

**Title** In vitro and in situ study of postharvest apple blue mold biocontrol by *Aureobasidium pullulans*: Evidence for the involvement of competition for nutrients

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### Abstract

*Aureobasidium pullulans* strain Ach1-1 was selected for its effectiveness against blue mold caused by *Penicillium expansum* on stored apple fruit. The possible involvement of competition for nutrients in the biocontrol activity of this antagonistic strain was investigated both *in vitro* and *in situ*. For *in vitro* assays, the effect of strain Ach1-1 on germination percentages of *P. expansum* conidia was evaluated after a 24 h incubation period in the presence of increasing apple juice concentrations (0–5%) using a system allowing the physical separation of both agents. In the absence of strain Ach1-1, conidial germination was strongly promoted by apple juice whatever the concentration. However, germination was significantly reduced by the presence of strain Ach1-1 except at the highest juice concentration. For conidia previously inhibited at 0.5% juice, germination after 24 h of incubation was partially recovered in the presence of strain Ach1-1 when fresh juice was added to a final concentration of 5%, and completely restored at both 0.5 and 5% juice concentrations in the absence of strain Ach1-1. For *in situ* assays, strain Ach1-1 was very protective against *P. expansum* on postharvest wounded apples. However, the application of high concentrations of exogenous sugars, vitamins and most particularly amino acids, significantly reduced such protection. Time-course analysis of apple amino acids at the wound site revealed that these compounds were more depleted in wounds treated with strain Ach1-1 alone and especially in those treated with both agents (strain Ach1-1 and *P. expansum*) compared to wounds treated with *P. expansum* alone or to untreated ones. Exogenous amino acids, applied at high concentrations on apple wounds as a mixture of specific amino acid groups or as individuals, significantly decreased strain Ach1-1 efficacy against *P. expansum*. The present study provides *in vitro* and *in situ* evidence that competition for apple nutrients, most particularly amino acids, may be a main mechanism of the biocontrol activity of *A. pullulans* strain Ach1-1 against blue mold caused by *P. expansum* on harvested apple fruit.