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ANTIFUNGAL ACTIVITY OF LIPID FRACTIONS OF MEDICINAL PLANTS AGAINST FUSARIUM ISOLATES FROM INFECTED GARLIC CLOVES

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Abstract. Garlic (*Allium sativum* L.) is widely cultivated for its culinary and medicinal value but is highly susceptible to fungal diseases, particularly those caused by Fusarium species. This study evaluated the antifungal activity of lipid fractions from seven medicinal plants against Fusarium isolates obtained from infected garlic cloves. The lipid fractions were added to PDA medium and fungal growth was monitored over nine days. The lipid fractions of Eucalyptus mellidora and Salvia officinalis significantly reduced mycelial growth of both isolates compared to the control, suggesting strong antifungal potential. Other oils exhibited moderate or low activity. These findings support the potential use of selected plant-derived lipid fractions as natural fungicides in garlic protection. Further research is needed to validate efficacy under field conditions.

Keywords: antifungal activity, essential oils, Fusarium spp., garlic, medicinal plants.

INTRODUCTION

Garlic (*Allium sativum* L.) is a globally cultivated vegetable crop valued not only for its culinary uses but also for its medicinal properties, including antimicrobial, anti-inflammatory, and antioxidant activities [1]. Despite its bioactive potential, garlic is highly susceptible to a range of soil-borne fungal pathogens, among which species of the genus *Fusarium* are among the most damaging [2]. *Fusarium* spp. cause serious diseases such as basal rot and bulb rot,

leading to significant yield losses during both cultivation and post-harvest storage [3]. Infected garlic cloves typically show symptoms like softening, discoloration, and decay of the basal plate, which compromise both market quality and seed viability.

Control of *Fusarium*-related diseases remains challenging due to the lack of effective and environmentally safe fungicides registered for use on garlic. Furthermore, the development of fungicide resistance among fungal populations and increasing regulatory restrictions on chemical pesticides have underscored the need for alternative plant protection strategies [4].

Despite growing interest in phytochemicals for disease control, relatively few studies have focused on their use against *Fusarium* isolates from garlic, and even fewer have examined the comparative activity of multiple plant oils under uniform *in vitro* conditions. Therefore, a systematic evaluation of essential oils from selected medicinal plants is warranted to identify potential biofungicides that can be incorporated into pre- and post-harvest management strategies for garlic crops.

In this context, essential oils derived from aromatic and medicinal plants have emerged as promising candidates for integrated disease management [5-7]. These lipid-based fractions are complex mixtures of volatile organic compounds, including monoterpenes, sesquiterpenes, and phenolic compounds, known for their broad-spectrum antimicrobial activities [8]. Numerous studies have demonstrated the antifungal effects of essential oils against plant pathogens, including various *Fusarium* species. However, their efficacy is highly variable and depends on the botanical source, chemical composition, mode of application, and target organism.

The present study was designed to evaluate the *in vitro* antifungal activity of lipid fractions extracted from the aerial parts of seven medicinal plant species against *Fusarium* spp. By comparing the inhibition of radial mycelial growth across treatments, this research aims to identify plant-derived substances with strong antifungal potential and practical relevance for sustainable agriculture.

MATERIALS AND METHODS

Fungal Isolates

Two *Fusarium* spp. isolates were obtained from the basal plates of garlic cloves collected in 2023. Isolates were cultured on Potato Dextrose Agar (PDA) for 10 days at room temperature.

Essential Oil Samples

Lipid fractions (essential oils) were obtained from the aerial parts of seven medicinal plants: *Laurus nobilis* (bay leaf), *Cetraria islandica* (Iceland moss), *Eucalyptus mellidora*, *Salvia officinalis* (sage), *Amaranthus* sp., *Origanum vulgare* (oregano), and *Calendula officinalis* (calendula). The lipid fractions were prepared via low-temperature liquefied gas extraction using chlorodifluoromethane [9, 10]. The

extraction was carried out at temperatures ranging from 12 °C to 32 °C and pressures from 0.6 to 1.2 MPa over a 10-hour period. The resulting extract had a yield of about 5% from the dry mass.

