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Substrate-Dependent Modulation of Volatile Aroma Profiles in Filamentous Fungal Fermentation

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Abstract

The ability to control aroma formation is critical for the successful application of fungal biomass as food ingredients. However, the influence of substrate composition on aroma development remains insufficiently understood. This study evaluates the effect of different media on volatile profile generation and associated sensory characteristics in selected filamentous fungi (F13859, F20595, F9022, and F9344).

Strains were cultivated in optimized media and food side-stream-derived substrates, including brewer's spent grain (BSG) and okara, with and without onion supplementation. Aroma profiles were evaluated using sensory screening (sniff test, n=3) and interpreted alongside trends in volatile diversity. Distinct substrate-dependent modulation of aroma intensity, composition, and sensory quality was observed across all strains. F9022 exhibited high volatile diversity and strong generation of lipid-derived compounds associated with meaty and fatty aromas, particularly under optimized conditions. F13859 demonstrated rapid formation of a diverse volatile profile under BSG-based substrates, yielding complex savory and fermented notes at early time points. F20595 produced characteristic floral and pandan-like aromas, consistent with the formation of heterocyclic compounds such as 2-acetylpyridine, indicating substrate-driven pathway specificity. F9344 generated profiles enriched in C8 compounds (e.g., 1-octen-3-ol), contributing to mushroom-like aroma characteristics.

These results demonstrate that substrate composition governs metabolic flux toward distinct volatile classes, enabling controllable aroma outcomes in fungal fermentation systems. This approach provides a foundation for rational strain-substrate pairing to design application-specific flavor profiles while valorizing low-cost food side-streams for scalable production.