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Review Article

Systematic Development and Performance Evaluation of Polyherbal Antifungal Soap

Omprakash Dewangan, Shweta Ram*, Suchita Wamankar, Dr. Gyanesh Kumar Sahu

Rungta Institute of Pharmaceutical Sciences, Bhilai

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ABSTRACT

Among the most prevalent skin conditions are fungal infections, particularly in areas with warm, humid climates. Microorganisms that develop quickly on the skin's surface, like yeasts and dermatophytes, are the primary cause of many diseases. While using synthetic chemical-based soaps may offer short-term comfort, prolonged use may result in dryness, inflammation. Because herbal and natural skincare products are safe and have few negative effects, their popularity has grown in recent years. For generations, traditional healthcare systems have utilized plant-based compounds because of their well-known medicinal qualities. In addition to offering extra advantages like protection and nourishment, herbal formulas are typically kind to the skin. The creation of a herbal antifungal soap with components including coconut oil, castor oil, neem, turmeric, tea tree oil, lemongrass oil, and clove is the main emphasis of this study. These components have antibacterial, antifungal, and anti-inflammatory properties. The cold process method was used to make the soap, and its efficacy and quality were assessed. The results indicate that the created soap is safe to use on a regular basis and could naturally aid in the prevention of fungal diseases.

INTRODUCTION

Skin fungal infections are prevalent health issues that impact people of all ages. Fungi like yeasts and dermatophytes, which thrive in warm, humid conditions, are the primary cause of these illnesses. Skin folds, feet, and underarms are among the body parts that are more prone to infection. Itching, redness, inflammation, and scaling are examples of symptoms that can be uncomfortable and increase if left untreated.[2]

People are more likely to get skin infections because of their current lifestyle, which exposes them to environmental elements including sweat, pollution, and inadequate hygiene. However,

***Corresponding Author:** Shweta Ram
Address: *Rungta Institute of Pharmaceutical Sciences, Bhilai*
Email : shwetaram2000@gmail.com
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continuous use of chemical-based soaps and skincare products might harm the skin's natural barrier. The need for safer and more skin-friendly substitutes has grown as a result.[2]

Because they come from natural sources and are thought to be safer for long-term usage, herbal products have become more and more popular. These products enhance the general health of the skin in addition to aiding in the treatment of infections. In addition to offering extra therapeutic advantages, the use of herbal compounds lowers the possibility of adverse effects.[3] Neem, turmeric, tea tree oil, lemongrass oil, and clove are the active herbal compounds in the current formulation, which also contains base oils like coconut oil and castor oil. Castor oil improves lather creation, while coconut oil offers moisturizing qualities. Lemongrass oil has antibacterial and fragrant qualities, clove has antiseptic qualities, neem and tea tree oil are potent antifungal agents, and turmeric reduces inflammation.[3]

This study's goal is to use these substances to make and assess a herbal antifungal soap. The goal of the formulation is to offer a safe, affordable, and efficient substitute for synthetic soaps. Additionally, it supports the idea of herbal-based formulations in contemporary pharmaceutical and cosmetic applications and encourages the use of natural resources in cosmetics.[2]

Fungal infection

Fungi are microscopic organisms that develop on the skin's surface and produce fungal infections, a common skin condition. Certain body parts, such as the feet, underarms, groin, and skin folds, are especially susceptible to these organisms since they typically flourish in warm, humid, and wet environments. Although fungal infections are usually not fatal, improper treatment can result in discomfort and irritation. They can be spread via direct touch, contaminated surfaces, and easy movement from one place to another.[5]

Itching, redness, rashes, and dry or scaly skin are the primary signs of a fungal infection. There may also occasionally be a burning feeling or skin discoloration. Excessive perspiration, poor hygiene, tight clothing, low immunity, and sharing personal objects like shoes or towels are all common causes of the infection. However, by using antifungal or herbal remedies on a regular basis, wearing breathable clothing, keeping the skin dry and clean, and practicing good hygiene.[5]

Symptoms of Fungal Infection

Fungal infections can show different symptoms depending on the affected area, but some common signs are:

