CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
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Project Number
S0403

Project Title
Inhibitory Effects of Metal-Chelates on Peroxidase Activity: Implications in Neurodegenerative Diseases (Year Three)

Abstract

Objectives/Goals
The effect of fifteen different metal-chelate complexes (Al3+, Ca2+, Mg2+, Mn2+ and Zn2+ with EDTA, DTPA, and NTA) on peroxidase activity was studied. The effect of molecular size and the stoichiometry of metal-chelates were also studied.

Methods/Materials
Tests were performed using the Guaiacol method. Guaiacol is readily oxidized by oxygen in the presence of the heme iron of peroxidases to yield a colored product, tetraguaiacol, which can be measured at 470 nm using a spectrophotometer. A total of 67,344 absorbance readings were made in 1104 tests performed. A microplate spectrophotometer was used to allow rapid absorbance measurements as a function of time.

Results
The results confirmed earlier findings in which the metal-EDTA complexes significantly slowed catalase and peroxidase activities, much more than could be attributed to additive effects of the metals or EDTA. EDTA complexes consistently had the highest inhibitory effect followed by DTPA and NTA complexes indicating that EDTA complexes may have the optimal size to interact with the active site of peroxidase. All 15 metal-chelates studied achieved the highest inhibitory effect with an equimolar ratio of metal:complexing agent. Higher concentrations of EDTA did not affect the reaction rate. Surprisingly, addition of excess DTPA lowered enzyme inhibition, which may be attributed to formation of metal-diDTPA complexes, too large to effectively interact with the active site of peroxidase.

Conclusions/Discussion
The results of this comprehensive three-year study suggest that chelation therapy for neurodegenerative diseases, such as Alzheimer's disease, may not be beneficial, but may in fact be detrimental. Inhibition of peroxidase could decrease breakdown of hydrogen peroxide in cells and impact the biological system's ability to protect cells from oxidative damage and cell death.

Summary Statement
The importance of molecular size and stoichiometry of metal-chelates on peroxidase activity was demonstrated through the study of 15 complexes (Al3+, Ca2+, Mg2+, Mn2+, and Zn2+ with EDTA, DTPA, and NTA) using the Guaiacol method.

Help Received
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