The photo-shielding effects of nanoceria on gelatin

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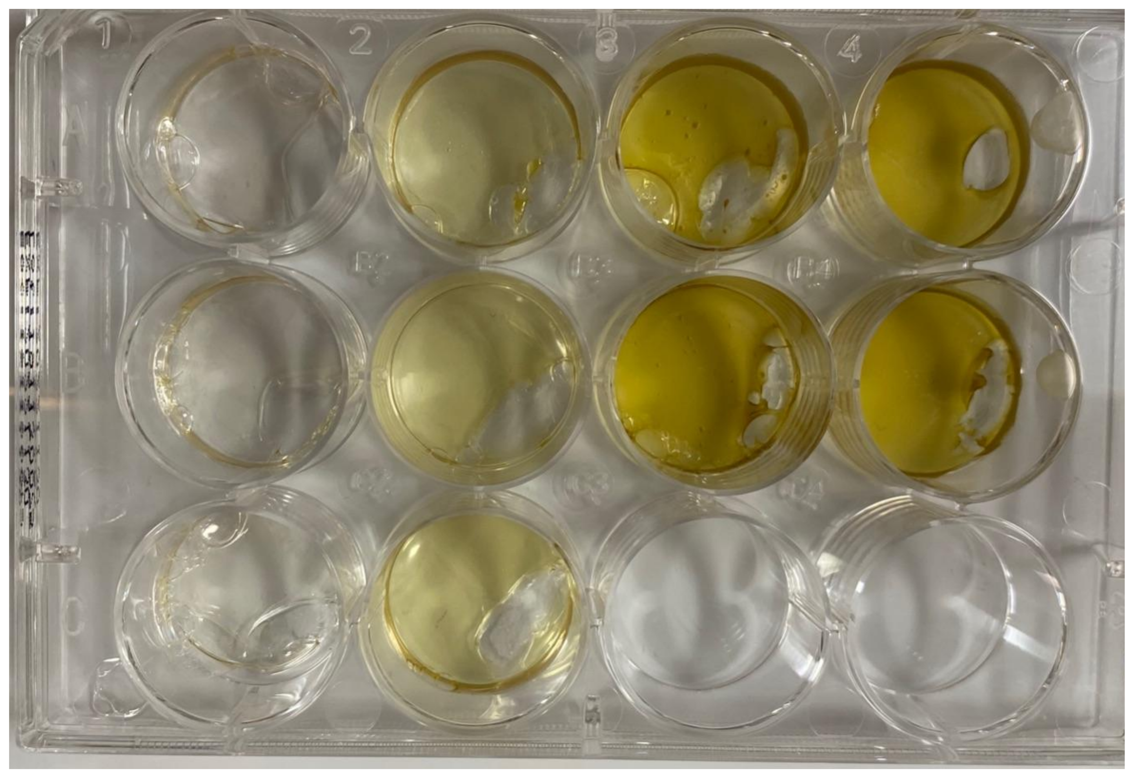
Abstract

Here, we present our findings on the UV-shielding property of nanoceria in its ability to prevent gelatin denaturation. The changes to confirmation of gelatin during exposure to UV-C radiation were monitored using Fourier-transform infrared spectroscopy (FTIR) to examine how transmittance changed in several key identifying peaks. This was completed in nanogels with various concentrations of nanoceria.

The transmittance increased in regions where a functional group has been damaged by the absorption of UV radiation. The Amide-A (3400), Amide-I (1600) and Amide-II (1500) regions of the spectrum were used for analysis. Each region showed a an in transmittance following irradiation. This increase in transmission was greater in samples which had the lowest concentration of nanoceria.

Fig 1. Dried Nanogel Samples



Introduction

Nanoceria refers to nanoparticles of cerium oxide (IV) within the size range of 1 and 100 nm. It is a versatile, catalytic material with several biomedical applications. Nanoceria has been used in surface coatings, polymer composites, and clothing as long term UV protectant. Therefore, it has become imperative to examine the UV shielding capabilities of nanoceria, and how it can be incorporated into biological UV protection.

Gelatin is widely applied in biomedical engineering to improve cell adhesion, as a component for hydrogel formation and for scaffolding materials. Despite its broad uses, gelatin's sensitivity to photo-degradation limits its applications. These constraints may be mediated through inclusion of other biocompatible materials.

Materials and Methods

Nanoceria: ~ 100 nm on average

Prepared using Cerium (III) Nitrate, deionized water, ammonium hydroxide, Citric acid and allowed to oxidize overnight.

Hydrogels: 11.1 % w/w gelatin and DI

Hydrogel solution was prepared and autoclaved. Gels were allowed to dry in biological safety cabinet over 48 hours.

