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Research Article

Evaluation of Anti-Dandruff Activity of *Carica Papaya* Linn. Seed Oil Against *Malassezia Furfur*

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ABSTRACT

Background: Dandruff is a chronic scalp condition primarily associated with the overgrowth of Malassezia furfur, a lipophilic yeast. Chemical antifungals like ketoconazole are commonly used for treatment, though long-term use may lead to side effects. Plant-based remedies, such as Carica papaya (papaya), are being explored as natural alternatives due to their antimicrobial potential. Objective: This study aims to evaluate the anti-dandruff activity of papaya seed oil against Malassezia furfur in vitro and compare its efficacy with the standard antifungal agent, ketoconazole. Methods: Papaya seeds were dried, powdered, and extracted with ethanol. The extract was subjected to phytochemical screening and tested against M. furfur using the agar cup plate method. Zones of inhibition were measured to assess antifungal activity. Results: Papaya seed oil exhibited minimal antifungal activity at concentrations of 100 µl and 200 µl, producing inhibition zones of 1 mm and 2 mm respectively. In contrast, ketoconazole (1 mg/mL) exhibited a zone of inhibition of 15 mm. Conclusion: Although Carica papaya seed oil demonstrated slight antifungal effects, it was significantly less effective than ketoconazole. Further research is necessary to optimize extraction methods, isolate active constituents, and enhance efficacy.

INTRODUCTION

Dandruff is a widespread scalp condition marked by the formation of flaky, white to yellowish scales caused by clustered corneocytes—cells with strong adhesive properties. It is often accompanied by itching, which can lead to discomfort and social embarrassment. Most commonly, dandruff occurs between puberty and middle age, when the sebaceous glands in the scalp are most active [01]. While *Malassezia* species are often considered the primary contributors to dandruff, the condition has multiple contributing factors, and its exact cause remains unclear. *Malassezia furfur*, a lipophilic yeast naturally present on human skin, is frequently found in sebum-rich regions such as the

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scalp, face, trunk, and upper back. Overgrowth of this yeast is strongly associated with dandruff and seborrheic dermatitis, particularly in individuals with weakened immune systems [02]. Though many chemical antifungal agents are available to manage dandruff, complete and lasting relief is still elusive. Moreover, some of these treatments can cause side effects with long-term use. This has led to growing interest in plant-based alternatives, which are generally perceived as safer and more economical [03]. Among the promising herbal candidates is *Carica papaya* L., a plant from the Caricaceae family widely cultivated in tropical and subtropical regions. The seeds of papaya contain a variety of bioactive compounds such as fatty acids, glucosinolates, benzyl isothiocyanate, myrosinase, and alkaloids, many of which have demonstrated antimicrobial and antifungal properties [04]. Previous studies have shown that extracts from papaya seeds can inhibit the growth of various microorganisms, including *Candida albicans* [05]. Considering the scientific literature and existing evidence on *Malassezia furfur* and the bioactive potential of papaya seed oil, the present study was designed to explore the antifungal efficacy of this natural extract. Specifically, the aim is to evaluate whether papaya seed oil exhibits anti-dandruff activity against *Malassezia furfur* under in vitro conditions. Additionally, the study seeks to compare the effectiveness of papaya seed oil with that of commonly used commercial anti-dandruff agents, to assess its potential as a safer, herbal alternative in scalp care treatments. The research began with an extensive literature survey to understand the current knowledge surrounding dandruff, its causative agents particularly *Malassezia furfur* and the potential of herbal remedies in treating this condition. Based on the findings, a suitable herbal plant, *Carica papaya* (papaya), was selected for its reported antimicrobial and antifungal properties. An experimental plan was developed to systematically investigate the anti-dandruff activity of papaya seed oil. The seeds were collected and subjected to extraction using appropriate methods to obtain the active components. The extracted material then underwent phytochemical screening to identify the presence of bioactive constituents. Following this, in vitro screening was carried out to evaluate the antifungal activity of the extract against *Malassezia furfur*. The data obtained were analyzed, and results were documented in detail. A thorough discussion was conducted to interpret the findings in light of existing literature. The study concludes with insights into the potential use of papaya seed oil as a natural alternative for managing dandruff.

