MEDFARM: Jurnal Farmasi dan Kesehatan, Vol. 14, No. 1, 2025, Page 23-31
e-ISSN : 2715-9957
p-ISSN: 2354-8487

# Antifungal Effect of Turmeric Extract (*Curcuma domestica*) in Liquid Soap Formulation Against the Growth of *Malassezia furfur* ATCC 14521

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**ABSTRACT**

Turmeric (*Curcuma domestica*) has been identified as a potential natural antifungal agent due to its curcuminoids and essential oils. *Malassezia furfur*, a lipophilic fungus, is commonly found on human skin but can become pathogenic, causing Pityriasis versicolor. This study aimed to evaluate the antifungal activity of turmeric extract in a liquid soap formulation against *Malassezia furfur*. A post-test only with control group design was used, employing the well-diffusion method to assess antifungal efficacy. Turmeric extract was incorporated into liquid soap at concentrations of 10%, 15%, and 20%, with positive (commercial antifungal soap) and negative (soap base) controls. The inhibition zones were measured using a vernier caliper, and data were analyzed using One-Way ANOVA followed by post hoc Bonferroni testing. Results showed that all formulations met the Indonesian National Standards (SNI). The highest inhibition zone was observed at 20% concentration (17,46 mm), while the lowest was at 10% concentration (15,80 mm). ANOVA analysis confirmed significant differences between groups ($p < 0,05$). The study concludes that turmeric extract in liquid soap formulations demonstrates antifungal activity against *Malassezia furfur* and has potential as a natural alternative to synthetic antifungal agents.

Keywords: Turmeric extract, *Malassezia furfur*, well diffusion method, Pityriasis versicolor, liquid soap.

## Introduction

Tropical climates, such as those found in Indonesia, provide an ideal environment for the proliferation of various microorganisms, including *Malassezia furfur*. This lipophilic fungus is part of the normal skin flora but can become pathogenic under certain conditions, leading to Pityriasis versicolor, a superficial fungal infection characterized by hypo- or hyper pigmented lesions. The prevalence of Pityriasis versicolor is significantly higher in humid regions, reaching up to 50%, compared to colder climates where it is found in only 1.1% of the population (Widyawati *et al*., 2017). The infection is commonly observed on the upper trunk, neck, face, and extremities, and while not life-threatening, it can cause significant cosmetic concerns and discomfort.

Traditional treatment for Pityriasis versicolor includes the use of antifungal agents such as sulfur-based soaps. Sulfur exhibits antimicrobial properties that effectively combat fungal growth; however, prolonged use can lead to adverse effects, including skin irritation and excessive dryness (Adlia *et al*., 2019). The need for a safer and more natural alternative has led researchers to explore plant-based antifungal agents.

Turmeric (*Curcuma domestica*), a widely used medicinal plant, has gained attention for its antimicrobial properties. It contains curcuminoids, primarily curcumin, which has been shown to exhibit antifungal activity against various pathogens, including *Candida albicans* and *Staphylococcus aureus* (Mubarak *et al*., 2019). The mechanism of action involves disrupting fungal cell membranes, inhibiting ergosterol synthesis, and interfering with fungal metabolism. Studies have suggested that turmeric extract can be incorporated into pharmaceutical formulations, including creams, gels, and soaps, to enhance its therapeutic efficacy.

Despite extensive research on turmeric's antimicrobial properties, limited studies have focused on its effectiveness against *Malassezia furfur*. A study by Nazliniwaty and Sitompul (2018) demonstrated that a liquid soap formulation containing turmeric and lemongrass extract exhibited significant antifungal activity against *Microsporum gypseum* and *Candida albicans*. Similarly, Putri (2019) formulated a nanoemulsion-based turmeric soap that successfully inhibited *Staphylococcus aureus* with a 16,6 mm inhibition zone. These findings suggest that turmeric-based soap formulations hold promise as an alternative antifungal treatment.

Given the increasing demand for natural and effective antifungal agents, this study aims to evaluate the inhibitory potential of turmeric extract in a liquid soap formulation against *Malassezia furfur*. By determining the optimal concentration required to achieve significant antifungal activity, this research could contribute to the development of safer and more sustainable alternatives to conventional antifungal treatments.