Nanogels: 11.1 % w/w gelatin and DI

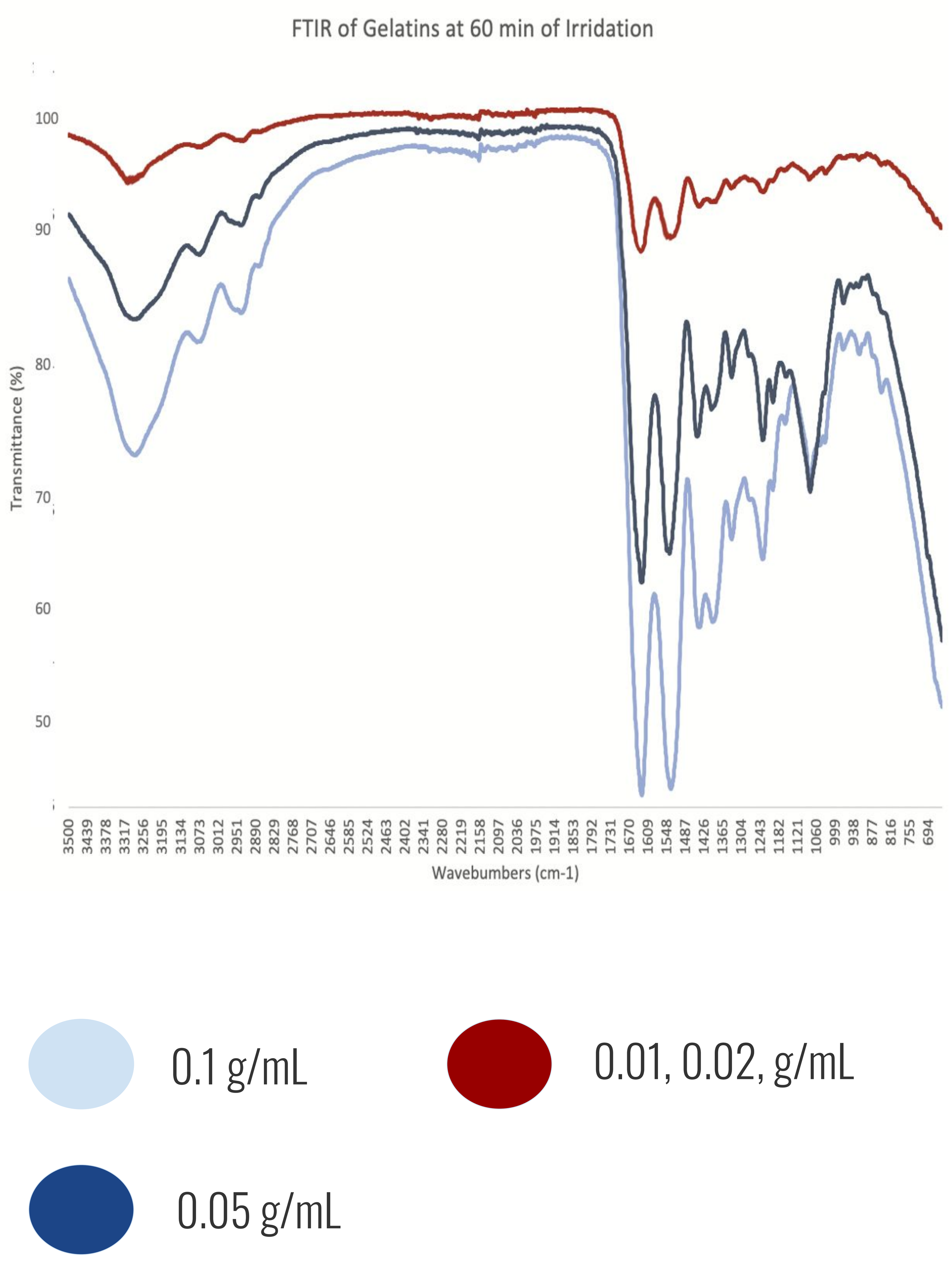
Prior to drying nanoceria was added in various concentrations (0.01, 0.02, 0.1, 0.5 g/mL).

Irradiation: Samples were irradiated for 60 min at 253.7 nm

Irradiation occurred following drying to prevent water absorption of light.

To observe the changes to gelatin structure Fourier Transform Infrared Spectroscopy (FTIR) machine to scan the individual samples of nanohydrogels.

Results



Conclusion

There was a increase in transmittance across all regions of analysis following radiation indicating the radiation induced destruction of the gelatin monomer.

Amide-A (3400 cm-1) corresponds to N-H stretching

Experienced 22% increase in transmittance on average (0 g/ml to 0.1 g/ mL)

Amide-I (1600 cm-1) corresponds to C=O and C-N stretching

Experienced 49% increase in transmittance on average (0 g/ml to 0.1 g/ mL)

Amide-II (1500 cm-1) corresponds to approximately equal parts C-N and N-H

Experienced 47% increase in transmittance on average (0 g/ml to 0.1 g/ mL)

Therefore, groups with trials with a lower concentration nanoceria were more likely to experience damage across all regions. These results indicate that when incorporated into dried hydrogels nanoceria does have photo-shielding capabilities.

Fig 2. Dried Nanogel Samples Post-Irradiation

Future Research

Collagen Focused

We intend to use this study to inform the procedure of subsequent research on the photo-shielding effects of nanoceria on collagen.
We expect to observe similar results since gelatin is a hydrolyzed derivative of collagen.

Alternative Analysis Methods

The next step in this research is to create a clear understanding of what functional groups are damaged and the mechanism with which this occurs.
Additionally, we will examine changes to nanoceria's conformation and ability to work as a free radical scavenger following irradiation.
For these analyses Circular dichroism (CD) spectroscopy, UV-Vis and H-NMR will be employed.

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