CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

S1732

Project Title

Potential Cure for Alzheimer's: A Novel Therapy Using Polymeric Nanoparticle-Encapsulated Curcumin to Inhibit Caspase

Abstract

Objectives/Goals

Alzheimer's disease (AD) is characterized by accumulation of beta amyloid (Abeta) plaques in the brain and activation of caspase pathway leading to neuronal apoptosis. Curcumin, a principal curcuminoid of turmeric, has anti-amyloid, anti-apoptotic, and antioxidant activities, which are beneficial in AD. However, curcumin's water insolubility and poor bioavailability limit its efficacy as a therapeutic agent in AD. This project overcomes these limitations by using a novel polymeric nanoparticle (PEG-PLGA) encapsulated curcumin as an effective vehicle for curcumin delivery to an in vitro AD neuronal cell model thus improving curcumin's potential as a therapeutic option in AD.

Methods/Materials

PEG-PLGA nanoparticle-encapsulated curcumin (nanocurcumin) was analyzed for size, shape, and in vitro release kinetics. Neuro-2A cells were exposed to Abeta oligomers and then treated with curcumin, nanocurcumin, and PEG-PLGA nanoparticles for 24 hours. The protective role of nanocurcumin versus curcumin on Abeta levels, cell viability, caspase activity, and antioxidant activity were determined. Cellular uptake of nanocurcumin and curcumin was imaged using fluorescence microscope. Healthy cells were kept as negative control and cells exposed to Abeta were kept as positive control.

Results

In vitro release kinetics of nanocurcumin showed 70% of curcumin release from nanoparticles at 24 hours. Characterization of nanocurcumin by DLS confirmed a size of 200nm. Fluorescence microscopy images proved an increased cellular uptake of nanocurcumin compared to curcumin. Cells treated with 20µM nanocurcumin exhibited less Abeta levels ($p<0.05$) and less caspase activity than those treated with 20µM curcumin. Increased cell viability was seen with nanocurcumin (>20%) compared to curcumin, as early as 7 hours with sustained effect at 24 hours. Also, nanocurcumin exhibited comparable antioxidant activity (90%) to that of the curcumin. Further, PEG-PLGA nanoparticles were not toxic to the cells.

Conclusions/Discussion

While previous studies have identified the therapeutic use of curcumin, this study is the first to use a polymeric nanoparticle vehicle for curcumin delivery in AD. By effectively increasing the water solubility and cellular uptake of curcumin, nanocurcumin successfully reduced the buildup of Abeta and inhibited the caspase-mediated apoptosis much more than curcumin alone. Nanocurcumin may thus be a viable potential cure for AD.

Summary Statement

I used a novel drug delivery system of curcumin encapsulated with PEG-PLGA nanoparticles, which could potentially be a therapeutic option in AD.

Help Received

Dr. Ibtisam Khalif and Dr. Aru Hill for advice and supervision of lab use; Dr. Keith Vossel, Gladstone Institute for advice on initial research; Nanoscience Lab for use of SEM, DLS, Fluorescence microscopy; Ms. Belinda Schmahl and my parents for support.