Preparation of Media and Treatments

To evaluate antifungal activity, 1% (v/v) of each essential oil was mixed into melted PDA medium supplemented with 0.05% (v/v) Tween 80 (Polysorbate 80) as a non-ionic emulsifier to facilitate oil dispersion. The PDA-oil mixtures were immediately poured into sterile 90 mm diameter Petri dishes (10 mL per dish). After solidification, a 5 mm agar plug taken from the periphery of a 7-day-old *Fusarium* colony was placed mycelium-side down in the center of each dish. The control group consisted of PDA plates containing Tween 80 but no essential oils.

Each treatment (essential oil × isolate combination) was replicated ten times. All plates were incubated at room temperature, and radial mycelial growth was measured every 24 hours using a millimeter ruler until the control colonies reached the edges of the Petri dish.

Growth Rate and Inhibition Analysis

The antifungal effect was quantified by calculating the daily radial growth rate (V) using the formula: $V = (Rx - R0)/T$,

where R_x is colony radius on day x, R_0 is initial radius, and T is the number of incubation days.

Statistical analysis of mean growth rates and standard deviations was performed using STATISTICA, version 14.0.0.15 from TIBCO Software Inc. (Palo Alto, California, USA). Significance of inhibition was evaluated visually through growth kinetics over 9 days, with particular attention to variance between isolates.

RESULTS AND DISCUSSION

The antifungal activity of lipid fractions derived from various medicinal plants was assessed by measuring the radial growth of two *Fusarium* isolates over a 9-day period. The results clearly demonstrated significant inhibition of mycelial growth for both isolates compared to the control, with the level of suppression varying depending on the plant species from which the lipid fraction was derived.

Figure 1 illustrates the progressive growth of both *Fusarium* isolates in untreated control conditions, showing rapid radial expansion and complete colonization of the Petri dish by day 9. In contrast, essential oils from several plant species reduced colony expansion substantially, as seen in the daily measurements (Table 1).

Among the tested essential oils, those from *Eucalyptus mellidora* and *Salvia officinalis* demonstrated the most pronounced antifungal effects. On day 9, the average colony diameter of F1 in the presence of *Eucalyptus* oil was 1.39 ± 0.12 mm/day, and for F2, it was only 0.95 ± 0.05 mm/day—both markedly lower than the respective control values (2.5 mm/day and 2.64 mm/day). Similarly, *Salvia officinali*s inhibited F1 to

1.09 ± 0.02 mm/day and F2 to 0.96 ± 0.04 mm/day by day 9.

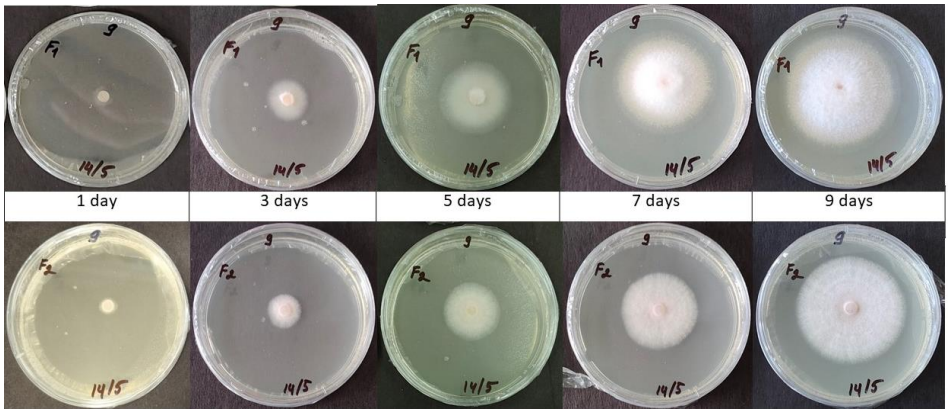


Figure 1. Progressive radial growth of two Fusarium isolates on control PDA medium over 1, 3, 5, 7, and 9 days of incubation at room temperature.
Colonies expand rapidly in the absence of essential oil treatment, reaching full Petri dish coverage by day 9.

