smoothness of the skin. The synergistic combination of these components results in a multifunctional formulation offering antifungal protection, pain relief, exfoliation, and hydration in a single product. The developed foot mask thus provides a natural, safe, and effective alternative to conventional synthetic antifungal preparations, promoting overall foot care and comfort through the integration of herbal and dermatologically active constituents.

INTRODUCTION

Framework of Foot

The human foot, being the primary weight-bearing structure, is continuously exposed to mechanical

stress, environmental factors, and microbial colonization. These conditions predispose the skin of the feet to xerosis, hyperkeratosis, callus formation, and fissuring, which not only compromise aesthetics but may also predispose individuals to secondary infections and

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discomfort. Unlike facial or hand skin, plantar skin is characterized by a thicker stratum corneum, limited sebaceous gland activity, and slower regenerative capacity, thereby necessitating specialized dermal care interventions. A subcutaneous connective tissue makes a layer on foot sole (2cm). This tissue contains pressure chambers which acts as a shock absorber and stabilizes the sole. Each of these chambers contains fibro fatty tissue covered by a layer of tough connective tissue made of collagen fibres. The sole of the foot is one of the most highly vascularized regions of the body surface. Cracked heels are foot condition that causes discomfort or even pain during walking. It is generally caused due to lack of moisture, deficiencies, pressure, obesity, exposing footwear, hygiene, water, poorly fitted shoes and genetics. Over time it may cause pain and irritations. Vertical cracking of skin at the edge of the soles is seen in many adults of India.



Figure 1.1. Healthy Foot

Foot Mask

Foot masks are emerging as a novel cosmetic and cosmeceutical formulation designed to provide intensive hydration, exfoliation, & nourishment to the skin of the feet. They are available in the form of sheet-based masks, gel-based formulations, or peel-off systems containing active ingredients such as moisturizers, essential oils, herbal extracts, antimicrobial agents and antifungal agent. These formulations act by softening the keratinized layer, promoting exfoliation, and replenishing moisture, thereby improving the texture and appearance of the feet. From a pharmaceutical outlook, foot masks offer an interesting approach to topical delivery of active agents for both cosmetic and therapeutic purposes. Their ease of application, patient compliance, and effectiveness make them a growing area of interest in dermal and cosmetic product development. The formulation and evaluation of a foot mask focus on improving skin hydration, removing of dead skin, and giving overall better foot care. It also explains the role of both natural and synthetic ingredients in making the product work well, safe, & be liked by users. [1,3,5,9,]

TYPES OF FOOT MASKS:

Table 1.1 Types of Foot Mask

Sr.no.	Types	Applications	Images
1	Peel-Off Mask	Exfoliation & treating calluses & rough skin	 Figure.1.2. Peel Off Foot Mask
2	Socks Mask	Hydrating dry skin, cracked heels, D-tanning	 Figure 1.3. Socks Foot Mask

3	Cream Mask	Deep moisturizing & soothing rough area of feet	 Figure 1.4. Cream Foot Mask
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ETIOLOGY OF TENIA PEDIS

1. Causative Organisms

- *Trichophyton rubrum* (most common)
- *Trichophyton interdigital*
- *Epidermophyton floccosum*

These fungi are keratinophilic, meaning they thrive on keratin (a protein in skin, hair, and nails).

2. Mode of Entry

The fungus spreads through direct contact (infected skin scales, contaminated floors, shoes, towels).

Entry points: warm, moist areas between toes or micro-abrasions in skin.

3. Colonization

Dermatophytes attach to the stratum corneum (outer layer of skin).

They secrete keratinases and proteolytic enzymes → break down keratin.

This provides nutrients for fungal growth.

4. Invasion of Epidermis

The fungi penetrate deeper layers of the stratum corneum but rarely invade living tissue.

They release mannans (cell wall components) that suppress local immune response → allowing persistence.

5. Host Immune Response

Innate Immunity: Langerhans cells, neutrophils, and macrophages recognize fungal antigens.

Adaptive Immunity:

Th1/Th17 responses → release cytokines (IL-17, IFN- γ) to control infection.

But fungi can evade immunity by altering antigens and reducing host inflammatory response.

Chronic infection occurs due to weak cell-mediated immunity and fungal immune evasion.

6. Clinical Manifestations

Interdigital type: maceration, fissures, scaling between toes.

Vesicular type: fluid-filled blisters due to inflammation.

Moccasin type: dry, scaly hyperkeratosis of soles.

Inflammatory type: intense redness, pustules, sometimes secondary bacterial infection.

Thus, foot peeling masks offer a non-invasive, effective method of chemical exfoliation that rejuvenates thickened plantar skin by promoting controlled desquamation and regeneration.

