100% BIO-BASED MATERIALS FOR COMFORTABLE AND DEMOUNTABLE CONSTRUCTIONS

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Objectives of the PhD thesis

Development of 100% bio-based insulation materials

- Vegetal aggregates
- Bio-based binders : mycelium and biogenic calcium carbonate

→ Avoid the use of synthetic fibers or mineral binders

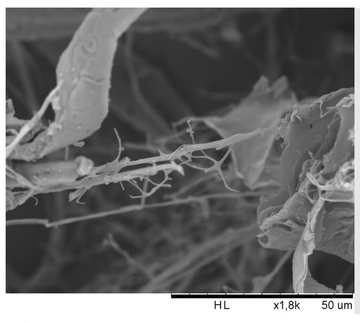
All stages of the life cycle taken into account

← Hemp shives – mycelium composite material

Hemp shives - bioprecipited $CaCO_3$ composite material →

Feedstock → Process → Material properties → Constructive system → Durability

Two bio-based binders under study



Mycelium matrix (mycocomposites)

- Mycelium network growth in a plant-based substrate[1]
- First designed for packaging and design, not available yet for insulation applications

↑ SEM picture of a wood fiber and mycelium composite material
PFE Alexandre COPIN 2022

Biogenic calcium carbonate matrix

- Precipitation of calcium carbonate by microbial strains[2]
- In literature, predominant use of mineral substrates (silica sand or limestone)

↑ Optical microscopy image of a hemp shives & $CaCO_3$ composite material
Internship Janette AYOUB 2022

Study of the mycelium-substrate combinations

Key features for the mycelium-substrate couple

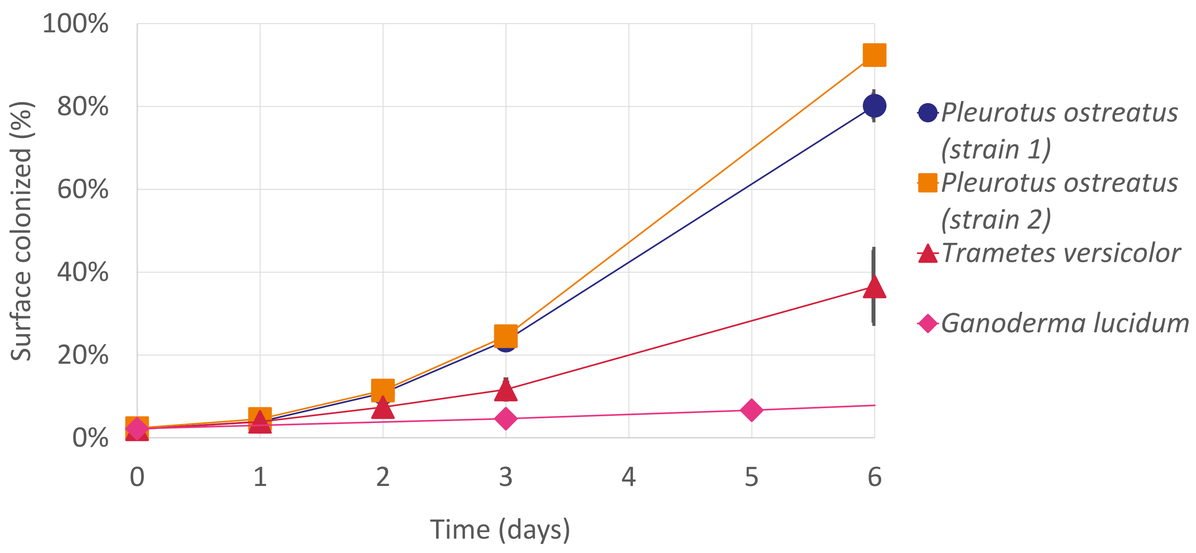
Several fungal species and substrates have been explored

- Nutritional versatility, preferential lignin degradation and rapid growth explain the predominance of white fungi[1]
- Fungal colonization rate is a crucial factor for efficient composite material production[3]

