Antifungal activity of components from essential oils against microfungi isolated from industrial resins.

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Essential oils produced by certain plants have been used since ancient times for their significant anti-inflammatory, antioxidant, biocidal, and antiparasitic properties. Many of these oils have found widespread use in industrial applications, ranging from food preservation to the production of plant protection products, as well as in the medical field. In this study, the potential biocidal activity in vitro of the most abundant components of essential oils from oregano (carvacrol), thyme (thymol), and lavender (linalool) was evaluated on four fungal species isolated from industrial resins used for the conservation of monuments. All pure cultures were molecularly identified by amplification and sequencing of their ITS regions. The four most frequent fungal species were: *Cladosporium neolangeronii* Bensch & Samson, *Cladosporium myrtacearum* K. Schub., U. Braun & R.G. Shivas, *Aspergillus versicolor* (Vuill.) Tirab., and *Penicillium rubens* (Biourge). Each strain was cultured on Petri dishes containing PDA with biocide concentrations ranging from 0% to 0.1%, and colony diameters were measured every 2-3 days. Linalool was found to be the least effective biocide, as at the highest concentration it slowed the growth of all isolates without completely inhibiting colony development. Carvacrol was the most efficient biocide, being able to inhibit the growth of all isolates even at the lowest concentration. Thymol exhibited intermediate characteristics, inhibiting growth up to concentrations of 0.05%. The conidia present in the inocula were transferred to plates without biocide to assess whether the effects of the tested substances were fungicidal or fungistatic. Both carvacrol and thymol showed biocidal effects at the highest concentration (0.1%), which was ten times lower than the maximum threshold concentration above which the biocide must be classified as extremely toxic to humans (GSH06). All tests were also replicated in liquid culture, confirming the results obtained on solid medium.

In conclusion, carvacrol emerges as a promising natural biocide, capable of replacing the currently used synthetic compounds, which pose risks to health and the environment, offering a safer and eco-friendly alternative.