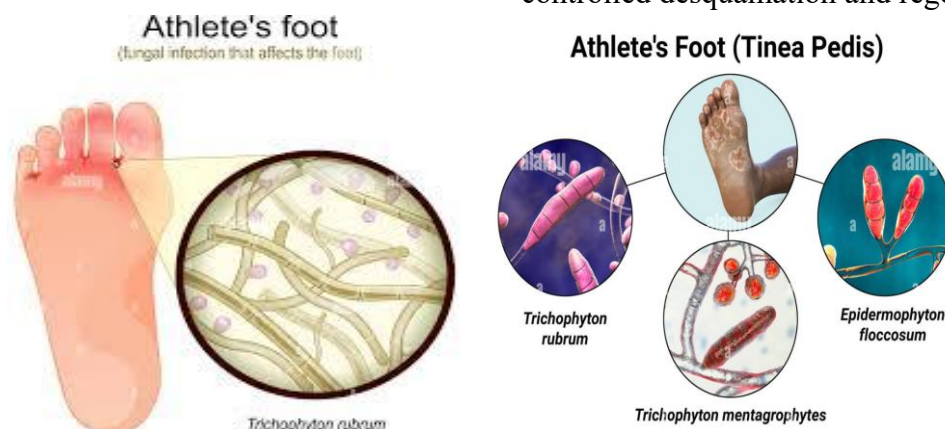


Figure 1.5. Causative Agents of Tenia Pedis

ETIOLOGY OF ANALGESIA

Pain Receptors: -

Pain receptors are free nerve endings that respond to painful stimuli. Pain receptors are found in all tissues in the body except the brain. They transmit information to the brain. They are stimulated by biological, electrical, thermal, mechanical, and chemical stimuli. Pain occurs when these stimuli are transmitted as signals to the spinal cord and then travel toward the central areas of the brain.

There are two main pathways that carry pain signals:

1. Spinothalamic tract:

The pain signal goes from the spinal cord up to a part of the brain called the thalamus, and then to the area that identifies where the pain is coming from.

2. Spinoreticular tract:

This pathway carries pain signals to the brainstem and then to areas of the brain that control the emotional side of pain.

Pain from the face takes a different route through a nerve called the trigeminal nerve.

Pain from the skin, muscles, and joints is called somatic pain.

Pain from internal organs is called visceral pain, and it can feel like it's coming from a different place; this is called referred pain.

FRAMEWORK OF INGREDIENTS

I) Antifungals

Ingredients which target fungi that commonly affect feet (like *Candida* or *Dermatophytes*).

A] Garlic extract

1. Potent Antifungal Activity – Garlic contains allicin and ajoene, which inhibit the growth of dermatophytes responsible for *Tinea pedis*.

2. Broad-Spectrum Effect – Active against various fungi (*Candida*, *Aspergillus*, *Trichophyton* spp.) and some bacteria, giving dual protection.

B] Tea Tree Oil

1. Natural antifungal and antibacterial agent.

2. Reduces fungal growth, itching and odor.

C] Neem Extract

1. Traditional herbal antifungal.

2. Helps heal cracked skin and prevents fungal reinfection.

D] Salicylic Acid (sometimes added)

1. Helps exfoliate thickened fungal-infected skin.

2. Clears dead cells, improving penetration of antifungals.

II) Analgesics

This helps reduce pain, swelling, or burning sensation in feet.

A] Clove oil

1. Block nerve signals in skin.

2. Provide temporary pain relief for cracked heels or sore feet.

B] Peppermint Oil

1. Natural analgesic and refreshing.

2. Improves circulation and gives cooling comfort.

C] Aloe Vera (supportive)

1. Soothes irritated or inflamed skin. [1-7,15-23]

A Brief Description of Ingredients

Garlic: - (*Allium sativum*) is famous for flavour, but it also has real medicinal punch. Certain compounds in it, like ajoene and allicin, are known to mess with fungal metabolism and damage their membranes. Small clinical studies have even compared topical ajoene gels (0.6–1%) with antifungal creams for athlete's foot and found similar results. The catch is that most of this research is older and not very large-scale. And while garlic itself sounds natural and harmless, applying raw garlic on skin can actually cause nasty burns. That's why standardized extracts or purified ajoene are safer choices when used in creams or gels.





Figure 1.6. Garlic Extract

Tea tree oil: - (*Melaleuca alternifolia*) exhibits strong antifungal activity due to its major component terpinen-4-ol, along with other terpenes such as α -terpineol and 1,8-cineole. It acts mainly by disrupting fungal cell membranes, increasing permeability, and causing leakage of cellular contents, leading to cell death. Studies have shown its effectiveness against various fungi, including *Candida* spp. and dermatophytes, by reducing ergosterol content and altering membrane fatty acid composition. These mechanisms contribute to its broad-spectrum antifungal ability, making it a valuable natural agent in topical formulations. [15-18,23]



Figure1.7. Tea Tree Oil

Neem oil: - (*Azadirachta indica*) has been used in traditional medicine for centuries, and now modern research is catching up to explain why. Compounds like azadirachtin and nimbin famous for its antimicrobial and anti-inflammatory punch.

In foot care, it's considered helpful for fungal infections, bacterial colonization, and even small ulcer care. Most of the scientific support comes from lab and animal studies, though some small human trials also show promise. Neem can be used in oils, extracts, or cream bases, and most people tolerate it well. On rare occasions, allergic reactions are possible, but overall, it's considered quite safe.



Figure1.8. Neem Oil

Peppermint oil: - (*Mentha piperita*) is more about comfort than curing. Menthol creates a cooling effect that instantly eases tiredness, itching, or mild burning in the feet. It also freshens up foot odour and adds a light antimicrobial effect, though that's not its main strength. Typically, it's included at very low levels (1–3%) in creams, masks, or sprays. Go too high, and it can irritate the skin, especially if applied on cuts or cracks. Used the right way, though, it gives a refreshing boost that makes foot care products more pleasant to use.