## Methodology

### Research Design

This study employed an in-vitro experimental design using a post-test only with control group approach.

### Preparation of Turmeric Extract

Two kilograms of turmeric rhizomes were thoroughly washed to remove impurities, sliced into thin pieces (~1 mm thick), and dried under sunlight or in an oven at 50$^{o}$C until completely dehydrated. The dried turmeric was ground into a fine powder using a blender. A total of 200 g of turmeric powder was macerated in 96% ethanol at a 1:10 (w/v) ratio. Maceration lasted 24 hours and was repeated three times, with filtrates collected after each cycle. The resulting extract was concentrated using a rotary evaporator at 50$^{o}$C to remove the solvent and obtain a thick turmeric extract (Pratiwi *et al*., 2019, with modifications).

**Formulation of Liquid Soap Containing Turmeric Extract**

Liquid soap ingredients were weighed according to the formulation. Olive oil (30 mL) was placed into a beaker, and 16 mL of potassium hydroxide (KOH) was gradually added while continuously heating at 50°C until a soap paste formed. Next, 15 mL of distilled water was added, followed by pre-dissolved carboxyl methyl cellulose (CMC). The mixture was stirred until homogeneous before incorporating stearic acid. Sodium lauryl sulfate (SLS) was added, followed by ethylene diamine tetra-acetic acid (EDTA) to ensure homogeneity. Finally, turmeric extract was incorporated at the designated concentrations (10%, 15%, 20%), and the volume was adjusted to 100 mL with distilled water. The final product was stored in clean, prepared bottles (Rinaldi *et al*., 2021, with modifications).

**Physical Quality Testing of Liquid Soap Formulations**

**Organoleptic Test**

The physical characteristics of the liquid soap, including color, odor, and texture, were evaluated using sensory observation. According to Indonesian National Standards (SNI), a good liquid soap should be in liquid form and have a distinctive color and scent (Adjeng *et al*., 2019).

**Homogeneity Test**

A sample of approximately 0.5 g was spread onto a glass slide and observed for uniformity. The formulation was considered homogeneous if no coarse particles were detected (Rinaldi *et al*., 2021).

**pH Measurement**

The pH of the soap was measured using a pH meter after dilution with distilled water. The acceptable pH range for liquid soap is 6-11 to ensure compatibility with human skin (Rahmawati *et al*., 2021, with modifications).

**Specific Gravity Test**

The density of the soap was determined using a pycnometer. The acceptable density range for liquid soap is 1.01-1.1 g/mL (Rahmawati *et al*., 2021, with modifications).

**Free Alkali Test**

A 5 g sample was mixed with 100 mL of 96% ethanol and phenolphthalein indicator, then heated for 30 minutes. If a purple color appeared, titration with 0.1N HCl was performed until the color disappeared. The maximum allowable free alkali content is 0.1% (Rinaldi *et al*., 2021, with modifications).

**Inhibitory Activity of Turmeric Extract in Liquid Soap Against Fungal Growth Using the Well-Diffusion Method**

The antifungal activity of turmeric extract in liquid soap was tested using the well-diffusion method. *Malassezia furfur* cultures aged 24 hours were suspended in

0.9% NaCl solution and adjusted to match the turbidity of the McFarland 0.5 standard. The suspension was evenly swabbed onto Potato Dextrose Agar (PDA) using a sterile cotton swab and allowed to stand for 5–10 minutes. Five wells, each 6 mm in diameter, were created using a cork borer. Each well was then filled with 20 µL of liquid soap formulation containing turmeric extract at concentrations of 10%, 15%, and 20%. A negative control (soap base without extract) and a positive control (commercial antifungal soap) were also included. The plates were incubated at 35°C for 48 hours. After incubation, the inhibition zones were observed and measured using a vernier caliper. The inhibition zone diameter was calculated by subtracting the well diameter from the total inhibition zone diameter (Rinaldi *et al*., 2021, with modifications).

**Data Analysis**

The inhibition zone data obtained from the antifungal activity test were analyzed using One-Way ANOVA to determine significant differences between treatment groups. This was followed by a Post Hoc Bonferroni test to identify specific group differences. Statistical significance was set at $p < 0.05$.