Measurement of the fungal growth

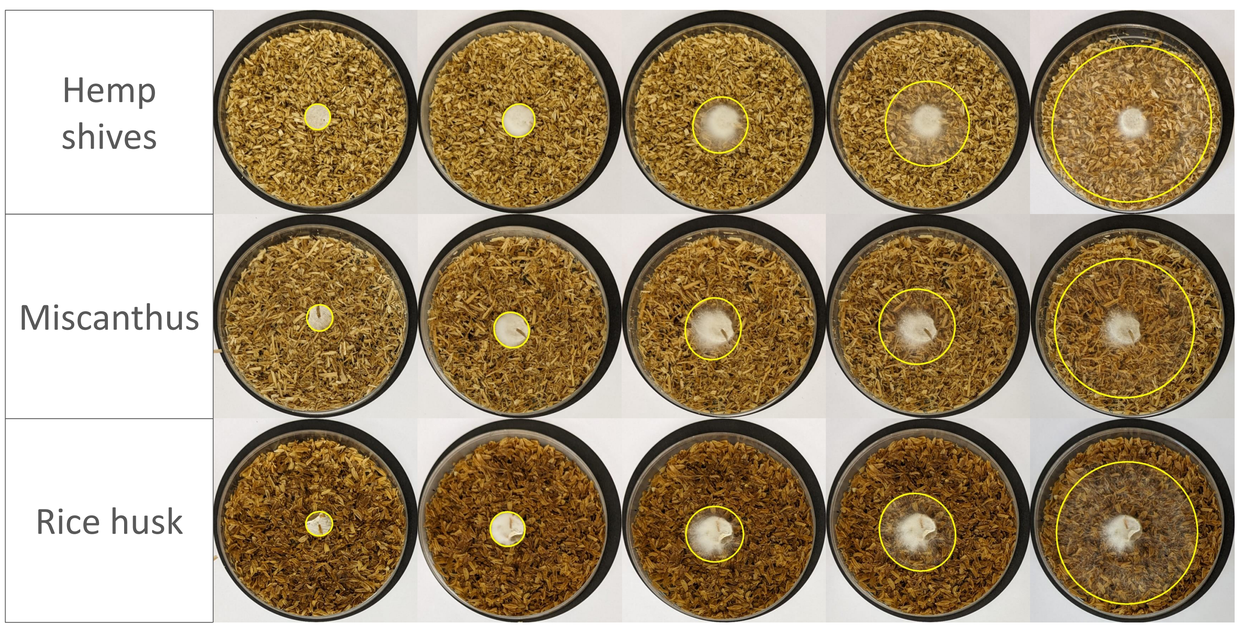
- 3 substrates, saturated in water : hemp shives, miscanthus and rice husk
- Inoculation of 4 fungal strains: *Pleurotus ostreatus* (2 variants), *Trametes versicolor*, *Ganoderma lucidum*
- Measurement of the fungal colonization on pictures

Impact of the mycelium strain



Radial growth measurements of 4 different mycelium strains on hemp shives

Impact of the substrate



Annotated photographs of the radial growth of *P. ostreatus* on different substrates, after 0,1,2,3 and 6 days

Conclusion and perspectives

- *Pleurotus ostreatus* identified as the fastest-growing species: up to 7 times greater radial growth speed than *Ganoderma lucidum*
- Hemp shives is a slightly preferential substrate: 10% greater radial growth rate
- Production of mycelium composite materials and characterization of their functional properties will enable further differentiation between mycelium strains and their substrates

References

1. Elsacker, E. et al. A comprehensive framework for the production of mycelium-based lignocellulosic composites. Science of The Total Environment 725, 138431 (2020).
2. Iqbal, D. M., Wong, L. S. & Kong, S. Y. Bio-Cementation in Construction Materials: A Review. Materials 14, 2175 (2021).
3. Sydor, M., Cofta, G., Doczekalska, B. & Bonenberg, A. Fungi in Mycelium-Based Composites: Usage and Recommendations. Materials 15, 6283 (2022).