Figure1.9. Peppermint Oil

Clove oil (*Syzygium aromaticum*) (family Myrtaceae), is a potent essential oil known for its broad pharmacological activities. Its major active component, eugenol (70–85%), is primarily responsible for its antifungal, analgesic, and antiseptic properties. Eugenol disrupts fungal cell membrane integrity by altering permeability and inhibiting ergosterol synthesis, leading to fungal death. As an analgesic, eugenol acts by blocking voltage-gated sodium channels and inhibiting prostaglandin synthesis, thereby reducing pain and inflammation. Its antiseptic action arises from its ability to denature microbial proteins and interfere with cell wall synthesis, making it effective against a range of bacteria and fungi. Due to these properties, clove oil is widely used in dental preparations, topical formulations, and herbal antifungal products. [18]



Figure 1.10. clove oil

Salicylic acid a β -hydroxy acid, is widely used in dermatological and cosmetic formulations due to its antifungal, analgesic, and keratolytic/exfoliating properties. As an antifungal, SA disrupts fungal cell walls and inhibits microbial growth, making it effective against dermatophytes and yeasts. Its analgesic action is attributed to the inhibition of cyclooxygenase enzymes, which reduces prostaglandin synthesis and inflammation. The exfoliating/keratolytic effect arises from its ability to solubilize intercellular cement in the stratum corneum, promoting shedding of dead skin cells and enhancing skin renewal. These combined

properties make SA useful in treating acne, fungal infections, psoriasis, and hyperkeratotic skin conditions. [5,8,14]



Figure 1.11. salicylic acid

Antifungal Mechanism of ingredients in Foot Mask

Garlic extract: - exhibits potent antifungal activity primarily due to its sulphur-containing bioactive compounds such as allicin, ajoene, diallyl disulfide, and diallyl trisulfide, among which allicin is the principal antifungal constituent. Allicin is enzymatically produced from the precursor alliin by the action of alliinase when fresh garlic is crushed or processed. The antifungal mechanism of allicin involves its ability to react with thiol (-SH) groups of essential fungal enzymes, leading to enzyme inactivation, disruption of metabolic processes, and damage to the fungal cell membrane, which results in leakage of intracellular contents and loss of cell viability. Additionally, allicin and ajoene interfere with ergosterol biosynthesis, an essential component of fungal cell membranes, thereby impairing membrane integrity and inhibiting fungal growth. Garlic's organosulfur compounds also induce oxidative stress by generating reactive oxygen species (ROS), which cause oxidative damage to fungal proteins, lipids, and DNA. Furthermore, ajoene has been shown to inhibit hyphal formation and biofilm development in *Candida albicans*, reducing fungal virulence and colonization. These combined actions contribute to the broad-spectrum

antifungal efficacy of garlic extract against species such as *Candida albicans*, *Aspergillus Niger*, *Trichophyton rubrum*, and *Cryptococcus neoformans*. The synergistic interaction of allicin, ajoene, and diallyl sulphides makes garlic a powerful natural antifungal agent suitable for topical formulations such as antifungal and analgesic foot masks.

Tea tree oil: - exhibits broad-spectrum antifungal and antimicrobial activity primarily due to its high content of terpene-based compounds, particularly terpinen-4-ol, α -terpineol, γ -terpinene, and 1,8-cineole. Among these, terpinen-4-ol is identified as the main active constituent responsible for antifungal activity. The mechanism of action involves disruption of fungal cell membrane integrity by altering the lipid bilayer structure, leading to increased membrane permeability, leakage of intracellular ions and metabolites, and ultimately cell lysis. This membrane disruption impairs essential cellular processes, including respiration and energy production. Additionally, tea tree oil components interfere with ergosterol biosynthesis, an essential sterol in fungal membranes, thereby compromising membrane stability and inhibiting fungal growth. The generation of reactive oxygen species (ROS) and oxidative stress further contributes to cellular damage and apoptosis in fungal cells. Tea tree oil has shown pronounced antifungal efficacy against species such as *Candida albicans*, *Trichophyton rubrum*, and *Aspergillus Niger*. The synergistic interaction of terpinen-4-ol with α -terpineol and cineole enhances the overall fungicidal effect, making tea tree oil an effective natural antifungal agent suitable for topical applications like antifungal and analgesic foot masks.

Neem oil: - Neem oil exhibits potent antifungal, antimicrobial, and deodorising properties due to its rich phytochemical profile, including nimbidin,

nimbin, nimbidol, azadirachtin, gedunin, and salannin. The primary antifungal action of neem oil is attributed to nimbidol and nimbidin, which disrupt fungal cell wall and cell membrane, leading to leakage of intracellular contents and inhibition of spore germination. Azadirachtin and gedunin interfere with ergosterol biosynthesis, an essential component for maintaining fungal cell membrane stability, thereby inhibiting fungal proliferation. Additionally, neem oil induces oxidative stress through the generation of reactive oxygen species (ROS), further contributing to fungal cell death. Its antimicrobial activity arises from the combined effects of azadirachtin, nimbidin, and limonoids, which disrupt bacterial membranes and inhibit key enzymes involved in microbial metabolism. The deodorising property of neem oil is primarily due to nimbidin, terpenoids, and fatty acids that suppress odour-causing bacterial growth (*Corynebacterium* spp.) and neutralise unpleasant odours through natural aromatic components. Thus, neem oil serves as an effective natural agent in topical formulations such as antifungal and analgesic foot masks, providing both antimicrobial protection and deodorising benefits. Various phytochemical tests have identified the existence of flavonoids, alkaloids, carotenoids, steroids, phenolic compounds, azadirachtin, nimbidin, and triterpenoids in this plant. These components are imparting potent analgesic and anti-inflammatory properties.

