CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Maggie S. Chen

Project Number

J1306

Project Title

Thermosensitive Injectable Hydrogel for Localized and Controlled Drug Delivery

Abstract

Objectives/Goals

This project aimed to develop a thermosensitive injectable hydrogel that will form gel at body temperature. When loaded with antibiotics, the hydrogel can locally release the antibiotics to fight against bacterial infections.

Methods/Materials

First, I carried out parametric investigation with the hydrogel composition so that the gellation occured at 37°C, the body temperature. To make the hydrogel, I used the liquids chitosan aqueous solution and beta-glycerophosphate. Second, I loaded doxycycline, a wide-spectrum antibiotic, into the hydrogel and measured its release rate at 37°C. Because doxycycline is sensitive to UV rays, the release rate was measured by a plate reader. Lastly, I observed the antibacterial effect of the hydrogel formulation in stopping the growth of E-coli bacteria.

Results

The hydrogel formed a robust gel at 37 °C, using a rough volume ratio 1:7 of glycerol to chitosan. Although the drug release had a burst (dramatic increase of drug release) in the beginning, minimizing the amount of water in the hydrogel decreased that burst release. The full release would take 10-12 hours. After testing the hydrogel on stopping bacteria growth, there was a concentration of 8.1x10^9 bacteria/mL in the hydrogel without the drug, and a concentration of 1x10^9 bacteria/mL in the hydrogel with the drug. Overnight, the vial containing the hydrogel without drug had solution that was cloudy with bacteria growth, while the vial containing the hydrogel with drug had solution that was clear.

Conclusions/Discussion

The chitosan and glycerol solutions can form a gel at the body temperature of 37 °C. In order to form a robust hydrogel, a high concentration of chitosan is required. Decreasing the amount of water by directly dissolving the drug into the liquid hydrogel deterred the burst release and allowed for a smoother release rate. By decreasing the amount of water, I made the pores that encapsulated the drugs smaller, so the drug was more trapped in the gel. This is crucial in that the release of drug should be moderately steady so that not all the drug will disperse at once. It is also proved that the drug infused hydrogel staunched the growth of bacteria.

Summary Statement

My project is about developing a thermosensitive injectable hydrogel to localize and control drug delivery.

Help Received

I did this project in the Nanomaterials and Nanomedicine lab at the University of California at San Diego under the supervision of Dr. Liangfang Zhang and Dr. Weiwei Gao, who provided the safety training, equipment, and materials needed.