CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Xiangyi (Angela) Ji

Project Number

S0409

Project Title

In Vitro Study of Manganese Compounds as Superoxide Dismutase Mimetics: The Search for the Fountain of Youth

Abstract

Objectives/Goals

This experiment investigated the effectiveness of various manganese salts (MnCl(2) and MnSO(4)) and complexes (salen-manganese complexes, EUK-189 and EUK-8) in mimicking the catalytic function of superoxide dismutase in two different buffers.

Methods/Materials

Free radicals generated by the xanthine/xanthine oxidase system were quantified by following the oxidation of NBT, which resulted in changes in absorption property. SOD activity was then measured as the degree of inhibition of absorbance changes. Reactions were initiated with the addition of NBT and xanthine and xanthine oxidase to the manganese salts or complexes, and NBT absorption at 550 nm was measured every 10 seconds for 5 minutes using a spectrophotometer.

Results

Changes in optical densities of the various samples were plotted against time for the solutions in both buffers. Slopes of the trendlines were used to determine SOD activity per micromolar, where one unit of activity was designated as 50% of the change in absorbance per second under control conditions. EUK-189 was found to be the most efficient SOD mimetic, with a catalytic activity of 0.475 units/micromolar in Tris-HCl buffer, whereas MnCl(2) and MnSO(4) exhibited fairly low SOD activities, averaging only about 0.01 units/micromolar in both buffers. Overall, SOD activities were higher in Tris-HCl buffer than in phosphate buffer.

Conclusions/Discussion

EUK-189 was the most efficient SOD mimetic, and Tris-HCl the more efficient buffer. Perhaps both the EUK-189's structure and the nature of the buffer facilitated the binding of oxygen free radicals to the complex and the cycling of manganese between Mn(II) and Mn(III) after removing the extra electron from the superoxide. Conversely, it was likely the lack of such a surrounding complex resulted in the low catalytic activity of the manganese salts. Nevertheless, results indicated that all manganese compounds exhibit some degree of SOD activity, with simple salts demonstrating significantly lower catalytic rates than organic manganese complexes. Thus the investigation suggests the possibility of substituting SOD with a smaller, yet relatively efficient small molecule in laboratory and pharmaceutical applications.

Summary Statement

Manganese compounds, especially salen manganese complexes, are superoxide dismutase mimetics which catalyze the conversion of oxygen free radicals and thus have potentially far-reaching medical implications.

Help Received

I would like to thank Dr. Xiaoning Bi for allowing me to work in her laboratory at University of California, Irvine, Professor Michel Baudry for his insight and guidance, and Eukarion, Inc. for granting me access to its salen manganese-complexes, EUK-8 and EUK-189.