ASSESSING THE NUTRIENT VALUE OF BIO-BASED MATERIALS IN RELATION TO EARLY FUNGAL GROWTH

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Background

Fig. 1 Wood engineered products.
Bio-Based Building (B³) Research Lab, 2017.

Bio-based materials are gaining importance in the building industry, as the focus on sustainability and life-cycle-assessment has increased dramatically over the last decade (Nobe & Dunbar, 2004). Wood and wood-engineered products (Fig. 1) as well as insulation materials made from flax, hemp, etc. are hence increasingly used. These materials originate from renewable resources and are often biodegradable, which can cause problems when bio-based materials are exposed to moisture and temperature conditions that are favourable for fungi (Ganotopoulou, 2014).

Fig. 2 Wood damage caused by *Coniophora. puteana.* Sachverständigenbüro für Holzschutz, 2016.

Fungal damage is not only aesthetical, but can also severely compromise the structural integrity of a building component (Fig. 2). Biological degradation in terms of fungal decay is the most common reason for surface disfigurement and structural failures of timber structures (Jones, 2015). Consolidated knowledge of the numerous decay-influencing factors is needed to estimate the service life to be expected for bio-based building components.

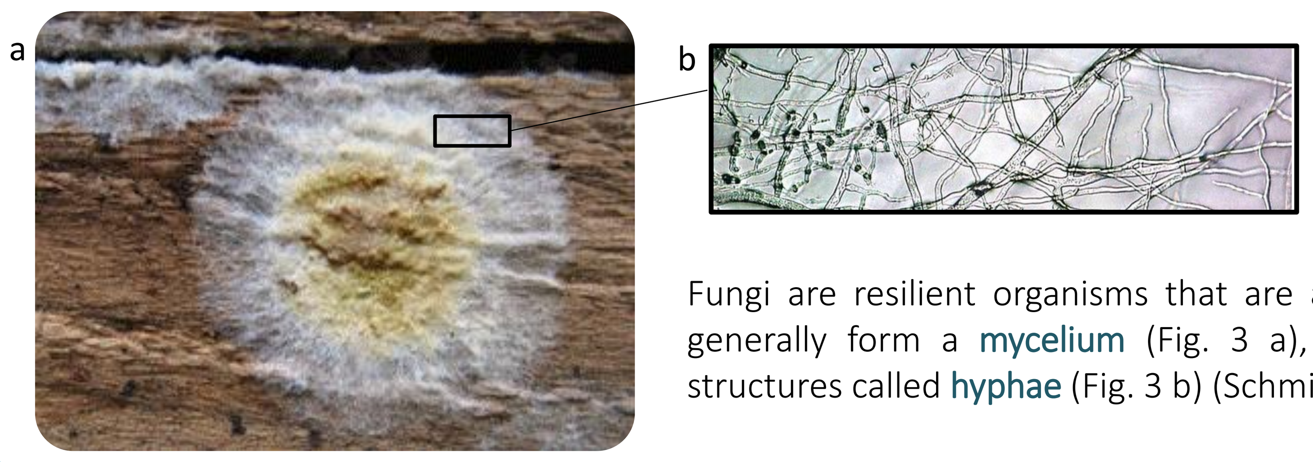

Fig. 3
a) Fungal mycelium of brown rot fungus *Coniophora puteana.*
Sachverständigenbüro für Holzschutz, 2016.
b) Fungal hyphae.
Blaylock, 2010.

Fungi are resilient organisms that are able to grow in almost any environment. They generally form a mycelium (Fig. 3 a), a widespread network of narrow, thread-like structures called hyphae (Fig. 3 b) (Schmidt, 2006).

Problem statement

Standards for the assessment of wood preservatives and of the inherent resistance of wood species against decay fungi are generally regarded as adequate (Kutnik, 2013).

Existing standards are typically inadequate for the correct qualification of other bio-based building materials (Fig. 4) (Candelier *et al.*, 2016; Kutnik *et al.*, 2014; Ormondroyd *et al.*, 2015; Ringman *et al.*, 2014;).

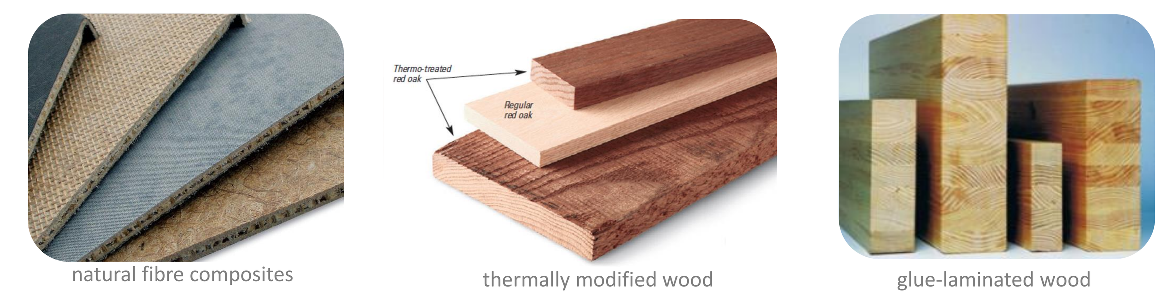

Fig. 4 Examples of bio-based materials for which the existing standards are not yet adequate for qualification.

