Engineering a Novel Polymeric Coating Incorporating Osteogenically-Active Antimicrobial Proteins to Combat Bone Implant Infection Related to Biofilm Formation

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Bone implants have a risk factor of 57.1% for infection, mostly caused by Staphylococcus aureus. These can transform into a deadly bone infection called osteomyelitis. Hospitals spend $17,000 dollars on each patient that contracts osteomyelitis because it is notoriously difficult because traditional antibiotics do not work. This antibiotic resistance is caused by biofilm formation, which is when S. aureus aggregates and forms an extracellular matrix. The hypothesis tested is that a polymeric coating containing proteins from Lactobacillus acidophilus will inhibit S. aureus biofilms, show proinflammatory downregulation and show osteogenic activity. First, proteins were extracted from the Lactobacillus acidophilus (gut bacteria) by Ammonium sulfate precipitation. The proteins were then combined with FDA- approved Polylactic Acid (PLA) to create a coating and spin-coated on to a implant grade Titanium discs. The discs were incubated with the biofilm medium and crystal violet staining (CVS) was done. For the pro-inflammatory genes, macrophages were treated with the protein sample. Finally, for Osteogenesis, human mesenchymal stem cells were incubated with the protein sample, and Alizarin Red S staining and qPCR was done. The CVS showed that when treated with the raw protein and the protein coating, the biofilm was almost completely inhibited and eradicated compared to the control samples. The osteogenic genes were all seen to be upregulated which indicates osteogenic activity. As for the pro-inflammatory genes, TNF-α, iNOS and IL-6, had been downregulated, which indicates anti-inflammatory activity. This multi-faceted coating would not only combat osteomyelitis but also drastically reduces costs for complicated surgeries and aids in the recovery process of patients.

Awards Won:

Lawrence Technological University: STEM Scholar Award, a tuition scholarship of $19,650 per year, renewable for up to four years and applicable to any major

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Associated Technologies Association (DCAT): DCAT First Prize