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The Influence of Mycelium Species and Incubation Protocols on Heat and Moisture Transfer Properties of Mycelium-Based Composites

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Abstract : Mycelium-based composites (MBC) are made by growing living mycelium on lignocellulosic fibres to create a porous composite material which can be lightweight, and biodegradable, making them suitable as a sustainable thermal insulation. Thus, they can help to reduce material extraction while improving the energy efficiency of buildings, especially when agricultural by-products are used. However, as MBC are hygroscopic materials, moisture can reduce their thermal insulation efficiency. It is known that surface growth, or “mycelium skin”, can form a natural coating due to the hydrophobic properties in the mycelium cell wall. Therefore, this research aims to biofabricate a homogeneous mycelium skin and measure its influence on the final composite material by testing material properties such as thermal conductivity, vapour permeability and water absorption by partial immersion over 24 hours. In addition, porosity, surface morphology and chemical composition were also analyzed. The white-rot fungi species Pleurotus ostreatus, Ganoderma lucidum, and Trametes versicolor were grown on 10 mm hemp fibres (Cannabis sativa), and three different biofabrication protocols were used during incubation, varying the time and surface treatment, including the addition of pre-colonised sawdust. The results indicate that density can be reduced by colonisation time, which will favourably impact thermal conductivity but will negatively affect vapour and liquid water control. Additionally, different fungi can exhibit different resistance to prolonged water absorption, and due to osmotic sensitivity, mycelium skin may also diminish moisture control. Finally, a collapse in the mycelium network after water immersion was observed through SEM, indicating how the microstructure is affected, which is also dependent on fungi species and the type of skin achieved. These results help to comprehend the differences and limitations of three of the most common species used for MBC fabrication and how precise engineering is needed to effectively control the material output.

Keywords : mycelium, thermal conductivity, vapor permeability, water absorption
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