Pharmacotherapy for Dandruff

The medical management of dandruff commonly involves the use of over-the-counter (OTC) and prescription medications aimed at controlling factors such as *Malassezia* yeast overgrowth, scalp inflammation, and excessive shedding of skin cells. Although many antifungal drugs exist, those that are well absorbed, effective against systemic fungal infections, and exhibit low toxicity are limited. Among them, ketoconazole stands out as a potent agent that meets these criteria. It is approved by the Food and Drug Administration (FDA) for oral treatment of various fungal infections, including blastomycosis, candidiasis, and histoplasmosis. Although ketoconazole has been used for treating conditions like pityriasis versicolor and onychomycosis, it lacks FDA approval for these specific uses. Additionally, ketoconazole's poor penetration into cerebrospinal fluid restricts its use for fungal meningitis. Some preliminary studies suggest its usefulness in preventing fungal infections in immunocompromised cancer patients.

Drugs and Chemicals

In this study, ketoconazole was used as a standard antifungal drug, with a concentration of 50 mg/10 mL, to compare the efficacy of the test compounds against *Malassezia furfur*. Various chemicals essential for the experimental procedures were procured, primarily from reputable manufacturers. The list of chemicals includes potassium hydroxide (KOH), hydrochloric acid (HCl), nitric acid, Mayer's reagent, iodine solution, concentrated sulfuric acid (H_2SO_4), ferric chloride ($FeCl_3$), chloroform, peptone, sodium chloride, dextrose, and sodium hydroxide (NaOH). Most chemicals were supplied by LOBA CHEMIE PVT. LTD, a well-known chemical manufacturer, except for sodium hydroxide which was obtained from POONA CHEMICAL LAB. These reagents played a vital role in phytochemical screening, preparation of culture media, and various analytical procedures throughout the study.

Plant Extract of Papaya Seed Oil

The plant material used in this study consisted of seeds collected from ripe papaya fruits. The seeds were thoroughly dried under shade to preserve their active components, followed by grinding into a fine powder. The powdered seeds were then sieved to obtain a uniform particle size suitable for extraction. The ethanolic extract of papaya seed oil was prepared by macerating the powdered seeds in ethanol for a specified duration, allowing the solvent to effectively dissolve the bioactive compounds. After extraction, the solution was filtered, and the solvent was evaporated under reduced pressure to yield a concentrated extract for further analysis and testing [6].

Anti-Dandruff Activity Screening

The Agar Cup Plate Method

The agar cup plate method is a widely used technique to evaluate the antimicrobial activity of a substance based on its ability to diffuse through an agar medium and inhibit microbial growth. In this method, sterile agar is first inoculated with a suspension of the target microorganism to ensure even distribution across the surface. A well, typically 6 to 8 mm in diameter, is then aseptically punched into the solidified agar using a sterile cork borer or similar tool. The test solution containing the antimicrobial agent at the desired concentration is carefully introduced into the well. Following this, the agar plates are incubated under optimal conditions specific to the microorganism being tested. During incubation, the antimicrobial agent diffuses radially into the agar, and if effective, creates a clear zone of inhibition where microbial growth is suppressed. The diameter of this inhibition zone serves as an indicator of the substance's antifungal potency.[7]

Media and Reagents Preparation

The antibiotic assay medium No. 19 (pH 6.1 ± 0.2) was prepared by dissolving peptone (9.4 g), yeast extract (4.7 g), beef extract (2.4 g), sodium chloride (10.0 g), dextrose (10.0 g), and agar (23.5 g) in 1000 ml of purified water. The solution was heated to boiling to ensure complete dissolution, and the pH was adjusted using 1 M sodium hydroxide or 1 M hydrochloric acid if necessary. The medium was sterilized by autoclaving at 121°C and 15 lbs pressure for 15 minutes [7].

Preparation of Sample Solution

Test samples were directly applied at volumes of 100 µl and 200 µl during inoculation [7].

Preparation of Test Organism and Suspension

The test organism, *Malassezia furfur* (ATCC 140521), was streaked from a slant culture onto

Sabouraud Dextrose Agar slants and incubated at 30–35°C for 24 hours to obtain active growth [7].

Plate Preparation for Analysis

Two milliliters of the fungal suspension were inoculated into 200 ml of sterile molten Antibiotic Assay Medium No. 19 cooled to 40–45°C. The inoculated medium was poured into sterile Petri plates to a depth of 3–4 mm and allowed to solidify at room temperature before refrigeration for 15–20 minutes to harden. Uniform agar thickness was maintained. Wells of 8–10 mm diameter were aseptically bored, and plates were labeled for sample, standard, and control [7].

