

# Antifungal and Antibacterial Activities of *Melaleuca cajuputi* Leaf Extract Against *Fusarium oxysporum*, *Geotrichum candidum*, and *Escherichia coli*

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## Abstract

**Background:** *Melaleuca cajuputi* leaf contains bioactive compounds associated with antimicrobial activity, and plant-derived extracts are increasingly explored as natural alternatives to synthetic antimicrobial agents. **Methods:** The antifungal activity of *Melaleuca cajuputi* leaf methanolic extract against *Fusarium oxysporum* and *Geotrichum candidum* and the antibacterial activity against *Escherichia coli* were evaluated using disc diffusion and broth serial dilution assays. **Results:** In the disc diffusion assay, slight to moderate inhibition zones against *Fusarium oxysporum* were observed after 5 days at extract concentrations of 3.33, and 6.66 mg per disc, while inhibition decreased after 10 days. In the broth serial dilution assay, the extract at 6.25 µg/mL showed higher percentage inhibition than itraconazole between 36 and 48 hours of incubation. The extract exhibited weak antifungal activity against *Geotrichum candidum*. Antibacterial activity against *Escherichia coli* was concentration-dependent, with higher extract concentrations showing greater growth inhibition at 12 and 24 hours. The most effective antibacterial concentration was 187.5 µg/mL. **Conclusion:** *Melaleuca cajuputi* leaf extract exhibited time-dependent antifungal activity against *Fusarium oxysporum* and concentration-dependent antibacterial activity against *Escherichia coli*, indicating its potential as a natural antimicrobial source.

## Introduction

*Melaleuca cajuputi* is a member of the family Myrtaceae and is widely distributed in Southeast Asia, including Thailand, Indonesia, and Malaysia. The leaves of *M. cajuputi* contain various bioactive compounds, particularly terpenoids, phenolics, and essential oil. *Fusarium oxysporum* is a ubiquitous soil-borne fungal pathogen causing Fusarium wilt disease in a wide range of economically important crops, while *Geotrichum candidum* is commonly associated with food spoilage. *Escherichia coli* is a well-known bacterial species linked to food hygienic. Due to the increasing demand for natural and environmentally sustainable antimicrobial agents, this study evaluated *in vitro* antimicrobial activity of *M. cajuputi* leaf extract against *F. oxysporum*, *G. candidum*, *E. coli*.

**Keywords** *Melaleuca cajuputi*, *Fusarium oxysporum*, *Geotrichum candidum*, *Escherichia coli*

## Materials and Methods

### 1. *Fusarium oxysporum*

Antifungal activity of *Melaleuca cajuputi* leaf methanolic extract against *Fusarium oxysporum* was evaluated using a paper disc diffusion assay to observe inhibition zones. And broth serial dilution assays at the concentration between 0.2 µg/mL and 400 µg/mL was used for quantitative antifungal activity using a 96-well microplates. Itraconazole was used as a positive control and this experiment was performed in triplicate.

### 2. *Geotrichum candidum*

Antifungal activity against *Geotrichum candidum* was evaluated using the paper disc diffusion method. Sterile paper discs impregnated with *M. cajuputi* leaf extract at different concentrations were placed on inoculated agar plates, and inhibition zones were observed after incubation. Methanol was used as a negative control. All assays were conducted in triplicate.

### 3. *Escherichia coli*

Antibacterial activity of *M. cajuputi* leaf extract against *Escherichia coli* was evaluated using a broth serial dilution assay in a 96-well microplate. Different extract concentrations were tested, and bacterial growth inhibition was monitored by measuring absorbance over incubation time. Penicillin was used as a positive control. All experiments were performed in triplicate, and results are presented as mean ± standard error.

## Results and Discussion

A slightly to moderate inhibition zones indicates that *Melaleuca cajuputi* leaf extract has a limited or intermediate effect on the inhibition of *Fusarium* at 5 days of incubation with the extract concentrations of 3.33, and 6.66 mg per disc, while no inhibition was observed in the negative control (Figure 1). Ten days after incubation, the inhibition zones were reduced and no longer clearly visible, indicating that early inhibitory effects decreased with prolonged incubation. However, only weak inhibition zones were observed against *Geotrichum candidum* at all tested concentrations after 5 days of incubation, and inhibition was decreased after 10 days, indicating limited antifungal activity of *Melaleuca cajuputi* leaf extract against this fungus (Figure 2).