In order to properly interpret experimental data when standard-testing bio-based materials, the influence of certain material characteristics (Fig. 5) on fungal susceptibility needs to be unravelled.

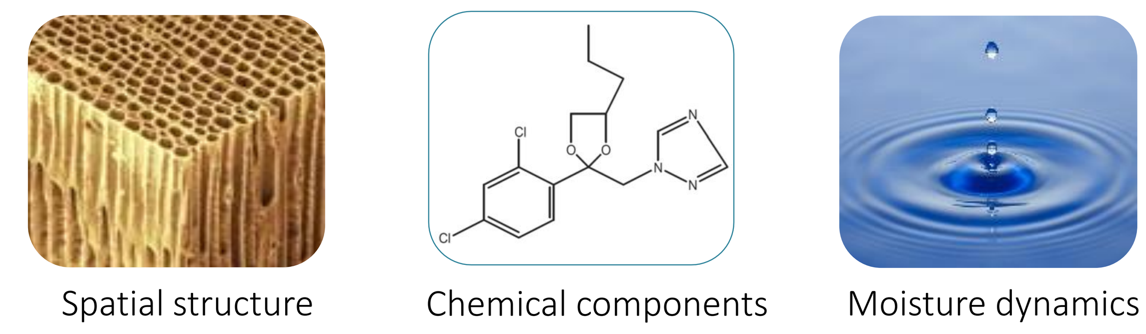

Fig. 5 Material characteristics influencing fungal resistance.

Method

By eliminating the spatial structure of a material, the influence of only the chemical component on the material's fungal resistance is assessed. In se, the nutrient value of a material is tested for decay fungi, without the material's structure and moisture dynamics playing a role.

In order to assess the nutrient value of bio-based materials, the following method is proposed (Fig. 6). Step 4-6 of this method has successfully been applied for the assessment of fungal growth on a standard malt agar medium (Vidal-Diez de Ulzurrun, 2016). Key to successfully assess the nutrient value of a bio-based material, is the determination of a suitable paste composition, for which differences in growth behaviour between different materials can be identified.

1. Milling of the bio-based material so structure gets largely eliminated
2. Turning the resulting sawdust into a paste by adding a gelling agent
3. Inoculating the paste with a Basidiomycete fungus
4. Capturing images to follow early fungal growth through time → time scale: several days
5. Processing the images by using an automatic image analysis technique (Vidal-Diez de Ulzurrun, 2015)
6. Interpreting the outcome of the image analyses by representing several fungal growth parameters through time, e.g. total length of the mycelium, total number of tips, area of the mycelium, etc.

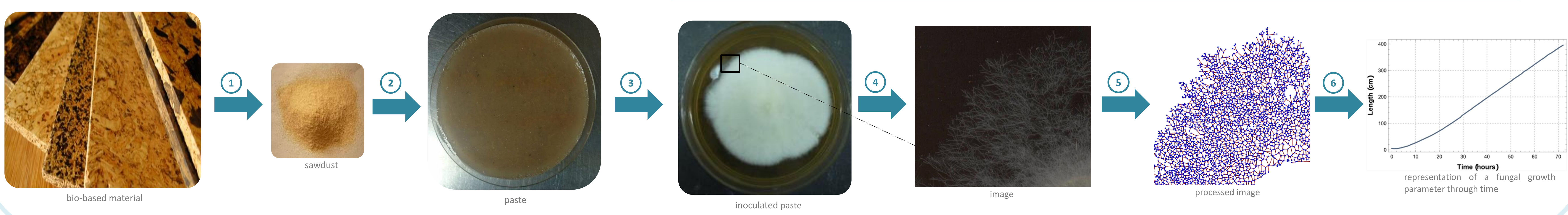

Fig. 6 Overview of the proposed method for assessment of the nutrient value of bio-based materials.

Results and discussion

Pastes with different compositions (differing in the amount of malt extract added) were created for 4 well-known wood species (beech, movingui, European cherry and African padouk) and inoculated with *Trametes versicolor*. Fig. 7 shows the evolution of fungal growth on 4 pastes with the following composition: 10% wood saw dust, 2% agar and 0.5% malt extract. A control sample (2% agar, 0.5% malt extract) without sawdust was also added to the test. In addition, a mini-block test (Bravery et al., 1979) was performed on samples originating from the same wood material as the wood pastes, to assess resistance against fungal decay following a standard procedure (Fig. 8) .

Fig 7. shows the differences in growth behaviour between the different wood samples and the control specimen. European cherry and African padouk develop the smallest mycelial growth area, while for beech a very large area is covered. This is, for African padouk and beech, in line with the mini-block test results (Fig. 8) and their known high and low durability respectively (Wagenfuhr, R., 2000). For the other two wood species the results are less unequivocal.