Aloe vera: - The antifungal activity of Aloe vera is primarily associated with anthraquinones, saponins, and phenolic compounds, which act synergistically and inhibit ergosterol biosynthesis, leading to leakage of intracellular contents and fungal cell death. Additionally, Aloe polysaccharides enhance the immune defence by stimulating macrophage activity and promoting wound healing, further contributing to antifungal protection. Studies have demonstrated that Aloe



vera gel and its extracts show strong inhibitory effects against pathogenic fungi such as *Candida albicans*, *Aspergillus Niger*, and *Trichophyton mentagrophytes*. The combination of salicylic acid's anti-inflammatory action and anthraquinone's antifungal effect makes Aloe vera an effective natural bioactive agent for topical analgesic and antifungal formulations, such as foot masks and healing gels.

Analgesic Mechanism of ingredients in Foot Mask

Peppermint oil: - Peppermint oil possesses significant analgesic, anti-inflammatory, and mild antifungal activities attributed mainly to its monoterpenoid constituents, particularly menthol, menthone, menthol acetate, and 1,8-cineole. The primary constituent menthol is chiefly responsible for the analgesic mechanism, which acts through the activation of transient receptor potential mela statin 8 (TRPM8) channels on sensory neurons. This activation produces a cooling sensation that modulates pain perception by blocking voltage-gated sodium channels and reducing neuronal excitability, thereby decreasing the transmission of pain signals. Menthol also exhibits a mild anti-inflammatory effect by inhibiting cyclooxygenase (COX) enzymes and reducing the synthesis of prostaglandins, which are key mediators of inflammation and pain. In addition to its analgesic properties, peppermint oil shows antifungal activity primarily due to the actions of menthol and menthone, which disrupt the fungal cell membrane structure, increase permeability, and inhibit ergosterol synthesis, leading to cell lysis and inhibition of fungal growth. Peppermint oil has demonstrated efficacy against fungal strains such as *Candida albicans*, *Aspergillus Niger*, and *Trichophyton rubrum*. The dual activity of menthol producing analgesia via neuronal modulation and antifungal action via membrane disruption makes peppermint oil a valuable

bioactive component in topical formulations like antifungal and analgesic foot masks. essential oils have potent anti-spasmodic properties which are mostly attributed to menthol.

Clove oil: - possesses potent analgesic, anti-inflammatory, and antifungal activities, primarily attributed to its major bioactive component eugenol, along with minor constituents such as eugenol acetate, β -caryophyllene, and vanillin. The analgesic mechanism of clove oil is mainly mediated by eugenol, a phenolic compound that acts through inhibition of prostaglandin synthesis by blocking cyclooxygenase (COX-2) and lipoxygenase (LOX) pathways, thereby reducing the production of inflammatory mediators responsible for pain sensation. Additionally, eugenol modulates voltage-gated sodium and calcium channels, decreasing neuronal excitability and producing a local anaesthetic effect by blocking the conduction of pain impulses at peripheral nerve endings. Alongside its analgesic action, eugenol also exhibits potent antifungal activity by disrupting fungal cell membranes, leading to leakage of intracellular materials and inhibition of ergosterol biosynthesis an essential component for maintaining fungal cell membrane integrity. This dual mechanism results in both fungistatic and fungicidal effects against pathogenic fungi such as *Candida albicans*, *Aspergillus Niger*, and *Trichophyton rubrum*. The phenolic hydroxyl group of eugenol facilitates membrane permeability changes and oxidative stress generation within fungal cells, contributing further to its antifungal potency. Hence, clove oil, due to the multifunctional action of eugenol, serves as a valuable natural ingredient in topical formulations like antifungal and analgesic foot masks, providing both pain relief and antimicrobial protection it is reported that clove has anti-inflammatory, pain-relieving, and anaesthetic effects on animal models, suppressing



prostaglandins and other inflammatory mediators to reduce the pain perception by sensory receptors, and impair the capacity for action in sciatic nerves.

Aloe vera: - possesses significant analgesic, anti-inflammatory, and antifungal activities due to its rich phytochemical composition, which includes anthraquinones (aloin, emodin), saponins, salicylic acid, flavonoids, and polysaccharides. The analgesic mechanism of Aloe vera is mainly attributed to the presence of salicylic acid and anthraquinone derivatives such as aloin and emodin, which act by inhibiting cyclooxygenase (COX) and prostaglandin synthesis pathways, thereby reducing inflammation and pain perception. These compounds also modulate the transient receptor potential (TRP) ion channels and suppress the generation of reactive oxygen species

(ROS), which helps in minimizing nociceptive signalling and tissue irritation.

COMPARISON

Herbal Foot Mask & Chemical Foot Mask

Herbal foot masks use natural ingredients to soothe, hydrate, and mildly exfoliate, focusing on gentle, nurturing care, while chemical foot masks employ strong exfoliating acids like lactic and linoleic acid to dissolve dead skin, resulting in a dramatic peel and significantly smoother skin. Herbal masks are suitable for sensitive skin and ongoing hydration, whereas chemical masks are best for severe calluses but require caution to avoid irritation. [1,2]

Key Difference

Table 1.2 Comparison Between Conventional & Novel Foot Mask

Features	Herbal Foot Mask	Chemical Foot Mask
Primary function	Hydrating, soothing, nourishment	Deep exfoliation, remove dead skin
Key ingredients	Natural extracts, oils	Exfoliating acids
Effects	Gentle hydration & refreshment	Intense exfoliation & skin peeling
Best for	Gentle foot care, soothing & moisturizing	Eliminating calluses & rough skin
Result	Soft, hydrate, & gently renewed feet	Dramatic peeling followed by very smooth skin

COMMON CONDITIONS OF FEET

- A fungal infection such as [athlete's] foot between your toes.
- Scaly peeling or cracked skin between the toes.
- Small blisters at the edge of the foot.
- Dry, flaky skin on the sole of the foot.