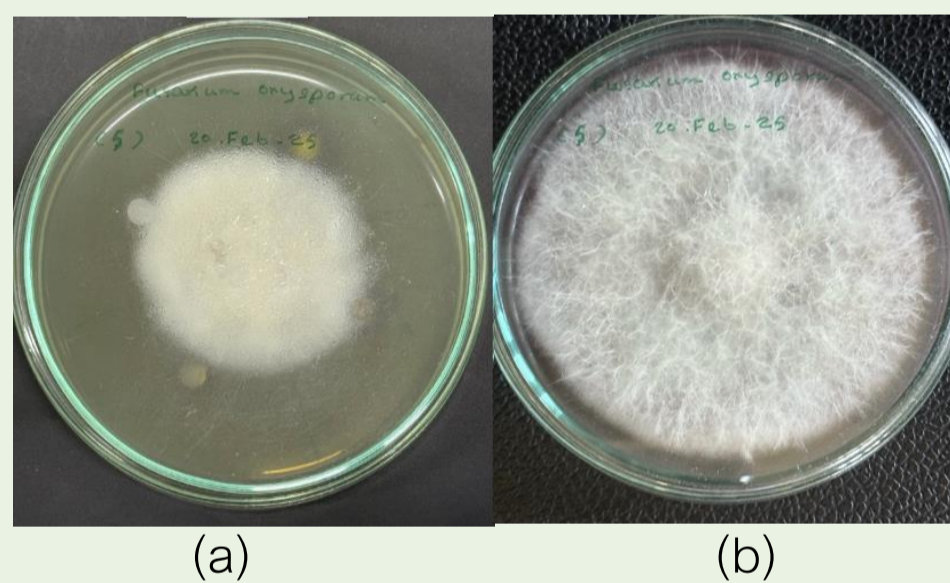


Figure 1. Antifungal activity of *Melaleuca cajuputi* leaf extract against *Fusarium oxysporum* by disc diffusion method after 5 days (a) and 10 days of incubation.

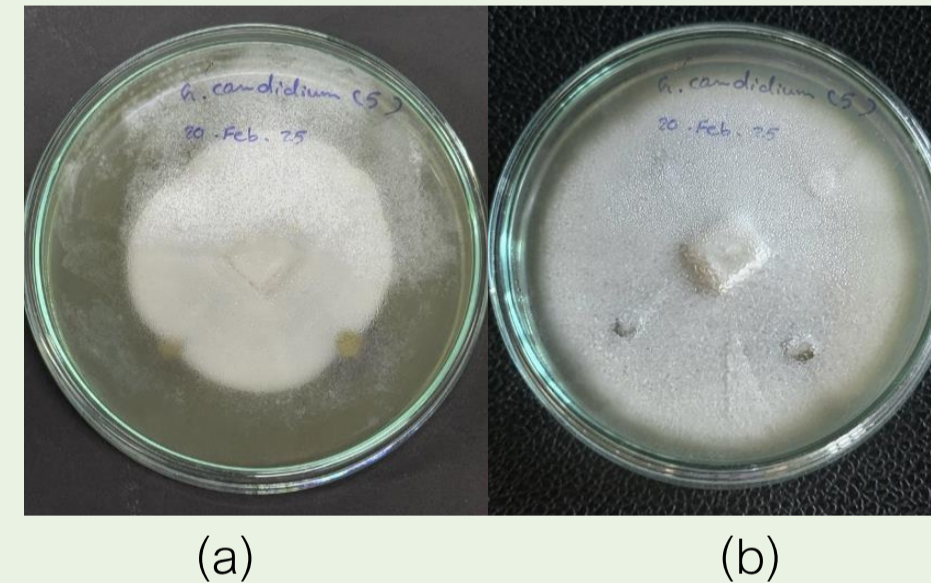


Figure 2. Antifungal activity of *Melaleuca cajuputi* leaf extract against *Geotrichum candidum* by disc diffusion method after 5 days (a) and 10 days of incubation.