- **Itching and irritation** – One of the earliest and most common symptoms
- **Redness of skin** – Infected area becomes red and inflamed
- **Rashes or patches** – Circular or irregular shaped patches may appear
- **Dry or scaly skin** – Skin may start peeling or become rough
- **Burning sensation** – Especially in severe infections
- **Cracks in skin** – Infections like athlete's foot can cause skin cracks
- **Discoloration** – Skin may become darker or lighter in the affected area

If not treated properly, the infection may spread to nearby skin areas.[5]

Causes of Fungal Infection

Fungal infections are mainly caused by the growth of fungi due to favorable conditions. Some major causes include:

- **Excess moisture and sweating**: Sweat creates a damp environment where fungi can grow easily
- **Poor personal hygiene**: Not cleaning or drying the body properly increases risk
- **Tight or non-breathable clothing**: Clothes that trap sweat (like synthetic fabrics) promote fungal growth
- **Weak immune system**: People with low immunity are more prone to infections
- **Sharing personal items**: Towels, clothes, or shoes can spread fungal infection from one person to another
- **Walking barefoot in public places**: Places like bathrooms, swimming pools, and gyms are common sources
- **Use of chemical products**: Some harsh soaps disturb the natural skin balance[4]

Prevention of Fungal Infection

Fungal infections can be prevented by maintaining proper hygiene and healthy habits:

- **Keep skin clean and dry**: Always dry body properly after bathing
- **Wear loose and breathable clothes**: Cotton clothes help reduce sweating
- **Avoid sharing personal items**: Use your own towel, clothes, and footwear
- **Maintain good hygiene**: Regular bathing and proper cleaning is important
- **Use antifungal or herbal products**: Natural soaps help prevent infection
- **Change clothes regularly**: Especially after sweating or exercise
- **Boost immunity**: Healthy diet and lifestyle help body fight infections
- **Avoid walking barefoot in public places**: Use slippers in bathrooms and public areas.[5]

Mechanism of Action of Herbal Antifungal Drugs

Natural bioactive chemicals found in plant-based substances are how herbal antifungal medications work. These substances disrupt fungal cells' regular processes in a number of ways. They have the ability to harm fungi's outer cell membrane, which allows vital cell components to seep out and eventually kills the fungal cell. Additionally, certain herbal ingredients delay the spread of infection by blocking the enzymes needed for fungal growth and reproduction.[6]

Additionally, by lowering moisture and preserving skin balance, some herbal substances create an environment that is not conducive to fungus survival. Additionally, they might stop fungus from adhering to the skin's surface, which is a crucial stage in the development of an infection. Herbal antifungal medications are effective and less likely to produce resistance since they function through several routes, in contrast to synthetic drugs that frequently target a single pathway.[6]

Role of Herbal Antifungal Drugs

Herbal antifungal medications are crucial for treating and preventing fungal infections. They aid in lowering fungal development, easing inflammation and itching, and accelerating the skin's healing process. Their antibacterial qualities shield the skin from more infection, while their anti-inflammatory qualities aid in reducing redness and swelling.[6]

Herbal antifungal medications also play a significant role in offering a safer substitute for therapies based on chemicals. They can be used for an extended period of time without causing significant adverse effects and are typically mild on the skin. These herbal formulations are perfect for daily usage in products like herbal antifungal soap because they not only treat infections but also support general skin health by protecting and nourishing the skin.[6]

Herbal Antifungal Soap

Herbal antifungal soap is a specially formulated cleansing product designed to prevent and control fungal infections using natural plant-based ingredients. Unlike chemical soaps that may cause dryness or irritation, this soap combines the benefits of base oils and herbal components to provide both cleansing and therapeutic effects. Ingredients such as Coconut Oil and Castor Oil act as the base, providing moisture and good lather formation, while herbal ingredients like Neem, Turmeric, Tea Tree Oil, Lemongrass Oil, and Clove work as active agents. These natural components contain bioactive compounds that help in damaging the fungal cell structure, inhibiting their growth, and preventing further spread of infection. At the same time, they soothe the skin, reduce inflammation, and promote healing of affected areas.[6]

The soap works effectively by maintaining proper skin hygiene and creating an environment that is unfavorable for fungal growth. Regular use helps in removing dirt, sweat, and excess oil from the skin, which are common factors responsible for fungal infections. Additionally, the presence of antifungal and antibacterial properties in herbal ingredients provides long-term protection without disturbing the natural balance of the skin. This makes herbal antifungal soap a safe, economical, and suitable option for daily use, especially for individuals living in humid conditions or those who are prone to recurrent skin infections.[6]

MATERIALS AND METHODS

1. Turmeric

Biological name: Curcuma longa

Common name: haldi

Chemical constituents: protein, fat, Mineral and Carbohydrates.