- Itching and stinging between the toes.
 - Inflamed skin that might appear red-purple or greyish depending on your skin colour.
- [6,10,20]



Figure 1.12. common conditions of feet [Athlete's foot]

ADVANTAGES OF FOOTMASK OVER THE CONVENTIONAL CREAMS & LOTIONS

[6]

- ❖ Safety and biocompatibility, as herbal formulations are generally free from harmful synthetic chemicals and artificial scents minimize the risk of skin irritation or allergic reactions.
- ❖ Herbal foot masks are their natural exfoliating and moisturizing action.
- ❖ Herbal foot masks can also enhance blood circulation in the foot region, promoting relaxation and relieving fatigue.
- ❖ Eco-friendly and sustainable.
- ❖ It completely eliminates the dead cells from the skin.

- ❖ It penetrates the skin and provides deeply nourishing the skin.
- ❖ It provides moisture to cracked feet.
- ❖ It promoting the infection free and healthy skin.
- ❖ Herbal component regenerate skin and improve microcirculation.
- ❖ As compared to creams and lotions herbal foot masks form a semi-occlusive layer that allows better penetration of active ingredients while maintaining skin moisture balance.

MATERIALS & METHODS

➤ PROPOSED COMPOSITION [5-8,11]

Table 1.3. The Proposed Composition for the Formulation of Foot Mask.

Sr.no.	Ingredients	Constituents	Category	Image
1.	Garlic extract	Allicin	Antifungal	

2.	Neem oil	Azadirachtin, Nimbin,	Analgesic, Antimicrobial	
3.	Peppermint oil	Menthol, Menthone	Analgesic, anti-inflammatory	
4.	Clove oil	Eugenol, Eugenol acetate	antiseptic Analgesic,	
5.	Tea tree oil	Terpinene-4-ol, 1,8-cineole	Antifungal, antimicrobial	
6.	Aloe vera	Aloin, emodin	Anti-inflammatory, Antioxidant	
7.	Urea	-	Exfoliating, moisturizing	
8.	Linoleic acid	-	Nourishing, wound healing	
9.	Salicylic acid	-	Exfoliating, soothing	
10.	Lactic acid	-	Exfoliating, Nourishing,	

➤ MANUFACTURING PROCESSES



The following methodology gives systematic steps involved in developing the formulation. These steps include various methods to ensure the product quality and performance standards.

- 1.Preparation of water phase
- 2.Preparation of oil phase
- 3.Mixing of phases
- 4.Blending
- 5.pH determination & safety
- 6.Final mixing
- 7.Packaging

1.Preparation of water phase

- Take a clean beaker & distilled water, warm it slightly (not too hot).
- Add aloe vera gel and mix until it becomes smooth.
- Add urea, lactic acid, and salicylic acid these help soften hard skin and remove dead skin.
- Mix gently until everything dissolves completely.

2.Preparation of oil phase

- In another container, add: Tea tree oil, Neem oil, Peppermint oil, Clove oil, Linoleic acid
- Mix these oils together.
- Add garlic extract.
- Blend lightly so all oils combine evenly.

3.Mixing of phases

- Slowly add the oil phase into the water phase while continuously stirring.
- Mild emulsifying agent is used if needed so that avoid the separation.
- Keep mixing until the mixture becomes uniform.

4.Blending

- Add a thickening agent (like xanthan gum or carbomer) to make the mask feel soft and spreadable.
- Mix until the lumps free smooth, creamy consistency occurs.

5.pH determination & safety

- Adjust the pH between 4.5–5.5, which is safe for foot skin.
- Add a mild natural preservative to prevent spoilage (like phenoxyethanol or potassium sorbate).

6.Final mixing & Filling and packaging

- Fill the foot mask into clean jars, tubes, or sachets.
- Seal properly to avoid contamination.
- Label the product with directions.

EVALUATION PARAMETERS FOR FOOT MASK

To ensure product quality, the formulate cream will be subjected to the following evaluations:

1. Physicochemical Evaluation [5-9]

a. Appearance and Organoleptic Properties

The formulated foot mask was visually examined for colour, homogeneity, and the absence of lumps or phase separation. The texture and Odor were also assessed to ensure an acceptable cosmetic feel. A uniform, smooth, and non-greasy appearance without visible aggregates indicated good physical stability of the formulation.

b. Weight and Dose Uniformity

To confirm product uniformity, the weight of individual masks ($n = 10$) was measure using a digital balance. A variation of less than ± 5 –10% from the mean weight was considered acceptable. Consistent mask weight ensures accurate dosing and reproducible therapeutic effects.

c. pH Measurement

The pH of the formulation was determined by dispersing 1 g of mask in 10 mL of distilled water and measuring with a calibrated pH meter at 25 °C. Maintaining the pH in the range of 5.0–7.0 ensures compatibility with the natural skin environment and minimizes the risk of irritation upon application.



d. Viscosity and Rheology

Viscosity was measured using a Brookfield viscometer at 25 °C with spindle number 64 at 10 rpm. Rheological behaviour was observed to determine whether the mask exhibited pseudoplastic flow, which facilitates easy application and spreading on the skin. Optimal viscosity prevents dripping while maintaining smooth coverage.

e. Spread ability

Spread ability was evaluated by the parallel-plate method, where a fixed amount of formulation was sandwiched between two glass plates and subjected to a defined weight. The diameter of spread was measured after a set time. Better spread ability reflects ease of application and uniform distribution of actives over the skin surface.

f. Adhesive Strength (Tack Test)

Adhesive properties were assessed using a texture analyser in peel-off mode. The test measured the force required to detach the mask from a skin-like surface. Sufficient adhesion is necessary to maintain contact during use, but the mask should also be easily removable without discomfort.

g. Moisture Content

Determined by the loss-on-drying method at 105 °C until constant weight. Water activity was also checked to assess microbial growth risk. Values below 0.6 indicate minimal susceptibility to microbial contamination. Controlled moisture ensures flexibility of the mask and prolongs shelf life.