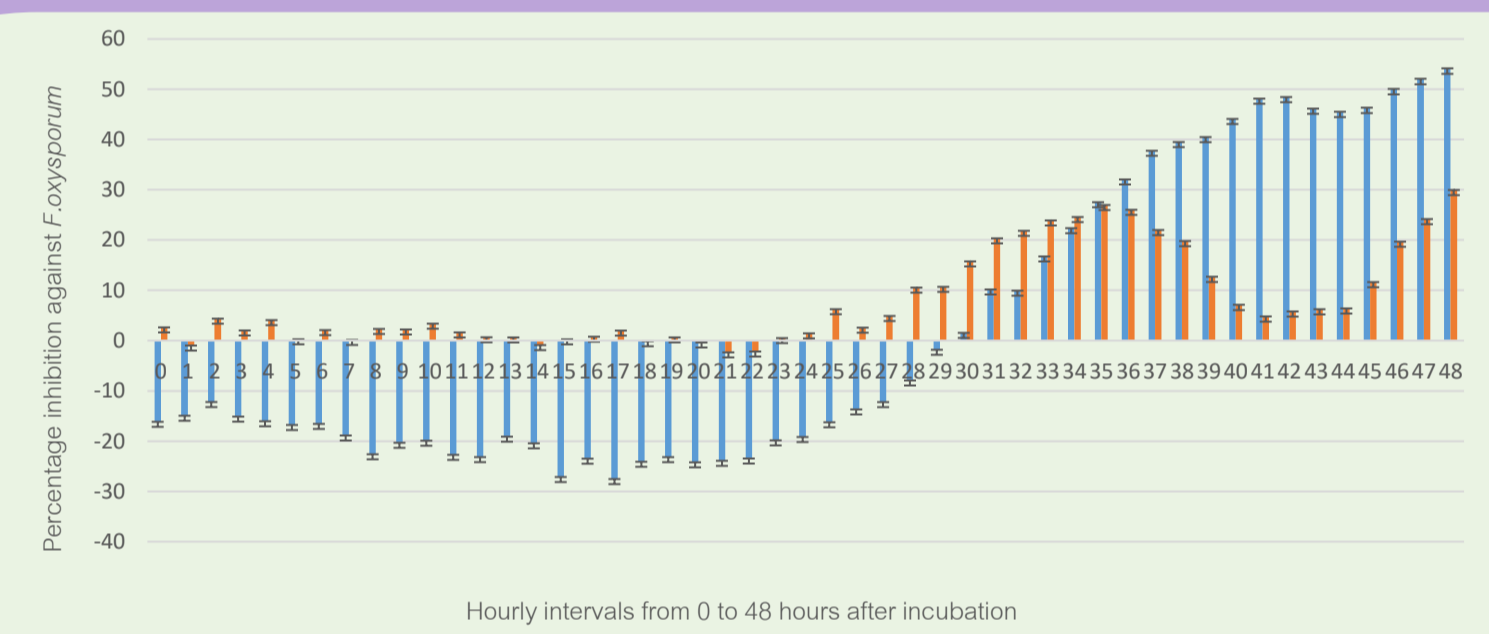


Figure 3. Percentage inhibition of *Fusarium oxysporum* growth by *Melaleuca cajuputi* leaf extract (M%) compared with itraconazole (A%) at the concentration of 6.25 µg/mL for 48-hour of incubation.

