Behaviour of biofilms formed by *Pseudomonas fluorescens* under different flow regimes when exposed to surfactants – role of the biofilm mechanical stability

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The effectiveness of cetyltrimethyl ammonium bromide (CTAB) and sodium dodecyl sulfate (SDS) to control biofilms formed by *Pseudomonas fluorescens* on stainless steel slides under laminar and turbulent conditions, using a flow cell reactor, is compared in this study. The antimicrobial action of the surfactants was evaluated in terms of the activity of the biofilm, the biofilm mass that remained on the surface after treatment and the biofilm morphological characteristics. The mechanical stability of the biofilm was also assessed using a bioreactor rotating device. For comparative purpose, the action of the surfactants against bacterial suspended cultures was also evaluated. The interference of proteins (bovine serum albumin-BSA), acting as soil, on the action of the surfactants was also investigated.

Turbulent *P. fluorescens* biofilm seemed to be more difficult to inactivate, by CTAB treatment, than the laminar biofilm. However, the total inactivation of the cells within the biofilms was not achieved for both types of biofilms. Concerning SDS, higher concentrations promoted significant biofilm inactivation. Biofilms formed under turbulent and laminar flow had analogous susceptibility to SDS application. Regarding biofilm removal, both surfactants appeared to have poor effect, independently of the flow regime under which biofilms were formed. It was also seen that, the structure of biofilms was changed after the application of both surfactants. The mechanical stability of the biofilm was differently conditioned depending on the surfactant used: CTAB increased the biofilm removal regardless of the concentration tested; whereas, SDS, for concentrations far from the critical micellar concentration promoted biofilm strengthening, since the amount of biomass that remained attached to the surface, after submission to the different shear stresses, increased with SDS application. As expected, the toxic action of the surfactants was more pronounced in suspended bacteria, than in biofilms. This toxic action was significantly reduced when BSA was added to the suspended cultures, emphasizing that these surfactants react strongly with proteins. From this study, it can be stated that chemical treatment is far from being a tool that induces massive detachment of *P. fluorescens* biofilms and even the synergistic chemical and mechanical treatment did not promoted total biofilm removal, emphasizing the need of care in choosing the correct procedure for biofilm control and the recalcitrant properties of biofilms.