2. Chemical and Analytical Evaluation

a. Drug Content Determination

The content of antifungal and analgesic drugs in the mask was quantified by a validated HPLC method. A suitable mobile phase and detection wavelength were optimized for each drug. Results were expressed as percentage of label claim. Drug content between 90–110% of the theoretical value confirmed uniform distribution.

b. Content Uniformity

Ten randomly selected masks were analysed individually for drug content. The percent drug content of each sample was calculated, and relative standard deviation (RSD) was determined. Uniformity ensures that every unit delivers the same therapeutic dose.

c. In Vitro Drug Release (IVRT) [8,25-27]

The release behaviour of active agents from the foot mask was studied using a Franz diffusion cell equipped with a synthetic membrane. The donor compartment contained the mask formulation. The receptor chamber was filled with the fresh buffer (pH 7.4) and was kept at 32 °C, similar to skin temperature. It was stirred continuously. At each time point, a small amount of liquid was taken out and replaced with fresh buffer. These samples were then checked using HPLC to see how much drug was released.

d. Skin Permeation and Retention (IVPT)

Permeation studies were performed using excised porcine skin mounted on Franz diffusion cells. The receptor medium was phosphate buffer (pH 7.4) containing 1% polysorbate 80 to maintain sink conditions. After the experiment, drug content in both receptor medium and skin layers (epidermis and dermis) was tested. These results demonstrate the ability of the formulation to deliver active constituents into the skin layers effectively.

3. Biological Evaluation

a. Antifungal Activity (Agar Diffusion Method) [29]

Antifungal activity was initially screened by the agar well-diffusion method using *Candida albicans*, *Trichophyton rubrum*, and *Aspergillus Niger*. Wells were filled with the test formulation, placebo, and a standard antifungal (clotrimazole or terbinafine). Plates were incubated at 28 °C for 48 hours, and zones of inhibition were measured. A larger zone indicated stronger antifungal activity,

confirming the mask's potential to inhibit fungal growth on the skin.

b. Minimum Inhibitory and Fungicidal Concentrations (MIC and MFC)

MIC was determined using the broth microdilution technique as per CLSI guidelines (M27 for yeasts, M38 for Molds). Serial dilutions of the formulation were inoculated with fungal cultures. The minimum concentration showing no fungal growth was recorded as MIC.

For MFC, small fraction from clear tubes were plated on drug-free agar; the lowest concentration showing no colony growth was noted as the MFC value.

Lower MIC and MFC values signify higher antifungal potency.

c. Time-Kill Kinetics

To evaluate the rate of fungal killing, time-kill assays were performed by exposing fungal cultures to the formulation at different time intervals. Viable counts were determined by colony-forming unit (CFU) enumeration. A 3-log₁₀ reduction in CFU within 24 hours indicated fungicidal action.

d. Anti-Biofilm Activity

Biofilm formation by *Candida* species was induced in microtiter plates, treated with the formulation, and quantified by crystal violet staining. Reduction in optical density compared to control wells demonstrated inhibition or disruption of fungal biofilms, which are often responsible for chronic infections.

4. Analgesic Evaluation

a. Experimental Pain Model

The analgesic potential of the foot mask was assessed using the capsaicin-induced pain model on healthy volunteers or animal skin models. The burning sensation was induced by applying capsaicin solution, followed by the mask. Strength of pain was measured using a Visual Analog Scale (VAS, 0–100 mm) at 0, 30, 60, 120, and 240

minutes. A significant reduction in VAS scores compared to control indicated effective analgesic action.

b. Clinical Pain Assessment

For human application studies, volunteers rated pain on a Numeric Rating Scale (NRS 0–10). Average pain reduction, onset of relief, and duration of effect were recorded. The mask providing faster onset and longer duration of pain relief was considered more effective.

c. Mechanism of Analgesic Effect

Analgesic activity is generally due to the inhibition of local inflammatory mediators or desensitization of nociceptors by active components such as menthol, peppermint oil, or clove oil. These constituents enhance skin cooling and suppress pain transmission, contributing to soothing comfort during use.

5. Safety and Biocompatibility Tests

a. In Vitro Cytotoxicity

Cytotoxicity of the formulation was tested on human keratinocyte (HaCaT) cell lines using the MTT assay. Cells were treated with varying concentrations of the mask extract, and cell viability was calculated. Viability above 80 % confirmed that the formulation was non-toxic to skin cells.

b. In Vitro Skin Irritation Test

Tissue viability after 24 hours of exposure was measured by MTT assay. A viability greater than 50 % indicated that the formulation was non-irritant and suitable for topical application.

c. Patch Test and HRIPT [26]

To ensure safety on human skin, a 24–48-hour patch test was conducted on healthy volunteers. The skin was examined for erythema, itching, or edema. Absence of visible reactions confirmed the product has dermal compatibility. For extended safety assessment, a Human Repeat Insult Patch Test (HRIPT) was also performed to check out sensitization.



