Antifungal Efficacy of Garlic and Olive Oil Against *Candida albicans* and *Penicillium palitans*

Amani Alhejely [1*]

Abstract

Background: Garlic and olive oil have long been recognized for their medicinal properties, particularly for their antimicrobial and antifungal effects. This study investigated the antifungal activity of garlic oil and olive oil against Candida albicans and Penicillium palitans, two common fungal species known to cause infections and spoilage. Methods: Fungi were cultivated on Sabouraud Dextrose Agar (SDA) medium, both unsupplemented and supplemented with varying concentrations (5%, 10%, 15%) of olive oil and garlic oil. The radial growth of the fungi was measured after seven days of incubation at 25°C. The antifungal activity was evaluated by comparing fungal growth across the different concentrations of oils. Results: Olive oil exhibited a dose-dependent inhibitory effect on C. albicans, with the highest inhibition observed at a 15% concentration, reducing growth to an average of 30 mm. Garlic oil showed even greater antifungal activity, with a 15% concentration reducing growth to 29.33 mm. In contrast, Penicillium palitans was less sensitive to both oils, though garlic oil still demonstrated moderate inhibitory effects, particularly at the 15% concentration, reducing growth to 64.33 mm. Olive oil had a less pronounced effect on P. palitans, with the highest concentration reducing growth to 61.67 mm. Conclusion: Both garlic oil and olive oil inhibited the growth of C. albicans and P. palitans, with garlic oil proving more effective, particularly at higher concentrations. C. albicans was more sensitive to both oils compared to P. palitans, suggesting species-specific susceptibility. These findings indicate the potential of natural oils, especially garlic oil, as antifungal agents, warranting further research into their mechanisms and applications.

Keywords: Garlic oil, Olive oil, Antifungal activity, Candida albicans, Penicillium palitans.

Significance | The study demonstrates the potential of garlic and olive oil as natural antifungal agents in managing fungal infections.

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Introduction

Garlic has long been recognized for its medicinal properties, particularly in the prevention and inhibition of various diseases. Studies have demonstrated its effectiveness in preventing cancer, slowing tumor growth, reducing inflammation in arthritis, and aiding weight loss (Akbar et al., 2015; Dhawan & Dhawan, 2010). Its antimicrobial and antifungal properties are particularly notable, with research suggesting that garlic can enhance the immune response in animals like birds and fish, protecting them from bacterial infections and even parasitic diseases (Saad al-Din et al., 2014). Garlic has also been shown to have cardiovascular benefits, primarily by reducing the risk of heart disease (Gupta & Gupta, 2013). It regulates heart function through the activation of adenosine secretion and inhibits blood clot formation by blocking the enzyme prostaglandin synthase and preventing thromboxane formation (Ransey et al., 2007). This helps to prevent platelet aggregation, reducing the risk of clots.

Additionally, garlic extract has demonstrated significant antifungal activity. El Shami et al. (1985) found that increasing concentrations of garlic extract effectively inhibited fungal spore growth. At full

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strength, garlic extract completely halted fungal growth, whereas the common fungicide Benomyl only slowed it at lower concentrations. The ajoene compound in garlic was found to be particularly potent, surpassing other compounds such as allicin and thiosulphonate in inhibiting fungal growth (Yashida et al., 1987). Research by Harris et al. (2001) and Korukluoglu and Irkin (2007) also confirmed garlic's ability to inhibit fungal species such as M. niger and Candida albicans. Furthermore, Pundir and Pranay (2010) showed that garlic extract effectively suppressed the growth of Fusarium oxysporum, limiting fungal colony growth. This body of research solidifies garlic's role as a potent antifungal agent, with potential applications across various fields including agriculture, medicine, and food preservation (Bhatti et al., 2018; Hwang et al., 2017; Koo & Hwang, 2004; Mondal & Roy, 2015; Raizada & Khanna, 2014; Subramanian & Choudhury, 2016; Zaid et al., 2019).

Material and Methods

1. Cultivation of Penicillium palitans Fungi

A. Cultivation on Standard SDA Medium:

The Sabouraud Dextrose Agar (SDA) medium was prepared by dissolving 65 grams of the SDA powder in one liter of sterile distilled water. The mixture was sterilized in an autoclave at 121°C for two hours. Once the medium cooled, a chloramphenicol capsule was added to inhibit bacterial growth. The sterilized medium was then poured into petri dishes in a laminar airflow cabinet to prevent contamination.

