

**Title** Effect of volatile compounds produced by *Bacillus* strains on postharvest decay in citrus  
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### Abstract

The antifungal effects of volatile compounds produced by *Bacillus* strains; *Bacillus subtilis* PPCB001 or *Bacillus amyloliquefaciens* PPCB004 and antagonist combination (PPCB001 + PPCB004) against *Penicillium digitatum* Sacc., *Penicillium italicum* Wehmer and *Penicillium crustosum* Thom isolates were investigated *in vitro* and *in vivo*. The antagonists alone or in combination inhibited the radial mycelial growth of *Penicillium* spp. *in vitro*. Among the three *Penicillium* isolates tested *P. crustosum* showed 73.3% of mycelial growth inhibition in presence of PPCB004. The antifungal effects of volatiles increased with increasing time (days), and PPCB004 showed the highest inhibition of radial mycelial growth in *P. crustosum* on the 10th day. The EC<sub>50</sub> was  $2.5 \times 10^5$  CFU ml<sup>-1</sup> for PPCB001;  $9.45 \times 10^6$  CFU ml<sup>-1</sup> for PPCB004 and  $7.76 \times 10^6$  CFU ml<sup>-1</sup> for PPCB001 + PPCB004. Antagonist PPCB004 incubated at 37 °C for 24 h showed higher inhibitory effect on spore germination and germ tube elongation in *P. crustosum* than all other treatments. Although, PPCB001 produced a higher number of volatile compounds (21 different types) than PPC004 (8 different types), 3-hydroxy-2-butanone (acetoin) was the predominant ketone produced by both PPCB001 (45.98%) and PPCB004 (97.52%). Antagonist PPCB004 showed significant inhibition on decay incidence and severity in Valencia, inoculated with *P. crustosum* and held at 25 °C for 12 days. The observations indicated that *B. amyloliquefaciens* PPCB004 to control *P. crustosum* in postharvest systems.