6. Microbiological and Stability Studies

a. Microbial Limit Test

Samples of the foot mask were tested for total aerobic microbial count and specific pathogens such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Candida albicans*. Results within pharmacopeial limits indicated suitable microbiological quality.

b. Preservative Efficacy Test (PET)

Test was carried out by inoculating the formulation with known microbial strains and measuring viable counts at predetermined intervals. A reduction of ≥ 3 log CFU within 7 days demonstrated adequate preservative effectiveness.

c. Stability Testing [28,31]

Long-term stability studies were performed as per ICH Q1A (R2) guidelines. Samples were stored at $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C} / 75\text{ \% RH} \pm 5\text{ \% RH}$ and $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C} / 60\text{ \% RH} \pm 5\text{ \% RH}$ (long-term) up to six months. Periodic evaluation of appearance, pH, viscosity, and drug content revealed no significant changes, confirming good stability of the product.

d. Packaging Compatibility

The filled masks were evaluated for leakage, material interaction, and physical integrity during storage. Absence of leaks or discoloration indicated that the packaging material was compatible with the formulation.

APPLICATIONS OF FOOT MASKS

1. Treatment and Prevention of Fungal Infections

Antifungal and analgesic foot masks are primarily applied to treat and prevent fungal infections such as athlete's foot (*Tinea pedis*) and onychomycosis. Natural antifungal ingredients like tea tree oil, garlic extract, and neem oil are known to inhibit fungal growth by disrupting the fungal cell membrane and preventing spore proliferation. Regular use reduces symptoms such as itching, redness, and scaling.

2. Pain Relief and Anti-inflammatory Action

Essential oils such as peppermint, clove, and menthol provide analgesic and anti-inflammatory effects through local cooling and desensitization of nociceptor. These properties help relieve muscle soreness, burning sensations, and foot fatigue, making the mask suitable for daily comfort or after physical activity.

3. Skin Softening and Exfoliation

Ingredients like urea, salicylic acid, and glycolic acid exhibit keratolytic activity, promoting the removal of dead skin cells and callus softening. This results in smoother, hydrated, and rejuvenated skin, improving the overall texture of the feet.

4. Wound Healing and Tissue Repair

Aloe vera, linoleic acid, and neem oil contribute to skin regeneration and wound healing by enhancing collagen synthesis and reducing oxidative stress. The mask helps repair minor fissures, cuts, and abrasions, maintaining skin barrier integrity.

5. Odor Control and Antimicrobial Protection

The antimicrobial and deodorizing effects of clove oil, tea tree oil, and neem oil inhibit odour-causing bacteria and prevent microbial colonization. This ensures freshness, hygiene, and infection prevention in humid or occlusive environments such as footwear.

6. Moisturization and Hydration

Humectant components such as urea and aloe vera gel provide deep hydration, making the mask beneficial for dry or cracked skin. Continuous hydration also helps in preventing fungal recurrence, as dry, damaged skin is more prone to infection.

7. Cosmetic and Post-Pedicure Care

In cosmetic or spa settings, the foot mask serves as a soothing and protective treatment post-pedicure, reducing irritation and preventing microbial contamination. It supports aesthetic care and maintenance of healthy, soft feet.

8. Supportive Therapy for Dermatological Condition



The formulation can act as adjunctive therapy in conditions such as eczema, psoriasis, and contact dermatitis affecting the feet. The anti-inflammatory and antimicrobial combination reduces secondary infection and promotes healing.

9. Therapeutic Use in Sports and Fitness

Athletes and active individuals often experience fungal infections and pain due to sweat accumulation and friction. Regular use of the mask aids in preventing fungal growth, reducing soreness, and maintaining foot hygiene.

10. Relaxation and Aromatherapy Benefits

The natural aroma and cooling sensation from essential oils such as peppermint and tea tree induce mental relaxation, reduce stress, and enhance circulation. This makes the mask both a therapeutic and cosmetic product. [10-20,29-30]

LIMITATION OF FOOT MASK

- ❖ Action period - It is having short duration of action, such as softer skin, smoother, tend to diminish after few days, Reapplication of product is required for ongoing effect.
- ❖ Cosmetic purpose- Rather than medical conditions like persistent dryness that may need professional care.
- ❖ Skin reaction for sensitive skin- May experience adverse reactions such as irritation excess exfoliation, making the product inappropriate for universal use.
- ❖ Skin physiological balance- Deplete the skins natural lipids, potential result may be dryness, increased sensitivity.
- ❖ Unpleasant Odor - They may contain the ingredients that may leave behind unwanted smell, stick film.
- ❖ Temporary nature- Higher coats compare with the long-term foot care.

FUTURE PERSPECTIVES

The future of herbal antifungal foot masks appears highly promising, driven by the increasing preference for natural and eco-friendly options in healthcare. These formulations, prepared from plant extracts with inherent antifungal activity, provide a holistic and safer approach to the management of fungal infections. Growing awareness of the limitations and potential side effects of synthetic antifungal drugs has encouraged greater interest in herbal alternatives. In comparison, herbal foot masks are generally better tolerated and less likely to cause adverse effects. Moreover, the rich diversity of bioactive phytochemicals present in medicinal plants allows for effective action against a wide spectrum of fungal strains. Integrating traditional herbal knowledge with modern pharmaceutical research offers significant potential for the development of novel, effective, and sustainable antifungal formulations in the future.

