Polymer-Based Nanocarriers to Treat Intestinal Infection and Reduce Impact on Gut Microbiome.

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Committee Chair: Dr. Debora F. Rodrigues, Civil and Environmental Engineering

Abstract

Nanomaterials have garnered huge attention for biomedical applications due to their extraordinary physio-chemical and biological properties. The current study presents the synthesis and characterization of polymer-based nanoparticles (NPs) of PLGA and lignin-graft-PLGA (LNP) loaded with the antibiotic enrofloxacin. The entrapment of enrofloxacin in the nanoparticle matrix improved and sustained the release of the antibiotic. Furthermore, the encapsulation of enrofloxacin led to minimization of reactive oxygen species (ROS) production from the free drug form, which has been established to be toxic to mammalian cells. The biocompatible concentration of free dugs and polymeric nanoparticles was further investigated for the treatment of pathogenic bacterial infection in the intestinal pig cell line. The biocompatible concentration of the loaded nanoparticles was based on the examination of bacterial inhibition, toxicity, and ROS generation. The biocompatible concentrations of the two nanoparticles, as well as the free drug, were used to treat bacterial infection at higher and lower level of infections. The nano delivered antibiotic demonstrated better efficiency in treating infected cells at all time points compared to the free antibiotic. The superior treatment achieved by the nano carried drug delivery systems is accredited to particle uptake by endocytosis and slow release of the drug intracellularly, preventing rapid bacterial growth inside the cells. The infection treatment efficacy of nano carried drug is not sufficient for their commercial use. The understanding of interaction and effects of nanocarriers for drug release on gut microbial systems is also very important because gut microbial health has important effects on human and animal health. Thus, this study also focused on the effects of drug-loaded nanocarriers in the pig gut microbial system. The result demonstrated biodegradable nanomaterials for drug delivery is highly beneficial in preserving the core microbiome of the gut. The PLGA nanoparticles outperformed lignin-graft-PLGA nanoparticles in terms of shielding the microbial community from the adverse effect of toxic antibiotic. This study indicates that that enrofloxacin loaded PLGA nanoparticles can be a great candidate for antimicrobial drug delivery, infection treatment and prevention, and preserving the core microbial community to maintain homeostasis.