Analysis

Each agar well was filled with 100 µl of either 1 mg/ml standard solution (ketoconazole), 1 mg/ml test compound, or dimethyl sulfoxide (DMSO) as negative control. Plates were pre-incubated at 2–8°C for 15–20 minutes to allow diffusion, followed by incubation for 24–48 hours at 30–35°C for bacteria or 20–25°C for yeast and molds. After incubation, the diameter of the inhibition zones was measured to assess antifungal activity [7,8].

RESULTS

8.1 Observations

The anti-dandruff activity of papaya seed oil was evaluated against *Malassezia furfur* using the agar cup plate method. The experiment was conducted with two concentrations of papaya seed oil (100 µl and 200 µl), and compared to a standard antifungal agent, ketoconazole (1 mg/ml). Dimethyl sulfoxide (DMSO) was used as the negative control. The plates were observed for the formation of zones of inhibition, which indicate antifungal activity. As expected, the standard drug ketoconazole exhibited a significant zone of inhibition, whereas the control (DMSO) showed no activity. Papaya seed oil showed mild antifungal activity, with a small inhibition zone observed at higher concentration (200 µl), indicating a dose-dependent response.

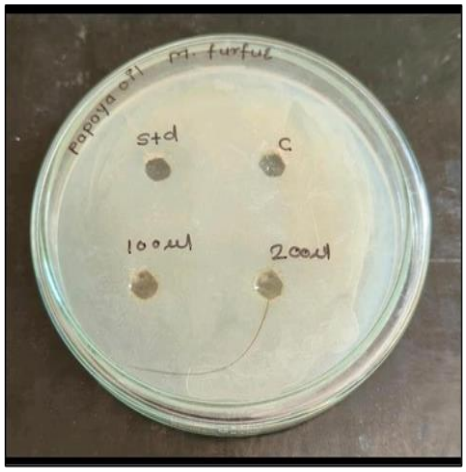

Fig No- 01 :Plates showing Zones of Inhibition for papaya against Malassezia furfur

Figure 01 displays the visual results showing the zones of inhibition, while **Table 01** summarizes the radius of the zones measured.

Table No 01 - Radius of Zones of Inhibition of Papaya Seed Oil Against *Malassezia furfur*

Sr. no.	Sample	Concentration	Zone of inhibition (mm) *M.furfur*
1.	Control	-	-
2.	Std. Ketoconazole	100 µl	15
3.	Sample papaya seed oil	100 µl	01
		200 µl	02

CONCLUSION

The present investigation aimed to evaluate the anti-dandruff activity of *Carica papaya* Linn. seed oil against *Malassezia furfur*, a yeast-like fungus recognized as a primary contributor to dandruff. Using the agar well diffusion method, the ethanolic extract of papaya seed oil was tested at concentrations of 100 µl and 200 µl. The observed zones of inhibition were compared to those produced by the standard antifungal agent ketoconazole (1 mg/ml), and DMSO was used as the negative control. The findings revealed that papaya seed oil exhibited a weak inhibitory effect on the growth of *Malassezia furfur*, with only minimal zones of inhibition observed, even at the higher concentration tested. In contrast, ketoconazole produced a significant and well-defined zone of inhibition, confirming its superior antifungal efficacy. The results clearly indicate that although papaya seed oil contains bioactive constituents with known antimicrobial properties—such as benzyl isothiocyanate, flavonoids, and alkaloids—these compounds may be either present in insufficient concentrations or not optimally extracted using the current methodology to exert a meaningful antifungal effect. Despite the limited in vitro results, the study supports the traditional belief that *Carica papaya* possesses medicinal properties, including antimicrobial potential. However, in the context of treating dandruff caused by *Malassezia furfur*, the efficacy of papaya seed oil appears inadequate when compared to conventional antifungal drugs. These findings highlight the need for further pharmacognostical research to identify, isolate, and concentrate the active constituents responsible for antifungal activity.

Future studies should focus on:

- Exploring different solvents or extraction techniques (e.g., Soxhlet, ultrasonic-assisted extraction) to improve the yield of active compounds.
- Formulating combinations of papaya seed oil with other known antifungal herbal extracts to explore potential synergistic effects.
- Conducting in vivo studies or clinical trials to assess the safety and efficacy in real-world applications.
- Standardizing extract doses and ensuring consistent phytochemical profiles across preparations.

In conclusion, while *Carica papaya* Linn. seed oil demonstrates some potential as an anti-dandruff agent, its current formulation and potency do not offer a competitive alternative to synthetic antifungals. However, with further refinement and development, it may still find a role as a natural, supportive therapy in herbal or cosmetic formulations aimed at scalp health.

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