Tropentag, September 20-22, 2023, hybrid conference

"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

Inhibitory activity of bacterial lipopeptides against *Fusarium oxysporum* f.sp. *strigae*

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Abstract

This study investigated the impact of bacterial cyclic lipopeptides (LP; surfactins, iturins, fengycins) on microbial interactions in the plant endosphere. The objective was to investigate whether the presence of bacteria inhibits fungal growth and whether this inhibition is due to the release of bacterial metabolites, particularly LP. The study employed selected endophytic bacterial strains with known plant-growth promoting potential that were cultured in the presence of *Fusarium oxysporum* f.sp. *strigae* (*Fos*), which was applied as the model fungal organism. The extracellular metabolome of tested bacteria, with a focus on LP, was characterised, and the inhibitory effect of bacterial LP on fungal growth was investigated. The results showed that *Bacillus velezensis* GB03 and FZB42, as well as *B. subtilis* BSn5 exhibited the strongest antagonism against *Fos*, while *Paraburkholderia phytofirmans* PsJN had a slight stimulatory effect. Crude LP from strains GB03 and FZB42 had the strongest inhibitory effect on *Fos*, with a significant inhibition of spore germination and damage to the hyphal structure. Liquid chromatography tandem mass spectrometry revealed the production of several variants of iturin, fengycin, and surfactin LP families from strains GB03, FZB42, and BSn5, with varying intensity. Using plate cultures, bacillomycin D fractions were detected in higher abundance in strains GB03, FZB42, and BSn5 in the presence of *Fos*. Additionally, the presence of *Fos* in dual plate culture triggered an increase in bacillomycin D production from the *Bacillus* strains, possibly through activation of signaling molecules. It was also suggested that fungal metabolites produced by *Fos* in dual culture might have triggered LP production by bacteria. The study clearly demonstrated the potent antagonistic effect of certain *Bacillus* strains, including *Bacillus* sp. GB03, FZB42, and BSn5, on *Fos* development. Conversely, we found that *P. phytofirmans* PsJN promoted the development of *Fos*. Our findings emphasise the crucial role of microbial interactions in shaping the co-existence of microbial assemblages in plant endospheres.

Keywords: Bacillomycin D, biological control, co-inoculation, lipopeptide abundance, microbial interaction

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