

THE CERIUM OXIDE GENERATED RADICAL ELIMINATION PROPERTIES OF PEG-NANOCERIA

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ABSTRACT

Reactive oxygen species (ROS) have been linked to cellular degeneration, irreversible DNA damage, and various diseases. Cerium oxide nanoparticles have shown promising medical applications for their SOD mimetic activity to catalyze the breakdown of various ROS. Increasing the biocompatibility, longevity of residence, and rate of internalization of nanoceria are essential to increase its range of biomedical applications. Polyethylene glycol's (PEG) hydrophilic, nonimmunogenic, and antioxidative properties make it an ideal coating for increasing cerium nanoparticle's applicability. Gelatin's low cost and versatility have made it widely employed as an antioxidant drug carrier in a variety of physiological systems. Because of gelatin's susceptibility to ROS denaturation and well-researched structure, it is a useful tool for assessing conformational damage in applications that involve acute oxidative stress. PEG-nanoceria of various molar weights was synthesized from Ce (III) nitrate and incorporated into gelatin hydrogels that were exposed to hydrogen peroxide to provide oxidative stress damage. This study aims to assess changes to gelatin conformation were assessed using Fourier transform infrared spectroscopy. PEG-Nanoceria showed radical damage mitigation in hydrogels as evident by the decreased change in transmittance over its non-PEG counterpart. There was notably exceptional damage mitigation in the amide A and amide II regions. These promising findings suggest more research should be done to examine polymer-coated nanoceria's antioxidative properties in more biologically relevant models.

Keywords: Nanoceria, Cerium oxide nanoparticles, Gelatin, Polyethylene Glycol, Reactive Oxygen Species, Fourier Transform Infrared Spectroscopy

INTRODUCTION

The oxidation state Ce^{3+} has been theorized to be highly active in the breakdown of radical oxygen species (ROS). The inactivation of ROS occurs on the surface of the particle; thus, the efficiency of the antioxidant reaction and the size of the nanoparticle are inversely related. The cerium oxide nanoparticle exists in two redox states Ce_2O_3 and CeO_2, which correspond to its two oxidative states, an activated $Ce^{3+,}$ and Ce^{4+}state, respectively. The number of activated Ce^{3+}oxygen defect sites increases with a decreased diameter of the particle. These vacancies in the lattice structure of the crystal allow CeO_2 to scavenge a free radical, producing water and deactivated CeO_2 [1,2]. This activation and stabilization of cerium oxide is known as the Ce4+/Ce3+ redox cycle. Highly active nanoscale cerium oxide has the capability to induce oxidative stress by generating radicals. This property of the particle has generated concerns regarding its safety in medicinal applications. Synthesizing cerium oxide particles in hydrophilic polymers has been employed to increase the radical scavenging capabilities of nanoceria by increasing their rate of redox cycling. Additionally, applying coatings of hydrophilic polymers may reduce cerium oxide-facilitated oxidative stress and thus increase biocompatibility [3].

Gelatin-based hydrogels have been widely applied in biomedical research for drug delivery, tissue scaffolding, and wound healing among other uses. Despite having a wide breadth of applications, gelatin is a radical-sensitive species and is subject to damage from excessive oxidative stress. Gelatin

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