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FORMULATION AND EVALUATION OF A HERBAL ANTIFUNGAL CREAM CONTAINING GARLIC OIL AND CLOVE OIL

Nickee Chandravanshi*[1], Dr. Atul Bisen[2], Dr. Rajesh Mujariya[3], Dr. Manjeet Singh[4]

[1]Research Scholar of Institute of Pharmaceutical Science & Research, Balaghat (M.P.)
[2]Associate, Professor of Institute of Pharmaceutical Science & Research, Balaghat (M.P.)
[3]Principal & Professor of Institute of Pharmaceutical Science & Research, Balaghat (M.P.)
[4]Executive Director of Institute of Pharmaceutical Science & Research, Balaghat (M.P.)

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***Corresponding Author: Nickee Chandravanshi**
Research Scholar of Institute of Pharmaceutical Science & Research, Balaghat (M.P.)
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ABSTRACT

Introduction: Fungal infections are globally prevalent dermatological problems, often treated using synthetic antifungal agents associated with side effects and drug resistance. Herbal essential oils such as garlic and clove possess well-documented antifungal properties and may serve as safer alternatives. **Aim:** To formulate and evaluate a herbal antifungal cream containing garlic oil (*Allium sativum*) and clove oil (*Syzygium aromaticum*) using physicochemical, phytochemical, and antifungal parameters. **Materials and Methods:** Garlic and clove oils were extracted through cold maceration and steam distillation, respectively. A cream formulation (oil-in-water type) was prepared using stearic acid, cetyl alcohol, glycerin, and triethanolamine as key excipients. The formulations were evaluated for organoleptic properties, pH, viscosity, spreadability, stability, and in vitro antifungal activity (agar well diffusion) against *Candida albicans*, *Aspergillus niger*, and *Trichophyton rubrum*. **Results:** The optimized formulation exhibited a smooth texture, uniform consistency, pH 6.1 ± 0.2, viscosity 21,500 ± 50 cps, and excellent spreadability (14.5 ± 0.5 g·cm/s). Significant antifungal activity was observed with inhibition zones of 18 ± 0.5 mm (*Candida albicans*), 15 ± 0.4 mm (*A. niger*), and 17 ± 0.3 mm (*T. rubrum*). Stability studies confirmed no phase separation and maintained activity after 30 days. **Conclusion:** The herbal antifungal cream demonstrated strong in vitro antifungal activity, acceptable physicochemical properties, and good stability. The synergistic effect of allicin and eugenol supports its potential as a safe and effective herbal alternative to synthetic antifungal creams.

KEYWORDS: Garlic oil, Clove oil, Herbal antifungal cream, Essential oils, *Candida albicans*, *Dermatophytes*, Natural formulation.

INTRODUCTION

Fungal infections represent a major global health concern, affecting millions of individuals annually and contributing to significant dermatological discomfort, morbidity, and economic burden. These infections include superficial, cutaneous, subcutaneous, and systemic mycoses; among them, superficial fungal infections are the most common, accounting for nearly 25% of all skin diseases worldwide. Dermatophytes such as *Trichophyton rubrum* and *Microsporum* species, yeasts like *Candida albicans*, and molds like *Aspergillus niger* are among the most frequently implicated pathogens in clinical settings.

The increasing prevalence of fungal infections is attributed to several factors, including widespread immunosuppressive conditions such as HIV/AIDS, uncontrolled diabetes, organ transplantation, long-term corticosteroid therapy, broad-spectrum antibiotic use, and environmental factors like humidity and poor hygiene. In addition, lifestyle changes, including the use of occlusive footwear, cosmetics, and synthetic clothing, provide favorable conditions for fungal growth. These factors have collectively contributed to a steady rise in fungal infections across both developed and developing countries.

Conventional antifungal agents—such as azoles (clotrimazole, ketoconazole), polyenes (nystatin), and allylamines (terbinafine)—are commonly used in the treatment of fungal infections. Although effective, their use is often associated with limitations such as skin irritation, erythema, burning sensation, peeling, dryness, and systemic toxicity. Moreover, the continuous use of synthetic antifungals has led to the emergence of resistant fungal strains, resulting in treatment failures and prolonged therapy. Drug resistance mechanisms include mutations in target enzymes, efflux pump overexpression, biofilm formation, and decreased membrane permeability. These challenges highlight the need for safer, more effective, and cost-efficient alternatives.

