Novel anti-biofilm strategies based on innovative antimicrobial nanoparticles: physicochemical and technological issues

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Treatment of biofilm-related infections represents a major challenge in public health management. Therefore, the accurate identification of both the composition and architecture of bacterial biofilms, in terms of microorganisms and surrounding extracellular polymeric substances (EPSs), represents a fundamental pre-requisite for the rapid diagnosis of recurrent/resistant biofilm-based infections as well as for the management of several industrial processes. Here, the results of a combined approach involving scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy in attenuated total reflectance geometry (FTIR-ATR) and μ-Raman spectroscopy for the structural and dynamical properties of single-species bacterial biofilms produced by Pseudomonas aeruginosa (PAO1) and Escherichia coli strains, both proficient in infecting human cells and in colonizing medical devices, are presented. Moreover, preformulation studies were conducted on novel chitosan-based nanoparticles, comprising an in-depth technological physicochemical characterization. These systems were developed to increase the anti-biofilm activity of natural and synthetic molecules, reduce their side effects, and achieve sustained release. The topics here discussed fall in the framework of the PRIN 2022 FINI (Future challenges in management of recurrent/resistant Infection: development of antimicrobial Nanoparticulate systems and physical-chemical investigation of their Interactions with biofilm-associated infection) project, CUP: J53D23008880006, funded by the European Union - Next Generation EU, PNRR – Mission 4, Component 2, Investment 1.1 – PRIN 2022 Call for Proposals - Directorial Decree No. 104 of 02-02-2022.