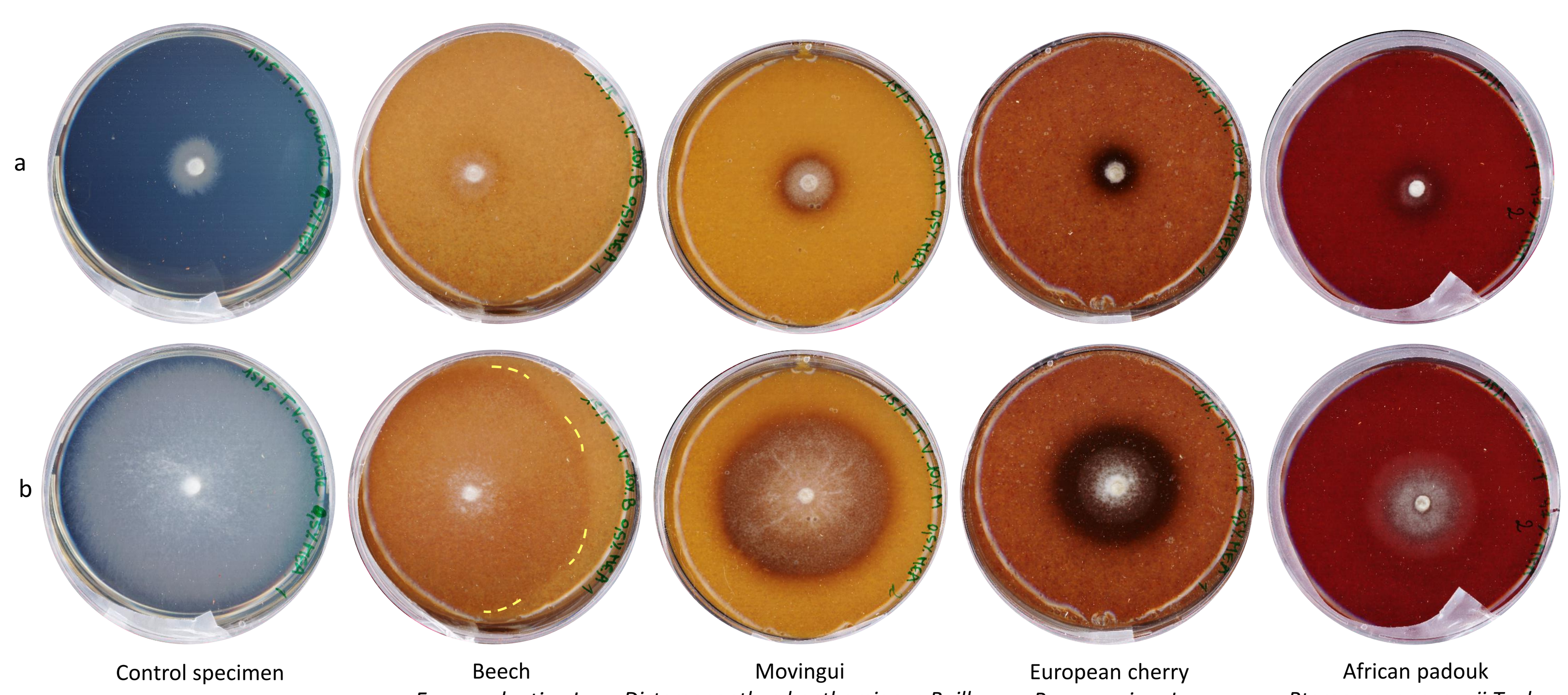

Fig. 7 Comparison of fungal growth development *(Trametes versicolor)* on 4 wood pastes (10% saw dust, 2% agar, 0.5% malt extract) and a control specimen (2% agar, 0.5% malt extract) after 3 (a) and 11 (b) days of growth.

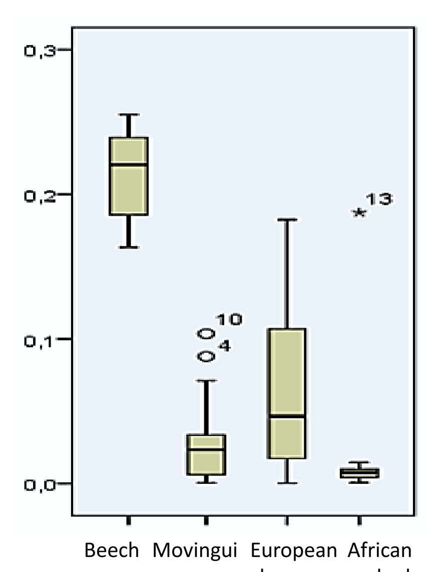

Fig. 8 Results of a mini-block test performed following the method of Bravery *et al.* (1979), displaying the percentage of mass loss caused by fungal decay (*Trametes versicolor*) after an incubation period of 6 weeks at 22°C and 65% RH.

Nonetheless, these results show that pastes of different materials show differing growth behaviour after a rather short period of time, indicating that there is a chemical component impacting resistance. Similar tests will be performed for a selection of bio-based materials. The results will be linked to tests including the structural component, as such assessing the influence of the material's spatial structure compared to its chemistry.

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