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Bio-Based Building Materials – How to Unravel the Role of Material Characteristics on Fungal Susceptibility?

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1 Introduction

Bio-based materials are gaining importance in the building industry, as the focus on sustainability and life-cycle-assessment has increased substantially over the last decade. Wood and wood-engineered products as well as insulation materials made from cellulose, wood, flax, hemp, etc. are increasingly used. These materials are made from renewable resources and with considerably lower energy consumption than various other building materials, such as insulation polymers, steel and concrete (Sathre and O'Connor, 2008; Jones and Brischke, 2017). As steel can corrode and concrete can rot, so can bio-based building materials degrade over time when exposed to those conditions that favour decay. Bio-based materials are inherently biodegradable, which can be an advantage as it reduces building waste at end of life. However, this can also cause problems when bio-based materials are exposed to moisture and temperature conditions that are favorable for decaying fungi. Since fungi cause not only aesthetical degradation, but can also severely compromise the structural integrity of a building component this is critical for any service life approach.

Consequently, a proper understanding of the fungal susceptibility of bio-based materials is needed. Some materials are protected against fungal attack by applying wood preservatives or protection by chemical or thermal modification techniques. Also chemical substances inherent to the product, such as glues, resins and the plastic component in composites, can have a fungal inhibiting effect, either by being toxic or by limiting moisture uptake. How these substances are arranged in the material structure as well as the material structure in itself affect the fungal susceptibility. Knowing how different material characteristics affect a material's fungal susceptibility is key, both for optimal application of bio-based materials as for the design of new materials.

2 Assessing the Role of Material Chemistry and Material Structure on Fungal Susceptibility

Based on a combination of tests we try to unravel the role of the material's chemical components, structure and moisture dynamics on its fungal susceptibility, as well as the interaction between those material characteristics. In a first test set-up, the 'paste test', the material's structure is removed and fungal growth is assessed over time in 2D, with only the material's chemical components playing a role (Fig. 1). In the second test set-up, the 'X-ray CT test', fungal development is assessed non-destructively in 3D with X-ray CT, giving an indication of moisture production and distribution over time, in relation to the material's structure (Fig. 2). By comparing the results, we have a better idea of how much each material characteristic influences fungal susceptibility. This knowledge can then be used for optimising fungal testing of bio-based materials, ensuring optimal application and providing the building industry with the confidence they need to pave the way to a more sustainable future.

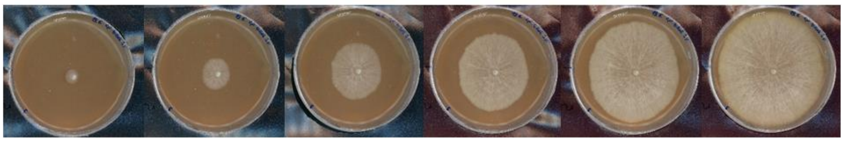

Figure 1. *C. puteana* growing on a paste of beech heartwood.

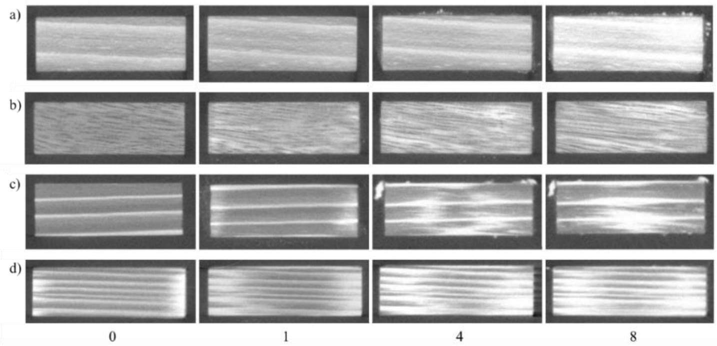

Figure 2. CT slices showing the fungal degradation of beech (*Fagus sylvatica* L.) (a), gaboon (*Aucoumea klaineana* Pierre) (b), Scots pine sapwood (*Pinus sylvestris* L.) (c) and Norway spruce (*Picea abies* (L.) Karst) (d) mini-blocks over time by *C. puteana*. The whiter the pixels, the higher the density.

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