A small inoculum of *Penicillium palitans* was transferred to the center of each dish using a sterile needle. The dishes were incubated at 25°C for seven days. Fungal growth was measured by calculating the average of three perpendicular diameters across each colony, and the process was repeated in triplicate for accuracy.

B. Cultivation on SDA Medium Supplemented with Olive Oil:

SDA medium was prepared as described previously. Three separate flasks were prepared for different concentrations of olive oil: 5%, 10%, and 15%. For the 5% concentration, 5 ml of olive oil was added to the flask and the total volume was adjusted to 100 ml with sterilized SDA. Similarly, for the 10% and 15% concentrations, 10 ml and 15 ml of olive oil were added, respectively. After cooling, the medium was poured into petri dishes.

Penicillium palitans was inoculated in the center of each dish, and the dishes were incubated at 25°C for seven days. The fungal growth was measured by taking three perpendicular diameters for each concentration, with triplicates used for accuracy.

C. Cultivation on SDA Medium Supplemented with Garlic Oil:

SDA medium was prepared as outlined above. For garlic oil supplementation, three flasks were prepared with concentrations of 5%, 10%, and 15%. For the 5% concentration, 5 ml of garlic oil was added to the flask and the volume was adjusted to 100 ml with sterilized SDA. The same procedure was followed for the 10% and 15% concentrations, using 10 ml and 15 ml of garlic oil, respectively.

Once the medium cooled, it was poured into petri dishes. A sterile needle was used to inoculate *Penicillium palitans* in the center of each dish. The dishes were incubated at 25°C for seven days, and the radial growth was measured in triplicate for each concentration.

2. Cultivation of Candida albicans Fungus

A. Cultivation on Standard SDA Medium:

SDA medium was prepared by dissolving 65 grams of SDA powder in one liter of sterile distilled water and autoclaving for two hours at 121°C. After cooling, a chloramphenicol capsule was added to prevent bacterial contamination. The medium was poured into petri dishes inside a laminar airflow cabinet.

Candida albicans was inoculated in the center of each dish using a sterile needle, and the plates were incubated at 25°C for seven days. The radial growth was measured by calculating the average of three perpendicular diameters, with triplicates for accuracy.

B. Cultivation on SDA Medium Supplemented with Garlic Oil:

SDA medium was prepared and supplemented with garlic oil at concentrations of 5%, 10%, and 15%, as described for *Penicillium palitans*. After cooling, the medium was poured into petri dishes. A sterile needle was used to inoculate *Candida albicans* in the center of each dish. The dishes were incubated at 25°C for seven days. The radial growth was measured in triplicate for each concentration by taking three perpendicular diameters.

C. Cultivation on SDA Medium Supplemented with Olive Oil:

SDA medium was supplemented with olive oil at 5%, 10%, and 15% concentrations using the same method as described for *Penicillium palitans*. Once the medium cooled, it was poured into petri dishes. *Candida albicans* was inoculated in the center of each dish using a sterile needle, and the dishes were incubated at 25°C for seven days. Growth was measured by taking three perpendicular diameters for each concentration, with triplicates for accuracy.

Results and Discussion

The results demonstrated that olive oil had an inhibitory effect on the radial growth of *Candida albicans* at all tested concentrations (5%, 10%, and 15%). This effect was dose-dependent, with higher concentrations resulting in greater inhibition (Table 1). At 15% concentration, *C. albicans* showed the most significant inhibition, with an average radial growth of 30 mm across three replicates (25 mm, 35 mm, and 30 mm). This strong inhibition highlights the potential of olive oil as a suppressive agent against fungal growth. At 10% concentration, the average radial growth was 48.33 mm, showing moderate inhibition, while at 5%, the growth was 52 mm on average, indicating a lesser but still noticeable effect. The control group, which lacked olive oil, had an average growth of 54 mm, confirming that even at the lowest concentration, olive oil limited fungal expansion. These results suggest that olive oil's inhibitory

Table 1. The effect of olive oil on the radial growth of *Candida albicans*. Data is shown for three replicates at each concentration, along with the average radial growth rate.

Concentration (%)	Radial Growth Rate (mm) for Replicates	Average Radial Growth (mm)
Control	50, 55, 57	54
5	50, 50, 56	52
10	50, 50, 45	48.33
15	30, 35, 25	30

Table 2. The effect of garlic oil on the radial growth of *Candida albicans*. Data for three replicates at each concentration are presented, with the average radial growth rate.