## Result and Discussion

The results of the physical quality evaluation of the turmeric extract liquid soap formulation included organoleptic, homogeneity, pH, free alkali, and specific gravity tests. The organoleptic evaluation showed that the liquid soap had different color variations based on turmeric extract concentration: 10% concentration produced an orange color, 15% resulted in a reddish-brown color, and 20% yielded a darker brownish-red color. The control group without turmeric extract (soap base) exhibited a milky white color with the characteristic scent of olive oil, whereas formulations containing turmeric extract had a distinct turmeric aroma (Table 1). The homogeneity test confirmed that all formulations were free from coarse particles and appeared uniform under microscopic observation. These findings are consistent with research by Rinaldi *et al*., (2021), which demonstrated that liquid soap formulations containing *Cymbopogon nardus* extract exhibited even color distribution and smooth consistency.

The pH analysis revealed that the pH values of the liquid soap formulations ranged from 8.6 to 10.5 (Table 1), which falls within the acceptable limits set by SNI (Gaol *et al*., 2022). A pH level that is too acidic or too alkaline may cause skin irritation (Hernani, 2010, in Untari and Robiyanto, 2018). The high alkalinity in soap is primarily due to residual NaOH, which may result from mis-calculated lye-to-oil ratios, incomplete saponification, high processing temperatures, or insufficient curing time. Bar soaps typically exhibit pH values between 9 and 10; values above this range often indicate unreacted alkali and are linked to barrier disruption and skin irritation risk (Nova *et al*., 2025). The specific gravity test results ranged from 1.030 to 1.086 g/mL (Table 1), aligning with the SNI standard range of 1.01–1.1 g/mL (Gaol *et al*., 2022). The negative control (soap base) had a specific gravity of 1.086 g/mL, while formulations with turmeric extract at 10%, 15%, and 20% had values of 1.030 g/mL, 1.065 g/mL, and 1.063 g/mL, respectively. These results support findings by Suyasa *et al*., (2023), which state that specific gravity is influenced by the composition and physical properties of a formulation.

The free alkali content of the liquid soap formulations ranged between 0.084% and 0.1% (Table 1), meeting the standard requirements for liquid soap. The low free alkali levels indicate that the saponification process was efficient, allowing potassium hydroxide (KOH) to completely react with fatty acids to form soap, as described by Suyasa *et al*., (2023).

**Table 1. Physical Quality Test Results**

| Treatment | Organoleptic | | | Homogeneity | pH | Free Alkali (%) | Specific Gravity (g/mL) |
|---|---|---|---|---|---|---|---|
| | Color | Odor | Form | | | | |
| 10% Concentration | Orange | Distinct turmeric | Liquid | Homogeneous | 9,3 | 0,089 | 1,03 |
| 15% Concentration | Brick red | Distinct turmeric | Liquid | Homogeneous | 9,3 | 0,095 | 1,065 |
| 20% Concentration | Brownish red | Distinct turmeric | Liquid | Homogeneous | 8,6 | 0,1 | 1,063 |
| Negative Control | Milky white | Distinct olive oil | Liquid | Homogeneous | 10,5 | 0,084 | 1,086 |
| Positive Control | Yellowish white | Sulfuric | Liquid | Homogeneous | 9,5 | 0,1 | 1,12 |

The antifungal activity test of the turmeric extract liquid soap formulation against *Malassezia furfur* demonstrated inhibitory effects, as indicated by the formation of inhibition zones around the wells. The largest inhibition zone was observed in the 20% turmeric extract formulation, with an average diameter of 17,46 mm, while the smallest inhibition zone was found in the 10% concentration, with an average diameter of 15,80 mm (Table 2). The categorization of inhibition zones into strong (≥20 mm), moderate (10–19 mm), and weak (≤9 mm) was adapted from previous literature and antimicrobial susceptibility standards (CLSI, 2018). This finding aligns with Putri (2019), who reported that nanoemulsion based turmeric extract soap exhibited antibacterial activity against *Staphylococcus aureus* with a 16,6 mm inhibition zone at a concentration of 20 mL. Additionally, Pulungan (2017) demonstrated that turmeric extract effectively inhibited fungal growth due to its active compounds, such as curcuminoids and essential oils.