CONCLUSION

The study of foot masks highlights their growing relevance in both cosmetic and therapeutic care. They serve as an effective solution for hydration, exfoliation, and overall foot health, making them valuable in daily self-care routines. With advancements in natural formulations and sustainable materials, foot masks are likely to gain wider acceptance as safe and convenient alternatives to conventional products. In conclusion, foot masks hold strong potential to contribute not only to beauty and comfort but also to preventive healthcare.

REFERENCES

1. Soleymani T, Lanoue J, Rahman Z. A practical approach to chemical peels: A review of fundamentals and step-by-step algorithmic protocol for treatment. *J Clin Aesthet Dermatol*. 2018;11(8):21–28.



2. Samargandy S, Raggio BS. Chemical peels for skin resurfacing. In. Treasure Island (FL): Stat Pearls Publishing; 2023 Oct 29.
3. Typology Skincare. Why should you do a foot peeling mask? Typology UK; 2025.
4. Ingale NA, Nagargoje PR, Surwase KP. Formulation and evaluation of foot care cream. IJARST. 2025;5(1).
5. Bisai A, Tandi DY, Singh V, Kumar N, Sahu GK, Sharma H. The role of herbal medicines for treatment of fungal infections: A systematic review. Int J Biol Pharm Allied Sci. 2025;14(1):215-227.
6. Bisai A, Singh V, Kumar N, Tandi DY, Sharma H, Sahu GK. Formulation and evaluation of herbal antifungal cream. *Acta Sci Pharm Sci*. 2024;8(6).
7. Gruwa A, Verma R, Kumar S, Singh S, Chohan JS. To study formulation, evaluation, and stability testing methods of herbal cream for regulatory compliance. *Int J Res Pharm Sci*. 2023;8(3):16–19.
8. Powar AD, Nitave SA. A review – polyherbal antifungal cream. *World J Pharm Res*. 2022;11(5):904–920.
9. Malgunde G, Varadkar V, Pise V, Chavan D, Desai S, Chavan P, et al. Herbal antifungal foot cream. *Int J Pharm Sci*. 2025;3(3):2678–2685.
10. Bohn M, Kraus M. Urea in dermatology: A review of its mode of action and use in dry skin conditions. *J Cosmet Dermatol*. 2016;15(4):465–472.
11. Chanda S, Rakholiya K. Combination therapy: Synergism between natural plant extracts and antibiotics against infectious diseases. *Sci Against Microbe Patho*. 2011:520–529.
12. Craig JP, Singh I, Tadros T. Peppermint oil: Pharmacological and therapeutic properties. *Phytother Res*. 2016;30(8):1239–1246.
13. Dhanasekaran D, Thajuddin N, Panneerselvam A. Herbal and natural remedies for skin disorders. *Res J Med Plant*. 2014;8(2):87–101.
14. Hammer KA, Carson CF, Riley TV. Antifungal effects of *Melaleuca alternifolia* (tea tree) oil and its components on *Candida albicans*, *Candida glabrata*, and *Saccharomyces cerevisiae*. *J Antimicrobe Chemother*. 2012;69(6):1407–1415.
15. Jung SH, Lee HG, Lee J. Antifungal activity of essential oils against *Trichophyton mentagrophytes* and *Tinea pedis*. *Mycobiology*. 2010;38(1):77–81.
16. Lis-Balchin M. Aromatherapy science: A guide for healthcare professionals. London: Pharmaceutical Press; 2002.
17. Park MJ, Gwak KS, Yang I, Choi WS, Jo HJ. Antifungal activities of the essential oils in combination with ketoconazole against *Trichophyton* species. *J Appl Microbiol*. 2007;103(2):710–718.
18. Rahman S, Carter P, Bhattarai N. Aloe vera for tissue engineering applications. *J Funct Biomater*. 2011;2(3):125–141.
19. Rich P. Skin care and barrier protection in foot health. *Foot Ankle Clin*. 2013;18(3):563–578.
20. Surjushe A, Vasani R, Saple DG. Aloe vera: A short review. *Indian J Dermatol*. 2008;53(4):163–166.
21. Carson CF, Hammer KA, Riley TV. *Melaleuca alternifolia* (Tea Tree) oil: A review of antimicrobial and other medicinal properties. *Clin Microbial Rev*. 2006;19(1):50–62.
22. Elewski BE. Topical antifungal therapy in dermatology. *Dermatol Ther*. 2000;13(1):5–19.
23. Radha MH, Laxmipriya NP. Evaluation of biological properties and clinical effectiveness of Aloe vera: A systematic

- review. *J Tradit Complement Med.* 2015;5(1):21–26.
24. U.S. Food and Drug Administration (FDA). In vitro bioequivalence data for a topical product.
 25. Human repeat insult patch test (HRIPT) protocols and reviews.
 26. International Council for Harmonisation (ICH). Q1A(R2) Stability testing of new drug substances and products.
 27. Anand P, et al. Topical capsaicin for pain management: Mechanisms and clinical evidence. 2011.
 28. Espinel-Ingroff A, et al. Multicentre evaluation of a new disk agar diffusion method for yeasts.
 29. Jung SH, Lee HG, Lee J. Antifungal activity of essential oils against *Trichophyton mentagrophytes* and *Tinea pedis*. *Mycobiology.* 2010;38(1):77–81.
 30. Gruwa A, Verma R, Kumar S, Singh S, Chohan JS. To study formulation, evaluation and stability testing methods of herbal cream as regulatory compliance. *Int J Res Pharm Pharm Sci.* 2023;8(3):16–19.

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