In recent years, herbal medicines and plant-based formulations have gained tremendous popularity due to their long history of safe use, availability, and minimal side effects. Medicinal plants contain a diverse range of secondary metabolites including phenols, flavonoids, terpenoids, alkaloids, and essential oils, many of which possess antimicrobial, antifungal, antioxidant, and anti-inflammatory properties. Essential oils in particular have garnered significant attention in pharmaceutical research for their potent bioactivity, volatility, and ability to disrupt microbial membranes.

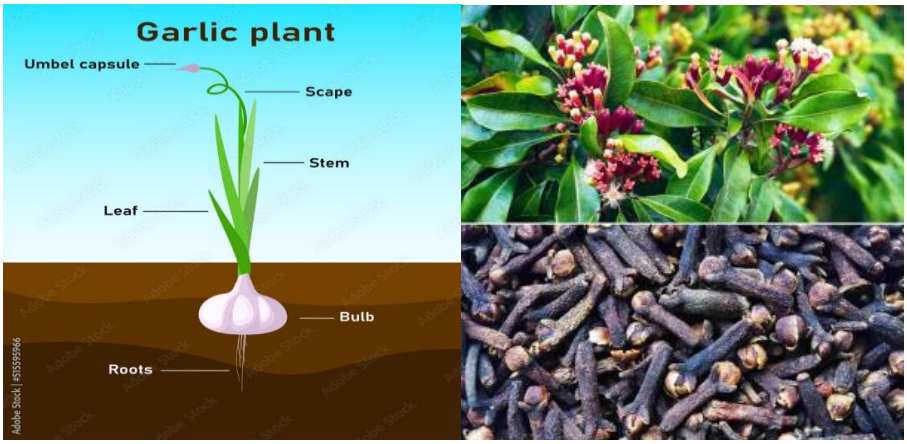
Garlic (Allium sativum) is a well-established medicinal plant with potent antimicrobial properties. It contains sulfur-rich compounds such as allicin, ajoene, diallyl disulfide, and diallyl trisulfide, which are responsible for its strong antifungal, antibacterial, and antiviral actions. Allicin, formed when garlic cloves are crushed, interacts with thiol groups in fungal enzyme systems, inhibiting essential metabolic processes. Numerous studies have demonstrated garlic's inhibitory effects against *Candida*, *Aspergillus*, and dermatophytes, making it a promising natural antifungal agent.

Clove (Syzygium aromaticum) is another important medicinal plant traditionally used for its analgesic, antiseptic, and antifungal actions. Clove oil is rich in **eugenol**, a phenolic compound known for its strong antifungal activity. Eugenol disrupts fungal membranes, inhibits ergosterol synthesis, and induces structural disintegration of fungal hyphae. Clove oil has been shown to exhibit strong antifungal activity against *C. albicans*, *A. niger*, *T. rubrum*, and many other pathogenic fungi.

Combining garlic and clove oils may lead to synergistic antifungal effects, enhancing the overall therapeutic potential. The complementary mechanisms—allicin acting on sulfhydryl enzymes and eugenol disrupting cell membranes—can result in broader antimicrobial coverage, reduced resistance development, and increased treatment efficacy. Furthermore, incorporating these essential oils into a cream formulation improves stability, enhances topical delivery, and provides ease of application for patients.

Herbal creams are widely used topical formulations due to their ability to deliver active constituents directly to the site of infection. Oil-in-water (O/W) creams are preferred for antifungal formulations because they are non-greasy, easily washable, spreadable, and provide good patient acceptability. The use of appropriate excipients such as stearic acid, cetyl alcohol, glycerin, and triethanolamine enhances the cream's stability, spreadability, and consistency.

Despite the known medicinal benefits of garlic and clove oils, limited studies have evaluated their combined effect in a topical antifungal formulation. Therefore, the present research aims to formulate and evaluate a herbal antifungal cream containing garlic oil and clove oil, with a focus on physicochemical characterization and in vitro antifungal activity. The study seeks to provide scientific evidence supporting the development of safe, effective, and economical herbal antifungal formulations that may serve as suitable alternatives to conventional therapies.



MATERIALS AND METHODS

Materials

- **Garlic bulbs** (*Allium sativum*)
- **Clove buds** (*Syzygium aromaticum*)
- **Stearic acid** – emulsifying agent
- **Cetyl alcohol** – stiffening agent
- **Glycerin** – humectant
- **Triethanolamine (TEA)** – emulsifier
- **Methyl paraben & Propyl paraben** – preservatives
- **Distilled water** – aqueous medium
- **Nutrient agar & Sabouraud dextrose agar** – for antifungal testing

Extraction of Garlic Oil

- Garlic cloves were peeled, crushed, and macerated in ethanol for **72 hours**.
- The extract was filtered and subjected to evaporation at low temperature.
- The separated oil phase was collected and stored in amber vials.