Part typically used: root

Pharmacological Action: Antifungal, anti-inflammatory, antioxidant

Uses: Promotes wound healing and reduces skin infections[4]

2. Neem

Biological Name: Azadirachta indica

Family: Meliaceae

Common Name: Neem

Part Used: Leaves

Chemical Constituents: Azadirachtin, Nimbin, Nimbidin

Pharmacological Action: Antifungal, antibacterial, anti-inflammatory

Uses: Used in skin infections, eczema, itching, and dandruff[4]

3. Lemongrass

Biological Name: Cymbopogon citratus

Family: Poaceae

Common Name: Lemongrass

Part Used: Leaves (Oil)

Chemical Constituents: Citral, Geraniol

Pharmacological Action: Antifungal, deodorizing

Uses: Provides fragrance and prevents microbial growth[4]

4. Tea Tree

Biological Name: Melaleuca alternifolia

Family: Myrtaceae

Common Name: Tea Tree

Part Used: Leaves (Oil)

Chemical Constituents: Terpinen-4-ol, Cineole

Pharmacological Action: Strong antifungal, antimicrobial

Uses: Used in acne, fungal infections, and skin cleansing[4]

5. Clove

Biological Name: Syzygium aromaticum

Family: Myrtaceae

Common Name: Clove

Part Used: Flower buds

Chemical Constituents: Eugenol

Pharmacological Action: Antifungal, antiseptic, analgesic

Uses: Reduces pain, irritation, and fungal infection[4]

6. Coconut Oil

Biological Name: Cocos nucifera

Family: Arecaceae

Part Used: Kernel oil

Chemical Constituents: Lauric acid, Capric acid

Pharmacological Action: Antimicrobial, emollient

Uses: Cleanses and moisturizes skin[7]

7. Castor Oil

Biological Name: Ricinus communis

Family: Euphorbiaceae

Part Used: Seeds (Oil)

Chemical Constituents: Ricinoleic acid

Pharmacological Action: Moisturizing, antimicrobial

Uses: Improves lather and softens skin[7]

8. Sodium Hydroxide

Chemical Name: Sodium Hydroxide

Formula: NaOH

Category: Alkali

Role: Used in saponification process

Uses: Converts oils into soap[7]

9. Distilled Water

Category: Solvent

Role: Dissolves NaOH and helps in soap formation

Uses: Ensures purity and proper chemical reaction[7]

To prepare 150 g herbal antifungal soap, the following ingredients were taken:

Sr. No.	Ingredient	Quantity (g)	Quantity (ml approx.)	Function
1	Coconut Oil	80 g	~87 ml	Hardness, cleansing
2	Castor Oil	20 g	~22 ml	Moisturizing, lather
3	Sodium Hydroxide (NaOH)	15 g	—	Saponification agent
4	Distilled Water	25 ml	25 ml	Dissolves NaOH
5	Neem Powder	5 g	—	Antifungal
6	Turmeric Powder	2 g	—	Antiseptic
7	Tea Tree Oil	1.5 g	~1.5 ml	Strong antifungal
8	Lemongrass Oil	1.5 g	~1.5 ml	Fragrance + antimicrobial
9	Clove Powder / Clove Oil	1 g	~1 ml	Antifungal, antibacterial

Total Weight Calculation

- Total Oils = 80 + 20 = **100 g**
- Additives (Neem + Turmeric + Clove + EO) = **10 g approx**
- NaOH = **15 g**
- Water = **25 ml**