Table 1. Daily radial growth (mm/day) of Fusarium isolates cultured on PDA medium supplemented with 1% essential oils from selected medicinal plants.
Values are expressed as mean ± standard deviation (n = 10)

Fusarium isolates	F 1			F 2		
Days of incubation	1	5	9	1	5	9
Control	2,0±0,281	3,36±0,079	2,5±0,000	1,79±0,100	2,53±0,090	2,64±0,061
Laurus nobilis	1,75±0,144	2,93±0,011	2,89±0,016	1,04±0,042	2,28±0,040	2,46±0,017
Cetraria islandica	1,29±0,164	2,28±0,060	2,37±0,054	1,33±0,083	2,28±0,028	2,01±0,021
Eukaliptus sp.	0,88±0,056	1,37±0,011	1,39±0,120	0,71±0,100	0,97±0,054	0,95±0,049
Salvia officinalic	0,88±0,191	1,19±0,035	1,09±0,019	0,83±0,105	0,94±0,035	0,96±0,035
Amaranthus sp.	1,37±0,155	2,23±0,060	1,88±0,067	1,08±0,083	1,54±0,057	1,49±0,049
Oregano vulgaris	1,38±0,107	2,64±0,045	2,07±0,035	1,42±0,083	1,69±0,039	1,54±0,017
Kalendula officinalis	1,38±0,085	1,69±0,051	1,56±0,023	0,96±0,042	1,04±0,052	1,26±0,086

This consistent and substantial inhibition suggests a strong fungistatic or even fungicidal effect, likely attributable to the high concentrations of bioactive monoterpenes such as eucalyptol and thujone. These compounds have well-documented antimicrobial properties, including disruption of fungal membrane

integrity and interference with spore germination [11].

Other essential oils such as those from *Cetraria islandica*, *Amaranthus* sp., and *Origanum vulgare* also demonstrated moderate inhibitory effects, with reductions in growth ranging between 20–40% compared to controls. Lipid fractions from *Calendula officinalis* and *Laurus nobilis* showed the least antifungal activity but still provided measurable suppression relative to untreated conditions.

While both *Fusarium* isolates responded similarly to most treatments, slight differences in sensitivity were observed. For example, F2 was marginally more sensitive to *Salvia* lipid fractions at all time points, suggesting a possible variation in membrane composition or metabolic adaptability between species.

These findings support the hypothesis that essential oils from selected medicinal plants can serve as natural antifungal agents against soil-borne pathogens. The strong inhibitory effect of *Eucalyptus* and *Salvia* oils underscores their potential for integration into eco-friendly disease management programs in garlic cultivation. However, further *in vivo* testing and formulation development are required to optimize delivery methods, dosage, and stability under field conditions.

CONCLUSIONS

The results of this study demonstrate that essential oils derived from medicinal plants possess notable antifungal properties against two pathogenic *Fusarium* isolates affecting garlic. In particular, lipid fractions from *Eucalyptus mellidora* and *Salvia officinalis* exhibited the most significant inhibitory effects on radial mycelial growth of both *Fusarium* isolates under *in vitro* conditions. These findings are consistent with the known bioactivity of monoterpenes such as eucalyptol and thujone, which likely contribute to the observed antifungal effects.

The broad-spectrum activity and reproducibility of these oils suggest that they hold strong potential as environmentally friendly alternatives to synthetic fungicides, which are increasingly limited by resistance development and regulatory restrictions. Importantly, the ability to suppress pathogenic fungi at relatively low concentrations (1% v/v) highlights their practical value for integrated disease management strategies.

Nevertheless, the transition from laboratory efficacy to field application requires further investigation. Future research should focus on evaluating the performance of these essential oils in greenhouse and open-field trials, their phytotoxicity to garlic plants, their formulation stability, and their long-term impact on soil microbiota and crop yield. Additionally, synergistic interactions among multiple plant oils and their components warrant exploration to optimize antifungal formulations.

In summary, the study supports the feasibility of incorporating plant-derived

lipid fractions, especially from *Eucalyptus* and *Salvia*, into sustainable garlic protection practices and contributes to the growing body of evidence advocating for biopesticide development from botanical sources.

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