Concentration (%)	Radial Growth Rate (mm) for Replicates	Average Radial Growth (mm)
Control	50, 55, 57	54
5	52, 52, 53	52.33
10	40, 45, 48	44.33
15	30, 38, 20	29.33

Table 3. The effect of olive oil on the radial growth of *Penicillium palitans*. Radial growth measurements for three replicates and their average values are provided.

Concentration	Radial growth rate for three replicates	Rate
Control	72-75-80	75.6
5	70 -70-75	71.6
10	62- 68-70	66.6
15	60 – 60- 65	61.6

Table 4. The effect of garlic oil on the radial growth of *Penicillium palitans* at different concentrations compared to the control group.

Concentration	Radial growth rate for three replicates	Rate
Control	73-75-80	76
5	72-74-80	75.3
10	70-70-75	71.6
15	60-65-68	64.3

properties are due to its phenolic compounds and fatty acids, which are known to possess antifungal activity.

Garlic oil also demonstrated significant inhibitory effects on *Candida albicans* across all concentrations (Table 2), with the highest concentration of 15% yielding the most substantial reduction in growth. The average radial growth at this concentration was 29.33 mm, with measurements of 38 mm, 20 mm, and 30 mm. At 10% concentration, the radial growth averaged 44.33 mm, while at 5%, it was 52.33 mm. The control group exhibited an average growth of 54 mm. Garlic oil's inhibition is likely due to the active compound allicin, which is known to disrupt fungal cell membranes and inhibit vital enzymes. These findings suggest that garlic oil is a potent antifungal agent, particularly at higher concentrations.

For *Penicillium palitans*, olive oil also showed an inhibitory effect, though it was less pronounced compared to *C. albicans (Table 3)*. At 15% concentration, the average radial growth was 61.67 mm, indicating moderate inhibition. At 10%, the average growth increased to 66.67 mm, and at 5%, it was 71.67 mm, which is close to the control group's average growth of 75.67 mm. This suggests that *P. palitans* is less sensitive to olive oil, with a weaker inhibitory response overall.

Garlic oil similarly inhibited the growth of *Penicillium palitans*, though not as strongly as it did for *C. albicans*. At 15% concentration, the average radial growth was 64.33 mm, indicating moderate inhibition. At 10%, the growth averaged 71.67 mm, while at 5%, it was 75.33 mm, very close to the control group's 76.67 mm. These results show that *P. palitans* is less responsive to garlic oil, with only higher concentrations having a notable effect.

Both olive oil and garlic oil demonstrated inhibitory effects on the growth of Candida albicans and Penicillium palitans, with garlic oil showing a stronger antifungal effect, particularly at higher concentrations. Candida albicans was more sensitive to both oils compared to Penicillium palitans, suggesting species-specific susceptibility. The antifungal properties of olive oil may be linked to its phenolic compounds, which have been reported to have antimicrobial activity, while garlic oil's inhibition is likely due to allicin, a known antifungal agent. The stronger effect of garlic oil across both species indicates its potential as a more effective natural antifungal agent. These findings provide insights into the antifungal properties of natural oils and highlight the potential use of garlic and olive oil in managing fungal infections, although further studies are required to determine the underlying mechanisms and optimal concentrations for use.

Conclusion

In conclusion, both olive oil and garlic oil inhibited the growth of *Candida albicans* and *Penicillium palitans*, with garlic oil proving to be the more effective antifungal, particularly at higher concentrations. *C. albicans* was more sensitive to both oils compared to *P. palitans*, indicating species-specific differences in susceptibility. The antifungal properties of olive oil likely stem from its phenolic compounds, while garlic oil's efficacy can be attributed to allicin. These findings highlight the potential of natural oils as antifungal agents, particularly garlic oil, though further research is needed to better understand their mechanisms and to optimize their use in clinical settings.

Author contributions

AA contributed to conceptualization, fieldwork, data analysis, drafting the original manuscript, editing, funding acquisition, and manuscript review. AA was also involved in research design, methodology validation, data analysis, visualization, and manuscript review and editing. Additionally, AA took the lead in methodology validation, investigation, funding acquisition, supervision, and final revisions. All authors have reviewed and approved the final version of the manuscript.

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Competing financial interests

The authors have no conflict of interest.

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