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Study of colonization mechanisms of construction products by micromycetes applied to the development of a preventive treatment

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CONTEXT

In nature, saprotrophic fungi have an essential ecological role in decomposition of organic matter. In soils, they break down material like leaves, wood, dead bodies, etc. Fungal colonization in natural environments requires advanced functional relationships, including various antagonisms and synergisms, between the different components of the biotope. Colonization of natural substrates has been described at different scales (macroscopic and molecular) and modeled.

In indoor environments, fungi find niches favorable to their development. They are able to induce pathologies to the occupants (allergies, poisoning and infections) and can also cause irreversible damages to the materials they infest.

Colonization of man-made substrates (construction and decoration products) by mold is insufficiently described to develop colonization models. A better knowledge of the dynamic of fungal colonization would be helpful to imagine preventive strategy to limit fungal growth.

OBJECTIVES

This research aims to describe and understand fungal colonization mechanisms in enclosed environments in order to propose preventive alternatives to limit fungal growth on building materials instead of using traditional biocides.

MATERIALS AND METHODS

Building materials

Wallpaper, glass fiber wall covering, plasterboard and bio-based insulation material



Fungal species most frequently identified

Aspergillus versicolor, *Penicillium chrysogenum* and *Cladosporium sphaerospermum*

RESULTS AND DISCUSSION

Towards a better understanding of building material colonization dynamic

TO

Before their implementation, building materials are variably contaminated by micromycetes in quantity and quality.

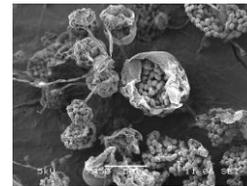


Initial contamination of a new bio-based insulation material by *Trichoderma*.
 → Raw material is probably contaminated in fields.

Fungal contamination characteristics	Wallpaper	Glass fiber	Plaster board	Bio-based product
Similar to aerobiocontamination	+	+	++	++
Fungal flora link to raw material				+++

21-28 days

Without water restriction, fungal development mainly consists of species belonging to genera *Penicillium*, *Aspergillus* and *Cladosporium*, ubiquitous airborne mycoflora.



Stachybotrys proliferation on wallpaper after 12 weeks incubation (25° C, RH 100%)

After 28 days

New invasive species such as *Stachybotrys* and *Alternaria*, known for their antagonist interactions, appear.

Biotic interactions between micro-organisms

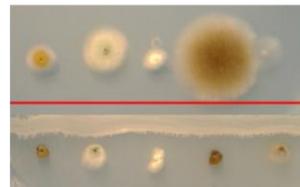
Diffusible substances

By contact (HI)

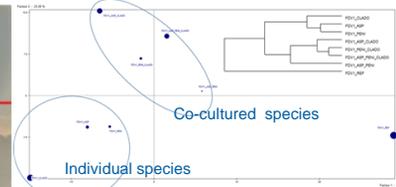
Volatile substances

Antagonistic behavior in culture

Micromycetes consortium's VOC characterization



Fungal growth in presence (top) and in absence (bottom) of *Bacillus*



Chemical ecology of species inoculated individually or in combination (PCA)

→ *Bacillus* are able to produce cyclic lipopeptides belonging to three families (Iturins, Fengycins & Surfactins) with antifungal properties.

→ Specific VOCs were identified and appear to be specific for each biotic interaction.

CONCLUSION AND PERSPECTIVES

- Fungal colonization of building materials involves same biotic relationships than those observed in natural environments → a succession of species with functional relationships like antagonism.
- Interaction mechanisms between microorganisms are mediated by diffusible substances in substrates (*Bacillus* sp). These antagonist active substances, whose safety must be verified, could be exploited to develop a dedicated eco-compatible treatment to limit fungal growth.
- Study of the involvement of MVOC in biotic interactions will be prosecuted.