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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***

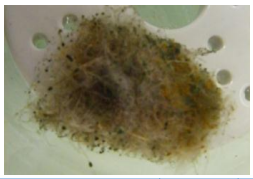
Aspergillus versicolor, Penicillium chrysogenum and *Cladosporium sphaerospermum*

RESULTS AND DISCUSSION

Towards a better understanding of building material colonization dynamic

T0

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

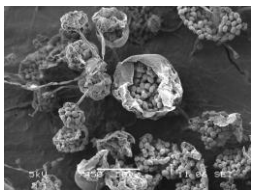


Initial contamination of a new bio-based insulation material by Trichoderma.
→ Raw material is probably contaminated in fields.

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, ubiquist airborne mycoflora.*



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

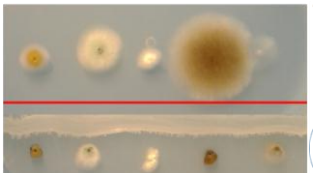
After 28 days

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**

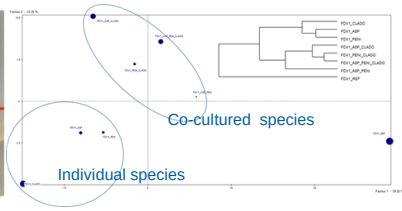
Antagonistic behavior in culture



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

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

Micromycetes consortium's VOC characterization



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

→ 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.