**Table 2. Inhibition Zone Diameter of Turmeric Extract Against *Malassezia furfur***

| Treatment | Ammount | Mean ± SD | Category |
|---|---|---|---|
| 10% Concentration | 3 | 15,80 ± 1,58 | Moderate |
| 15% Concentration | 3 | 16,60 ± 1,4 | Moderate |
| 20% Concentration | 3 | 17,46 ± 0,45 | Moderate |
| Negative Control | 3 | 13,76 ± 1,12 | Moderate |
| Positive Control | 3 | 24,33 ± 1,48 | Strong |

Curcuminoids exert their antifungal effects by disrupting fungal cell membranes and inhibiting protein synthesis, leading to cell lysis (Mubarak *et al*., 2019). Essential oils in turmeric also contribute to antifungal activity by forming protein-lipid complexes within the fungal cell membrane, leading to membrane permeability disruption and impaired nutrient transport, ultimately inhibiting fungal growth (Nadifah *et al*., 2018).

Olive oil, used as a base in the liquid soap formulation, also plays a role in antimicrobial activity. Muthamil *et al*, (2020) reported that olive oil contains oleic acid, which has antibacterial and antifungal properties against both Gram-positive and Gram-negative pathogens. Rahayu and Mita (2016) further explained that oleic acid enhances penetration by forming a new lipid layer with the stratum corneum, reducing the skin barrier function. Consequently, even the soap base exhibited mild inhibitory effects, with inhibition zone diameters ranging from 2,04 mm to 3,7 mm.

Compared to previous studies, Putri (2019) reported the highest inhibition zone of 16,6 mm with a 20 mL nanoemulsion turmeric extract formulation. Meanwhile, Nazliniwaty and Sitompul (2018) observed a 33,05 mm inhibition zone against *Candida albicans* using a 25% turmeric and lemongrass extract liquid soap. The lower inhibition zones in this study may be attributed to variations in antimicrobial compound production, which can influence microbial growth inhibition. Lestari *et al*, (2021) suggested that higher antimicrobial concentrations correlate with greater microbial inhibition, resulting in larger inhibition zones.

Statistical analysis using One-Way ANOVA revealed a p-value < 0.05, indicating a significant difference between treatment groups (Table 3). Post Hoc Bonferroni testing further confirmed significant differences (p > 0.05) among liquid soap formulations containing 10%, 15%, and 20% turmeric extract compared to the positive control, as well as between the positive and negative controls.

**Table 3. Results of One-Way ANOVA Test on Liquid Soap Formulation with Turmeric Extract against *Malassezia furfur***

| Treatment | P-value |
|---|---|
| 10% Concentration | |
| 15% Concentration | |
| 20% Concentration | 0,000 |
| Control (+) | |
| Control (-) | |

**Table 4. Results of Post Hoc Bonferroni Test on Liquid Soap Formulation with Turmeric Extract against *Malassezia furfur***

| Treatment | Concentration | | | | |
|---|---|---|---|---|---|
| | 10% | 15% | 20% | Control (+) | Control (-) |
| 10% Concentration | | 1,000 | 1,000 | 0,000* | 0,797 |
| 15% Concentration | | | 1,000 | 0,000* | 0,216 |
| 20% Concentration | | | | 0,001* | 0,053 |
| Control (+) | | | | | 0,000* |

Explanation: * = significant difference

**Conclusion**

This study confirms that turmeric extract in liquid soap exhibits antifungal activity against *Malassezia furfur*. The highest inhibition zone was observed at a 20% concentration (16,60 mm), demonstrating greater effectiveness than the 15% (15,80 mm) and 10% (13,76 mm) concentrations. Statistical analysis confirmed significant differences among treatment groups ($p < 0.05$).

These findings highlight turmeric extract as a promising natural antifungal agent. Future studies should explore formulation stability, long-term efficacy, and clinical applications to optimize its potential for pharmaceutical and personal care products.

**Declaration of Competing Interest**

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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