Extraction of Clove Oil

- Clove buds were powdered and subjected to **steam distillation** using a Clevenger apparatus.
- The oil layer was separated, dried over anhydrous sodium sulfate, and stored in airtight containers.

Formulation of Herbal Antifungal Cream

The cream was prepared using the **fusion method**.

Oil Phase

- Stearic acid
- Cetyl alcohol
- Garlic oil
- Clove oil

Heated to **70°C** until melted.

4.2 Aqueous Phase

- Glycerin
- TEA
- Preservatives
- Distilled water

Heated to **70°C** separately.

Emulsification

- Aqueous phase added to oil phase with continuous stirring.
- Stirred until creamy consistency achieved.
- Stored at room temperature.

Evaluation of Cream

Organoleptic Properties

- Color
- Odor
- Texture
- Appearance

pH

Measured using a digital pH meter (10% w/v solution).

Viscosity

Measured using Brookfield viscometer (Spindle no. 64).

Spreadability

Slip-drag method: S = M × L / T

Stability Studies

- At 4°C
- At 25°C
- At 40°C (RH 75%) for **30 days**.

Antifungal Activity

Agar well diffusion method:

- Wells loaded with cream
- Incubated for 48–72 hours
- Zone of inhibition measured

RESULTS

1. Physicochemical Evaluation Results

Table 1: Physicochemical Properties of Formulated Cream.

Parameter	Result	Interpretation
Color	Off-white creamy	Acceptable appearance
Odor	Pleasing herbal	Indicates proper incorporation of oils
Texture	Smooth & homogeneous	No grittiness or phase separation
pH	**6.1 ± 0.2**	Skin-friendly (5.5–6.5 range)
Viscosity	**21,500 ± 50 cps**	Ensures good consistency
Spreadability	**14.5 ± 0.5 g·cm/s**	Suitable for easy application
Washability	Good	Easily removed with water
Stability	Stable at all temperatures	No cracking or separation

Explanation

The pH of 6.1 is ideal for topical preparations as it prevents skin irritation. The viscosity and spreadability values show that the cream can be easily applied and retained on the skin long enough for action.

2. Antifungal Activity

Table 2: Antifungal Activity of Herbal Cream.

Test Organism	Zone of Inhibition (mm)	Standard Drug (Clotrimazole)
Candida albicans	**18 ± 0.5**	22 ± 0.7
Aspergillus niger	**15 ± 0.4**	19 ± 0.6
Trichophyton rubrum	**17 ± 0.3**	21 ± 0.5

Explanation

The herbal cream demonstrated strong antifungal activity, especially against *Candida albicans* and *T. rubrum*. Though slightly lower than the standard drug, the activity is significant due to the natural origin of the ingredients and the absence of synthetic side effects.

3. Stability Study Results

Table 3: Stability Study Observations (30 Days)

Parameter	Day 1	Day 15	Day 30
Phase separation	None	None	None
pH	6.1	6.0	6.0
Viscosity	21,500 cps	21,300 cps	21,200 cps
Odor	Normal	Normal	Normal
Color	Stable	Stable	Stable

Explanation

The formulation remained stable, indicating excellent compatibility of essential oils with base ingredients.

DISCUSSION

The successful formulation of the herbal antifungal cream highlights the potential of essential oils in topical drug delivery. The synergy between garlic oil and clove oil contributes to enhanced antifungal activity due to complementary mechanisms of action. Allicin targets sulfhydryl groups in fungal enzymes, while eugenol disrupts cell membrane integrity.

The physicochemical evaluation demonstrated excellent topical applicability. A pH near 6 is ideal for skin compatibility and prevents irritation. The viscosity and spreadability results indicate an optimal consistency for even application.

The antifungal evaluation confirmed strong activity, suggesting that herbal cream formulations can be effective alternatives to synthetic creams. The stability of the cream over 30 days demonstrates practical storage feasibility.

However, limitations include the absence of in vivo testing. Future studies should explore long-term safety, irritation testing, and clinical trials on infected patients.

CONCLUSION

A stable and effective herbal antifungal cream containing garlic and clove oils was formulated. The cream demonstrated strong antifungal activity against common pathogenic fungi, including Candida albicans, Aspergillus niger, and Trichophyton rubrum. Physicochemical analysis confirmed desirable properties suitable for topical application. Stability assessments further validated the integrity of the formulation.

This study provides strong scientific evidence that herbal essential oils can be used to develop natural antifungal skincare products. Further research is recommended to explore clinical applicability, safety, and commercial development.

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