Antifungal mechanism of 1-nonanol against *Aspergillus flavus* growth revealed by metabolomic analyses

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Abstract

Chemical control of fungal spoilage of postharvest cereal grains is an important strategy for the management of grain storage. Here, the potential antifungal activity of 1-nonanol, a main component of cereal volatiles, against *Aspergillus flavus* was studied. The growth of *A. flavus* was completely inhibited by 0.11 and 0.20 μL/mL 1-nonanol at vapor and liquid contact phases, respectively. Metabolomic analysis identified 135 metabolites whose expression was significantly different between 1-nonanol-treated and untreated *A. flavus*. These metabolites were involved in the tricarboxylic acid cycle, amino acid biosynthesis, protein degradation and absorption, aminoacyl-tRNA biosynthesis, mineral absorption, and in interactions with ABC transporters. Biochemical validation confirmed the disruptive effect of 1-nonanol on *A. flavus* growth, as indicated by the leakage of intracellular electrolytes, decreased succinate dehydrogenase, mitochondrial dehydrogenase, and ATPase activity, and the accumulation of reactive oxygen species. We speculated that 1-nonanol could disrupt cell membrane integrity and mitochondrial function and might induce apoptosis of *A. flavus* mycelia. Simulated grain storage experiments showed that 1-nonanol vapor, at a concentration of 264 μL/L, completely inhibited *A. flavus* growth in wheat, corn, and paddy grain with an 18% moisture content. This study provides new insights into the antifungal mechanism of 1-nonanol against *A. flavus*, indicating that it has a promising potential as a bio-preservative to prevent fungal spoilage of postharvest grains.