CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Richard J. Li

Project Number
S0510

Project Title
Biodegradable Nanoparticles: A Novel Approach to Chemotherapy

Abstract

Objectives/Goals
This study explored one of the potential applications of cutting-edge nanotechnology in medicine, aiming to develop an anticancer drug delivery system using biodegradable nanoparticles, to optimize the formation process, and to incorporate the anticancer drug, doxorubicin, into the created system.

Methods/Materials
The nanoparticles were formed by mixing solutions of protamine and dextran sulfate with zinc sulfate as a cross-linking agent. Effects of polymer ratio (1:1-1:4, w/w), agitation speed (325-2500 rpm), pH (pH 5-7.5), temperature (3-40 deg. C), on nanoparticle formation were evaluated. Doxorubicin was loaded into the nanoparticles. The nanoparticles were characterized by zeta potential, size, polydispersity index, and nanoparticle counts.

Results
Nanoparticle formation was found to be pH-dependent with an optimum pH of 7.
An ANOVA statistical analysis showed that nanoparticles formed at neutral pH had significantly higher nanoparticle densities than those formed at acidic pH. More nanoparticles were formed at 1000 RPM than at other speeds. Nanoparticles at room temperature displayed a higher uniformity than those at other temperatures. The optimal conditions for formation of protamine-dextran sulfate nanoparticles were polymer ratio 1:1 (w/w), pH 7, stirring speed of 1000 RPM, and room temperature. The nanoparticles were within a size range of 100-250 nm, an adequate size for drug delivery purposes. Doxorubicin, an anticancer drug, could be loaded into the nanoparticles. Loaded particles displayed a size of 30-180 nm with negative zeta potential.

Conclusions/Discussion
A novel biodegradable nanoparticle delivery system for chemotherapy was developed using ionic interactions between positively-charged protamine and negatively-charged dextran sulfate. This nanoparticle delivery system has two major advantages over drug delivery systems previously reported in the literature. It uses biodegradable, naturally-occurring polymers and simplifies the nanoparticle preparation process by using the charge interactions principle. This system could potentially be used to sustain the release of doxorubicin and reduce toxic side effects in the body.

Summary Statement
A biodegradable nanoparticle drug delivery system, potentially useful in chemotherapy, was developed and characterized.

Help Received
I used lab equipment at the labs of Dr. Xiaoling Li, Dr. Bhaskara Jasti, and Dr. Guo at the University of Pacific under the supervision of Dr. Ravichandrian Malihingan.