World Academy of Science, Engineering and Technology
International Journal of Bioengineering and Life Sciences
Vol:10, No:05, 2016

Immobilizing Quorum Sensing Inhibitors on Biomaterial Surfaces

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Abstract : Bacterial infections on biomaterial implants and medical devices accounts for 60-70% of all hospital acquired infections (HAIs). Treatment or removal of these infected devices results in high patient mortality and morbidity along with increased hospital expenses. In addition, with no effective strategies currently available and rapid development of antibacterial resistance has made device-related infections extremely difficult to treat. Therefore, in this project we have developed biomaterial surfaces using antibacterial compounds that inhibit biofilm formation by interfering with the bacterial communication mechanism known as quorum sensing (QS). This study focuses on covalent attachment of potent quorum sensing (QS) inhibiting compounds, halogenated furanones (FUs) and dihydropyrrol-2-ones (DHPs), onto glass surfaces. The FUs were attached by photoactivating the azide groups on the surface, and the acid functionalized DHPs were immobilized on amine surface via EDC/NHS coupling. The modified surfaces were tested in vitro against pathogenic organisms such as Staphylococcus aureus and Pseudomonas aeruginosa using confocal laser scanning microscopy (CLSM). Successful attachment of compounds on the substrates was confirmed by X-ray photoelectron spectroscopy (XPS) and contact angle measurements. The antibacterial efficacy was assessed, and significant reduction in bacterial adhesion and biofilm formation was observed on the FU and DHP coated surfaces. The activity of the coating was dependent upon the type of substituent present on the phenyl group of the DHP compound. For example, the ortho-fluorophenyl DHP (DHP-2) exhibited 79% reduction in bacterial adhesion against S. aureus and para-fluorophenyl DHP (DHP-3) exhibited 70% reduction against P. aeruginosa. The results were found to be comparable to DHP coated surfaces prepared in earlier study via Michael addition reaction. FUs and DHPs were able to retain their in vitro antibacterial efficacy after covalent attachment via azide chemistry. This approach is a promising strategy to develop efficient antibacterial biomaterials to reduce device related infections.

Keywords : antibacterial biomaterials, biomedical device-related infections, quorum sensing, surface functionalization
Conference Title : ICBE 2016 : International Conference on Biomaterials Engineering
Conference Location : Berlin, Germany
Conference Dates : May 19-20, 2016