Characterization of the glycomaterial adhesion properties of fungal mycelium

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Introduction

Filamentous fungi colonize lignocellulosic biomass, forming a network of continuous hyphae. The fungal mycelium is a natural binder that can grow on and be incorporated into lignocellulosic biocomposites.

Little is known about how the fungal mycelium modifies the cellulosic structure and how these changes affect its adhesive properties.

Research Question

- What is the adhesion mechanism of filamentous fungi to lignocellulosic surface?
- What is the molecular structure of mycelium after different treatments and their influence on the material properties?

Methods

Glycosyl composition analysis was performed by gas chromatography-mass spectrometry (GC-MS) of trimethylsilyl-derivatized methyl glycosides.

Glycosyl linkage analysis was carried out by GC-MS through methylation, carboxyl reduction, and formation of partially methylated alditol acetates (PMAAs).

Molecular weight measurements were done by size exclusion chromatography using an analytical Superose-6 column, eluted with 50 mM ammonium acetate, pH 5.

Solid-state NMR was acquired on a Bruker Neo 600 MHz system, equipped with a CP-MAS probe operated at 10000 Hz.

Results

Samples were collected from fungal mycelium grown on wood. The glycosyl composition (Fig. 1) and linkage (Fig. 2) analysis showed a marked difference in monosaccharide composition between the two samples. The Wood sample contained much more xylose and galacturonic acid, whereas the mycetin sample was higher in fucose, mannose, and galactose.

Figure 1. Results of the glycosyl composition analysis in mole %. Total CHO was 6% in Wood and 4% in Mycetin
Blue: Wood; red: Mycetin

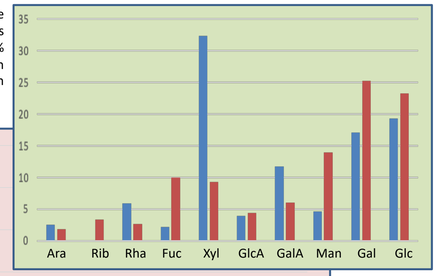
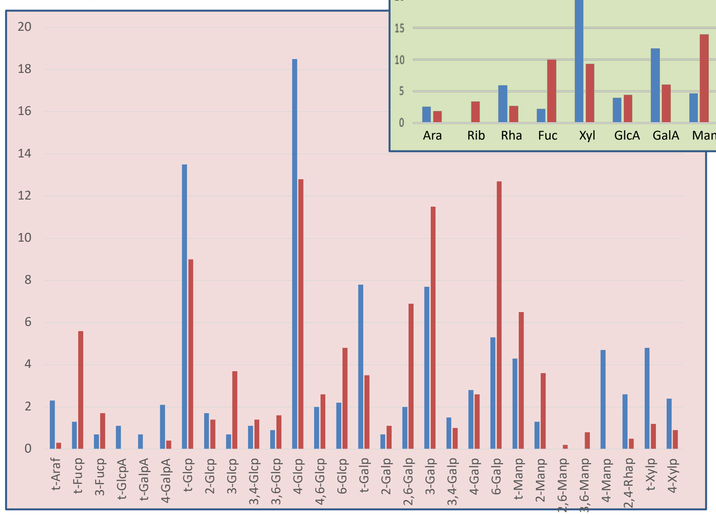


Figure 2. Results of the glycosyl linkage analysis in area %.
Blue: Wood; red: Mycetin



The molecular weight analysis (Fig. 3) showed little difference between the two samples. Both samples consisted largely of small molecules.

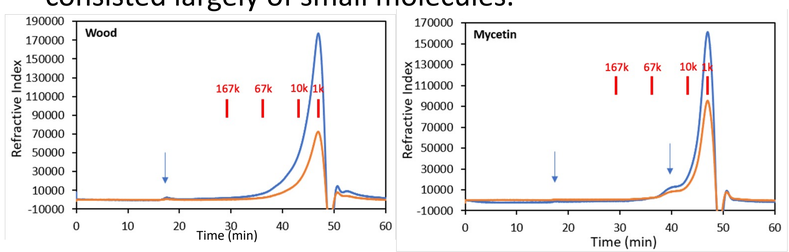


Figure 3. Molecular weight determination of the Wood and Mycetin samples. Blue: 200 µg; red 100 µg.
The red molecular weight markers were determined by dextran standards.

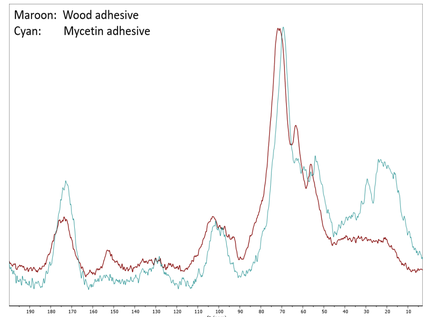


Figure 4. Comparison of CP-MAS ^{13}C-NMR spectra of samples Wood (red) and Mycetin (blue).

The solid-state NMR analysis (Fig. 4) showed that the Mycetin sample contained more protein than the Wood sample, suggesting that protein may be partially responsible for enhanced adhesion.

Conclusion

The carbohydrate analyses showed that Sample Wood consists of fragments of plant cell wall cellulose, pectin, and arabinogalactan, while Sample Mycetin contains mainly fragments of galactan, mannan, and glucan, which are typical fungal cell wall components.

The CP-MAS NMR analysis indicated that protein may also play a role in adhesion.

Acknowledgement

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References

Wenjing Sun, Mehdi Tajvidi, Caitlin Howell, Christopher G. Hunt (2022) Insight into mycelium-lignocellulosic biocomposites: Essential factors and properties. Composites Part A161:107125.