Farnesol antimicrobial role as biofilm cell detachment inducer in S. epidermidis biofilms

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Objetives: Farnesol is a naturally-occurring sesquiterpene that was originally isolated from essential oils found in many plants has been described to have antimicrobial potential against several bacteria, including S. epidermidis. However, farnesol mechanism of action is not yet fully understood and some contradictory findings have been reported. We recently described that while farnesol was not efficient at killing biofilm bacteria, a strong reduction on biofilm biomass was detected, and we hypothesize that farnesol could be inducing biofilm detachment. Here, we address this hypothesis.

Methods: To test our hypothesis we used 36 representative clinical strains of S. epidermidis from different parts of the world and characterized them in terms of genetic variability, biofilm formation and on the effect of farnesol on biofilm physiology and gene expression.

Results: Farnesol had no bactericidal effect on stationary phase populations equal or above 108 CFU/mL. In exponential phase planktonic bacteria, farnesol showed a bacteriostatic effect after cell density reached 108 CFU/mL. In any of the growth phases studied, farnesol was effective in killing above 90% of bacteria in 4 h when cell density was 107 CFU/mL or below.

Confocal microscopy and flow citometry analysis confirmed that in biofilms bacteria were not killed by farnesol but nevertheless cell wall integrity was affected. Gene expression studies revealed differential responses to farnesol, depending on the bacterial strain tested. Farnesol cell detachement from biofilms was also strain-dependent.

Conclusions: We found that while farnesol cannot kill high density bacterial communities, such as biofilms, it was nevertheless able to induce biofilm detachment in 50% of the strains that formed biofilm.

Keywords biofilms; antimicrobial resistant; cell detachment; gene expression; confocal microscopy