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Evaluation of the Effect of Essential Oil of Some Chemotypes of *Zataria multiflora* and *Salvia mirzayanii* on the Control of *Aspergillus niger*

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Introduction

Essential oils have gained significant attention for their potential to control postharvest fungi in recent years. These volatile natural compounds extracted from plants possess antimicrobial properties and can be effective in inhibiting the growth and development of various fungal pathogens. Essential oils are derived from plants and are considered natural products, making them an attractive alternative to synthetic fungicides. They are biodegradable and have minimal adverse effects on the environment compared to conventional chemical-based fungicides. Fungicide resistance is a significant concern in postharvest disease management. Essential oils offer an alternative control method, and their complex composition makes it difficult for fungi to develop resistance. The diverse array of active components in essential oils can act synergistically, making it challenging for fungi to adapt and develop resistance mechanisms. Postharvest fungal infections can lead to significant economic losses by causing spoilage and decay of fruits, vegetables, and other perishable agricultural commodities. Essential oils can help extend the shelf life of these products by inhibiting fungal growth and reducing decay incidence. While essential oils show promise in postharvest disease management, it is important to note that their effectiveness can vary depending on the specific fungal pathogen, concentration, application method, and environmental conditions. Further research and development are necessary to optimize their use and integrate them into practical postharvest disease control strategies.

Material and Methods

The research was conducted in two separate experiments. All experiments were conducted in three replicates using a completely randomized factorial design. The factors in each experiment included different strains (*Zataria multiflora*, including 1. Khonj-Fars, 2. Nasrabad Isfahan, 3. Ziarat Ali River, 4. Bushehr, 5. Tang-e Zagh, 6. Tashk-Fars, 7. Faryab Rudan) and *Salvia mirzayanii* (1. Bastak-Hormozgan, 2. Sar-Chahan-Hormozgan, 3. Deq-Finu-Hormozgan, 4. Khonj-Fars), different cultivation methods (inoculation method and mixing essential oil with PDA culture medium), and different concentrations of the essential oil (0, 50, 100, 200, 400 µL of thyme essential oil and 0, 100, 200, 400 µL of *Salvia* essential oil. In the combined method: after preparing the cultivation medium and cooling it, before solidification, it was prepared using Shirazi and Mortelkh thyme essential oil chemotypes with different concentrations, and then it was poured into 8 cm plates and under a laminar hood. To prevent the release of essential oil compounds, the petri dishes were blocked with parafilm and connected to each other. In fumigation method: the culture medium was prepared and poured into 8 cm plates and after coagulation of the culture medium, 10 microliters per liter of fungal spores in sterile conditions were placed on agar in the center of the plate, then different concentrations of essential oils fixed on the filter paper in the lid of the plate. At the end, the Petri dishes were blocked with parafilm to prevent the escape of essential oil compounds.

Result and Discussion

In first experiment, a comparison of the means showed that with an increase in the concentration of thyme essential oil up to 200 µL, the halo diameter of *Aspergillus fungus* significantly decreased. However, no significant difference was observed between the concentrations of 200 and 400 microliters per liter. Additionally, no significant difference was found between the different cultivation methods at each concentration. a comparison of the means revealed that the essential oil of different strains (except for Nasrabad Isfahan) had the greatest effect at concentrations of 200 and 400 µL in both type methods. In second experiment, at a concentration of 200 µL of Hormozgan sarchahan, a significant reduction in the halo diameter was observed compared to the control. At a concentration of 400 µL, a significant difference between the strains (except for Bastak Hormosgan) and the control was observed. No significant difference in inhibiting fungal growth was observed between different cultivation methods at various concentrations. In general, the potential antifungal effect of essential oils is attributed to the main compounds present in essential oils, such as phenolic terpenoids, alcohol, and oxygen. Phenols are a class of chemical compounds that exhibit antifungal properties. While the exact mechanism of action of phenols on fungi may not be completely understood, there are several proposed mechanisms by which they can exert their antifungal effects. One proposed mechanism is related to the ability of phenols to penetrate the lipids present in the cytoplasmic and mitochondrial membranes of fungi. Fungal membranes are comprised of a lipid bilayer, and phenols may disrupt this structure by interacting with the lipid molecules. This disruption can lead to alterations in the integrity and fluidity of the fungal cell membrane. By interfering with the cell membrane, phenols can disrupt various cellular processes. They may inhibit the function of membrane-bound enzymes and transport proteins, which are essential for the normal functioning of the fungal cell. Additionally, the disruption of the cell membrane can result in the leakage of intracellular contents, such as ions, metabolites, and proteins, leading to cellular dysfunction and eventual cell death. Furthermore, phenols may also interfere with the synthesis of important cellular components in fungi. They can inhibit key enzymes involved in fungal cell wall synthesis, leading to weakened cell walls and increased susceptibility to environmental stresses. It's important to note that the specific effects of phenols on fungi can vary depending on the specific phenolic compound and the fungal species being targeted. Different phenols may have varying degrees of efficacy against different types of fungi. While the mechanisms described above provide a general understanding of how phenols can affect fungal cells, it's worth mentioning that the field of antifungal research is continuously evolving, and new insights into the specific mechanisms of action of phenols may emerge in the future.

Conclusions

Based on the obtained results, the efficacy of essential oils in controlling fungal growth depends on the type, species, and even different strains of the fungus. Generally, different strains of thyme had a greater impact on controlling fungal growth compared to the control. The cultivation method in this study was not statistically significant in most cases. Therefore, the use of essential oils as an organic compound for human and environmental control of various fungi, especially postharvest fungi, is recommended.

Keywords: Fungi, Postharvest, Essential oils, Salvia, Thymus.

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Declaration of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.