

# Exploring the antifungal mechanism of limonin-loaded eugenol emulsion against *Penicillium italicum*: From the perspective of microbial metabolism

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## Abstract

*Penicillium italicum* (*P. italicum*), the cause of citrus blue mould, is a pathogenic fungus that seriously affects the postharvest quality of citrus fruit and causes severe economic loss. Our previous research showed that adding limonin to eugenol nanoemulsion could improve the antifungal activity, and inhibited the growth of *P. italicum* on the surface of citrus fruit. Accordingly, the present study aimed to investigate the underlying mechanism of limonin-loaded eugenol emulsion (EuLm) against *P. italicum* based on the influence on membrane structure and intracellular substance metabolism. Results indicated that EuLm showed disruptive activity on the fungal cell membrane, mitochondrial membrane potential and the ergosterol synthesis. Meanwhile, EuLm treatment causes the intracellular substances of total lipids, cell proteins and total sugars to decrease by 56.7 %, 37.4 % and 17.4 %, respectively. GC–MS-based metabolomics showed 34 metabolites declined after EuLm treatment, including amino acids, fatty acids, carbohydrates, alcohols, and glycosides. The results suggested that EuLm interferes with fungal metabolic pathways, such as the TCA cycle, lipid metabolism and protein synthesis. Our study provides new insight into exploring the underlying mechanisms of antifungal phytochemicals against *P. italicum*.