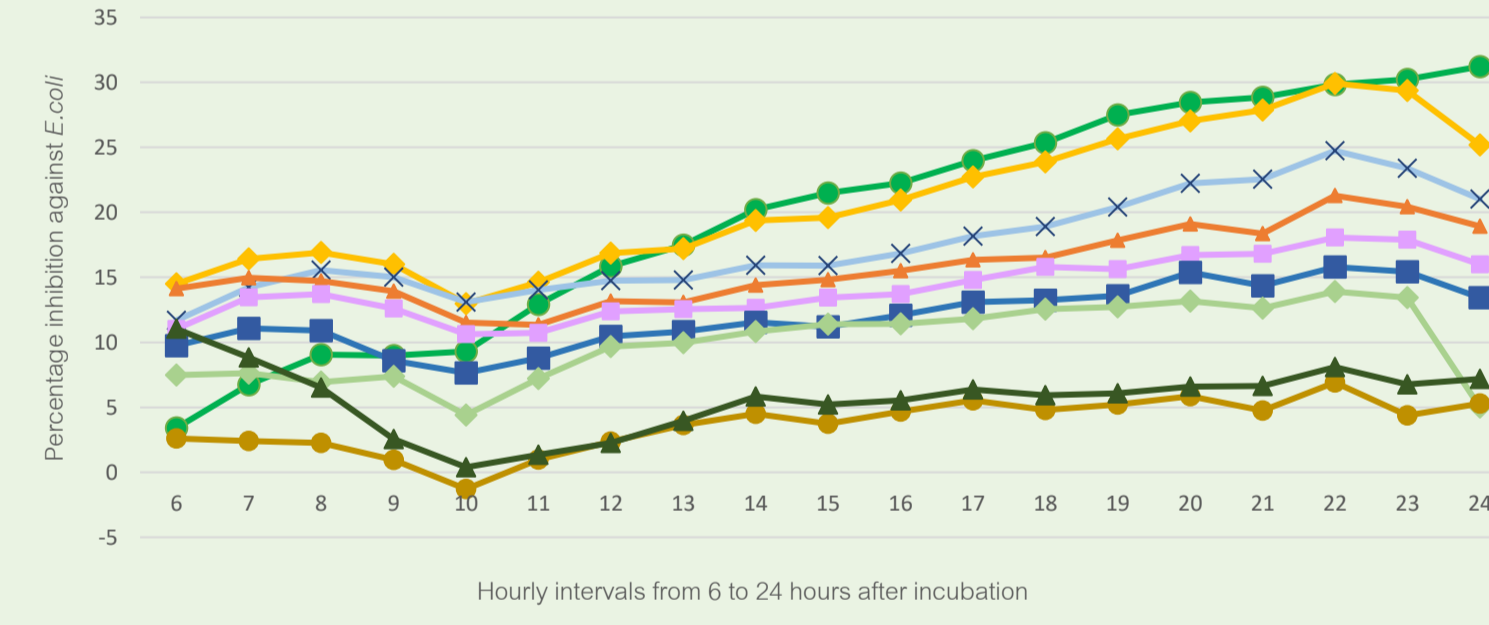


Figure 4. Percentage inhibition of *Escherichia coli* growth at 24 hours of incubation with *Melaleuca cajuputi* crude extract (M1–M8) at varying concentrations (2.93 to 23.44 µg/mL), while penicillin (A8) at 23.44 µg/mL as a positive control.

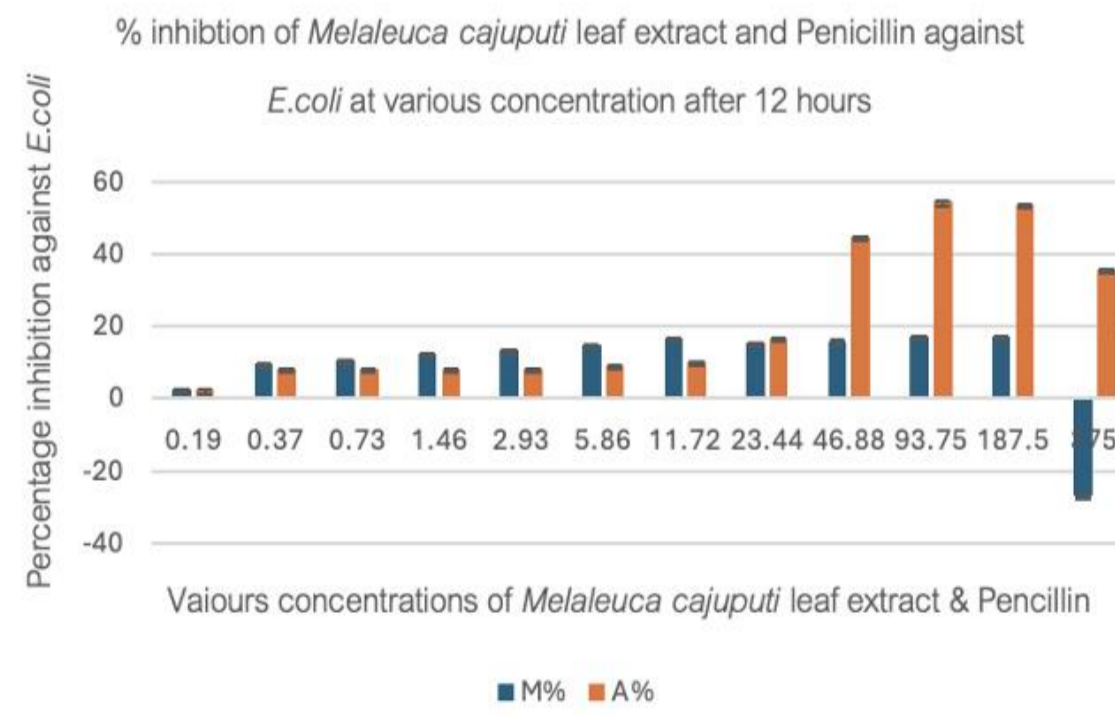


Figure 5. Percentage inhibition of *Escherichia coli* growth at 12 hours of incubation with *Melaleuca cajuputi* crude extract (M) and penicillin (A) at the concentrations ranging from 0.19 to 375 µg/mL.