Total Batch Weight ≈ 150 g

COLD PROCESS METHOD

The cold process method is a widely used technique for preparing soap in which oils and sodium hydroxide (lye) react at a controlled temperature without external heating after mixing. In this method, the lye solution is first prepared by dissolving sodium hydroxide in distilled water and allowing it to cool. Separately, base oils such as coconut oil and castor oil are mixed and brought to a similar temperature. The lye solution is then slowly added to the oils with continuous stirring until the mixture thickens to a stage known as "trace." At this stage, herbal ingredients like neem, turmeric, clove, and essential oils such as tea tree and lemongrass are added. The mixture is poured into molds and left to solidify for 24–48 hours, followed by a curing period of 2–3 weeks, during which the soap hardens and becomes safe for use.[8]

Procedure

Step 1: Preparation of Alkali Solution (Lye Solution)

- The required amount of Sodium Hydroxide (NaOH) is accurately weighed.
- NaOH is slowly added to distilled water (always add NaOH to water, not vice versa).
- The solution is stirred continuously using a glass rod.
- The reaction is exothermic, so heat is generated.

- The solution is allowed to cool.

Step 2: Preparation of Oil Phase

- Coconut oil and castor oil are taken in the required proportion.
- The oils are gently heated until completely melted.
- The oil mixture is stirred well to obtain a uniform phase.

Step 3: Mixing of Oil and Alkali Phase

- When both the oil phase and lye solution reach a similar condition, they are mixed.
- The NaOH solution is slowly added to the oil mixture.
- Continuous stirring is carried out (manually or using a blender).

Step 4: Achieving Trace

- The mixture is stirred continuously until it reaches the "trace stage."
- At this stage, the mixture thickens and leaves a visible pattern on the surface.

Step 5: Addition of Herbal Ingredients

- Neem powder, turmeric powder, and clove powder are added to the mixture.
- The mixture is stirred thoroughly to ensure uniform distribution.

Step 6: Addition of Essential Oils

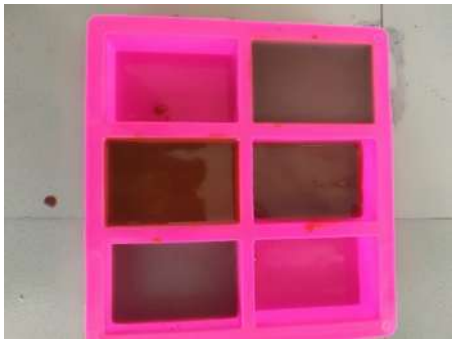
- Lemongrass oil and tea tree oil are added.
- These provide antifungal activity and fragrance.
- Gentle stirring is done to mix them evenly.

Step 7: Molding

- The prepared mixture is poured into soap molds.
- The molds are lightly tapped to remove air bubbles.

Step 8: Hardening (Setting)

- The soap is allowed to set for 24–48 hours.
- During this time, it becomes solid.



Step 9: Demolding and Cutting

- The soap is carefully removed from the molds.
- It is cut into the desired shape and size.

Step 10: Curing

- The soap bars are kept in a dry place for 2–3 weeks.
- This allows excess moisture to evaporate and improves soap quality and mildness.

EVALUATION

1. pH Test

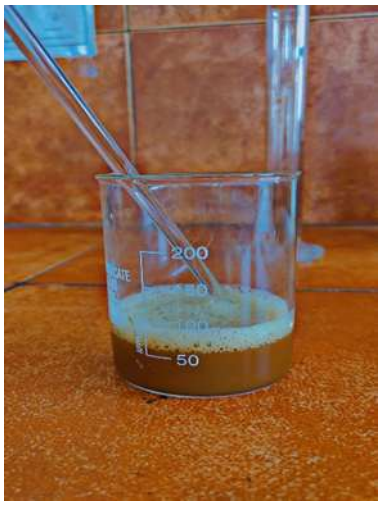
6 g of soap was dissolved in 60 ml of distilled water and stirred until a clear solution was obtained. The pH of the solution was measured using a pH meter or pH paper.

Result:

The pH of the soap was found to be in the range of 8–10, which is suitable for skin and indicates mild alkalinity.

2. Foam Height

6 g of soap was dissolved in 60 ml of distilled water in a measuring cylinder. The cylinder was shaken vigorously 25 times, and the foam height was measured in centimeters.



Result: Higher foam height indicates better cleansing ability of the soap.

After the foam was generated, it was allowed to stand for 5 minutes. The stability of the foam was observed.

3. Foam Retention Test

Result: Stable foam indicates good quality and better performance of the soap.

