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Solid-state Fermentation of Birch Sawdust by Pleurotus ostreatus for Mycelial Protein Production: Effects of Nutrient Addition and Reactor Types

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Abstract

Edible fungi offer a promising alternative to animal proteins, given their rich protein profile and ability to upgrade lignocellulosic residues. However, conventional mushroom production faces challenges in terms of significant residue generation, which consists of protein-rich mycelia but is contaminated with pesticides and antibiotics (Leong et al., 2022). To revolutionize this process, our Wood2Food project proposes to convert raw wood material via controlled, continuous, and contamination-free solid-state fermentations (SSF) into a product predominantly composed of mycelia and a minor fraction of cellulosic dietary fiber, which is presumed to be safe, wholesome, and suitable for human consumption. In this particular study, we first investigated the impact of nutrient addition, particularly nitrogen, on the mycelial expansion and oxygen consumption of a model strain, *Pleurotus ostreatus*, cultivated on birch sawdust substrate. Our findings indicate that the addition of nitrogen effectively accelerated the mycelial expansion of *P. ostreatus* in Petri dishes, but lead to a decrease in oxygen consumption rate when cultivating the fungus in SSF reactors. A potential inhibitory effect of nitrogen may have been imposed on fungal lignin degradation, which is a crucial step in their decomposition of lignocellulose. These observations suggest that a careful optimization of nutrient supplementation, particularly nitrogen, is crucial to balance the need for fungal protein synthesis and lignin-degrading activity. We also employed three different types of reactors (two static reactors with or without spacers and one rotary drum reactor) to understand the engineering aspects of this process. A marked difference was noted in the oxygen consumption pattern between the rotary drum reactor and the static reactors. Additionally, extensive drying and agglomeration of the substrate were observed in all static reactors but not in rotary drum reactors. These variations confirm the crucial role of reactor design in affecting the fungal physiology and mass transfer of nutrients and metabolites. Overall, our study sheds light on an innovative solution to produce fungal protein from woody biomass, i.e. converting wood directly into food that

is rich in mycelial protein and fibers. This approach holds promise for addressing the limitations of conventional mushroom production and meeting the increasing demand for sustainable protein sources. By evaluating the impact of nutrient addition and comparing different reactor types, we have demonstrated a proof of concept and gained preliminary understandings of the process limitations. Further research is warranted to delve deeper into the optimization of different environmental factors and reactor design, with the aim of developing a robust and environmentally friendly process with higher productivity and quality of products.

Keywords: Fungal protein, Wood, Lignocellulose, Solid-state fermentation

References

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