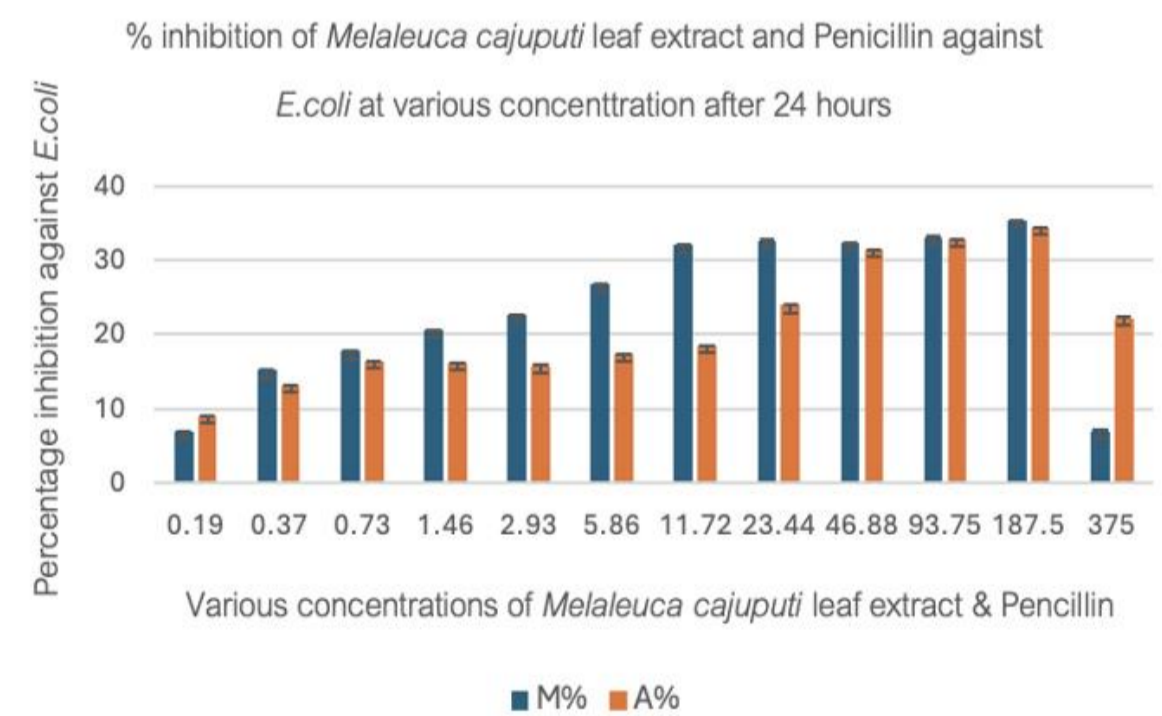


Figure 6. Percentage inhibition of *Escherichia coli* growth at 24 hours of incubation with *Melaleuca cajuputi* crude extract (M) and penicillin (A) at the concentrations ranging from 0.19 to 375 µg/mL.

*Melaleuca cajuputi* leaf extract at 6.25 µg/mL showed higher percentage inhibition of *Fusarium oxysporum* growth than itraconazole between 36 and 48 hours of incubation using broth serial dilution assay, demonstrating a time-dependent antifungal effect (Figure 3). The antibacterial activity of *Melaleuca cajuputi* leaf extract against *Escherichia coli* showed a concentration-dependent manner at 24 hours of incubation, with higher extract concentrations exhibiting greater bacterial growth inhibition compared with the penicillin positive control (Figure 4). Increasing the concentration of leaves extract resulted in greater growth inhibition of *Escherichia coli* at 12 hours of incubation, indicating early antibacterial activity of *Melaleuca cajuputi* leaf extract (Figure 5). Sustained inhibition of *Escherichia coli* growth was observed after 24 hours of incubation, with the highest percentage inhibition recorded at 187.5 µg/mL (Figure 6).

These findings support the antimicrobial potential of *M. cajuputi* leaf extract, particularly its time-dependent antifungal activity against *F. oxysporum* and concentration-dependent antibacterial activity against *E. coli*. These results highlight the bioactivity of *M. cajuputi* for soil-borne fungal pathogen causing wilt disease and for food hygienic. Then suggest that this plant may serve as a promising natural source of antimicrobial agents for agricultural and food applications.

## Conclusion

This study achieved its objective of evaluating the antifungal and antibacterial activities of *M. cajuputi* leaf extract. The extract exhibited moderate and time-dependent antifungal activity against *F. oxysporum*, weak inhibition against *G. candidum*, and concentration-dependent antibacterial activity against *E. coli*. Notably, the highest antifungal activity against *F. oxysporum* was observed at 6.25 µg/mL between 36 and 48 hours of exposure, while the most effective antibacterial concentration against *E. coli* was 187.5 µg/mL at 12 and 24 hours of incubation. These findings indicate that *M. cajuputi* leaf extract possessed measurable antimicrobial potential and may serve as a natural source of bioactive compounds for further investigation in agricultural and food safety applications.

## References

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