4. Physical Appearance

- The prepared soap was rectangular in shape with slightly uneven edges.
- The color of the soap was brownish-orange, which indicates the presence of herbal ingredients such as clove, turmeric, and essential oils.
- The surface was moderately smooth with minor whitish patches, possibly due to incomplete mixing or saponification variation.

5. Texture

- The soap appeared firm and solid.
- Slight surface irregularities were observed but overall texture was acceptable.
- No stickiness was observed.

6. Odor

- The soap had a mild herbal odor, characteristic of clove, lemongrass, and tea tree oil.
- The fragrance was natural and not irritating.

7. Moisture Content

Calculated using drying method.

Result: Acceptable moisture level ensuring longer shelf life.

9. Weight Variation Test

Result – The wheight of soap was found 95.01 gram.

Results Table

Sr. No.	Parameter	Method	Acceptance Criteria
1	Physical Appearance	Visual inspection (color, texture, cracks)	Smooth, uniform, no cracks, acceptable color and shape
2	Odor	Organoleptic evaluation (smell test)	Pleasant, characteristic herbal fragrance
3	pH	Digital pH meter (1% soap solution in distilled water)	8 – 10 (skin-friendly range)
4	Foam Height	Cylinder shake method	≥ 1–2 cm foam height indicates good foaming
5	Foam Retention	Measure foam stability over time (5–10 min)	Foam should remain stable for at least 5 minutes
6	Moisture Content	Oven drying method at 105°C	≤ 15% (to ensure stability and hardness)

7	Hardness	Manual pressing or penetrometer	Firm, not too soft or brittle
8	Total Fatty Matter (TFM)	Acid splitting method	≥ 60% (good quality soap)
9	Skin Irritation Test	Patch test on skin (24 hrs observation)	No redness, itching, or irritation
10	Antifungal Activity	Agar well diffusion method (zone of inhibition)	Clear zone of inhibition (≥10 mm indicates activity)
11	Washability	Rinse with water manually	Easy to wash off, no residue
12	Stability Study	Store at room temp for 30 days	No change in color, odor, or texture
13	Solubility	Soap dissolved in water	Should dissolve gradually without residue
14	Spreadability	Apply on skin surface	Should spread easily on skin

RESULTS AND DISCUSSION

The formulated herbal antifungal soap showed acceptable physical appearance with smooth texture, uniform shape, and pleasant herbal odor, indicating proper formulation.

The pH (8–10) was within the skin-friendly range. The soap exhibited good foam height and foam retention, demonstrating effective cleansing ability.

The moisture content (<15%) and adequate hardness indicated good stability and durability. The Total Fatty Matter (≥60%) confirmed the good quality of the soap.

No skin irritation was observed, proving its safety for topical use. The soap showed significant antifungal activity (≥10 mm zone of inhibition), supporting the effectiveness of herbal ingredients.

Additionally, the soap demonstrated good washability, solubility, and spreadability. No significant changes were observed during stability studies, indicating that the formulation is stable.

CONCLUSION

Using natural ingredients including clove, coconut oil, castor oil, lemongrass oil, tea tree oil, and other excipients, the current study effectively concentrated on the creation and assessment of a herbal antifungal soap. Numerous physicochemical and biological characteristics of the produced soap were assessed.

The evaluation's findings showed that the soap's formulation had acceptable physical qualities, such as a pleasing herbal scent, a smooth texture, and an appropriate hue. The soap's pH was determined to be within a skin-friendly range, suggesting that topical application is safe. Additionally, the soap demonstrated strong foaming ability and foam stability, both of which are necessary for a successful cleaning action.

The weight variation test verified the formulation's homogeneity, demonstrating appropriate mixing and molding methods. The moisture content was within permissible bounds, indicating the product's stability and extended shelf life.

The efficiency of herbal components against fungal species was further confirmed by the antifungal activity research, which revealed a significant zone of inhibition. The soap is safe for frequent use and does not cause skin irritation, according to the results of the skin irritation test.

All things considered, the prepared herbal antifungal soap is a safe, efficient, and environmentally beneficial substitute for synthetic

antifungal soaps. Because it contains natural substances, its therapeutic value is increased and its adverse effects are reduced, making it appropriate for daily usage.

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