Synthesis and UV-Induced Modulation of Organic Selenium Nanoparticles

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Introduction

Organic selenium plays vital roles in antioxidant defense, immune regulation, thyroid balance, and reproductive health. Selenium nanoparticles (SeNPs) have emerged as safer, more effective alternatives to bulk selenium due to their reduced toxicity and enhanced bioactivity arising from a high surface-to-volume ratio. While most studies focus on conventional synthesis, this work introduces a novel approach by applying ultraviolet (UV) irradiation, UVC (254 nm), and UVA (365 nm) to investigate how photonic treatment modulates SeNP characteristics.

Key findings

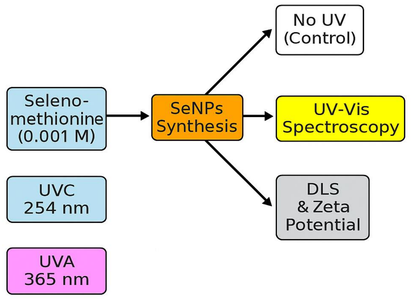
UV irradiation was found to modulate the physicochemical properties of selenium nanoparticles (SeNPs). UVC exposure (254 nm) increased absorbance values and induced mild aggregation, whereas UVA exposure (365 nm) decreased absorbance and caused greater polydispersity. Diffuse reflectance analysis confirmed wavelength-dependent changes, with UVC reducing reflectance more strongly than UVA. Dynamic light scattering (DLS) revealed that control SeNPs measured 40–90 nm, UVC-treated SeNPs increased to 50–100 nm, and UVA-treated SeNPs expanded further to 45–110 nm, reflecting altered aggregation and polydispersity. Despite these variations, colloidal stability of the nanoparticles was preserved across all conditions. Overall, these results demonstrate that UV light is a tunable factor for modifying SeNP optical absorption and size distribution without compromising stability.

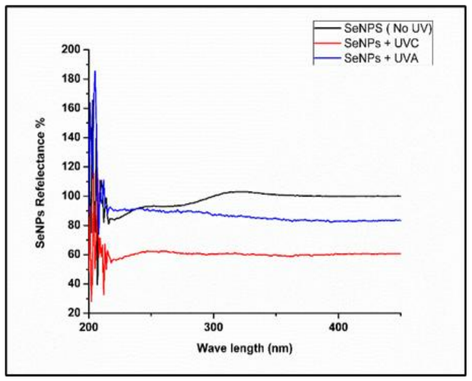
Methods

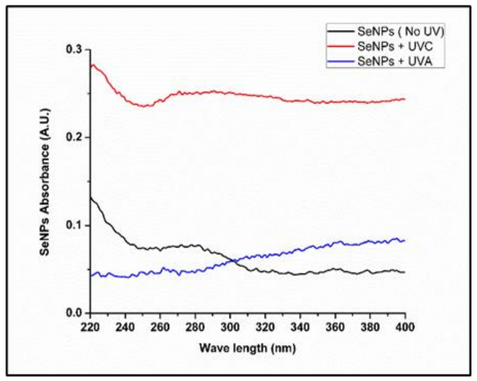
SeNPs were synthesized by reducing 400 µL of 0.001 M selenomethionine with 30 mL of 0.001 M $NaBH_4$ under ice-bath stirring (500 rpm, 20 min), followed by dropwise addition (~1 drop/s). The suspensions were divided into three groups: non-irradiated control (S1), UVC-exposed (S2), and UVA-exposed (S3), each irradiated for 20 min at a distance of 10–15 cm. Characterization was performed immediately using UV–Vis spectroscopy (200–800 nm, *Thermo INSIGHT™ 2 software, Thermo Fisher Scientific, USA*), diffuse reflectance analysis, and dynamic light scattering (DLS) with zeta potential (25 °C, *Zetasizer Nano ZS*).

Results

UV–Vis spectra exhibited a broad SeNP absorption band between 220–400 nm. Baseline absorbance increased after UVC exposure compared to the control, whereas it decreased following UVA treatment. Correspondingly, diffuse reflectance declined from ~95–100 % in the control to ~60–70 % after UVC and ~80–85 % after UVA exposure, indicating wavelength-dependent optical modulation. Dynamic light scattering (DLS) analysis revealed average particle size distributions of 40–90 nm for S1, 50–100 nm for S2 (indicating mild aggregation), and 45–110 nm for S3 (reflecting increased polydispersity).

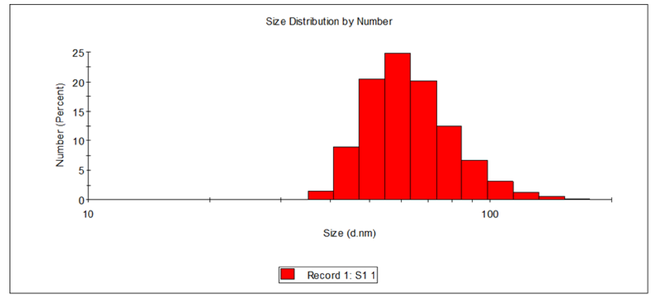






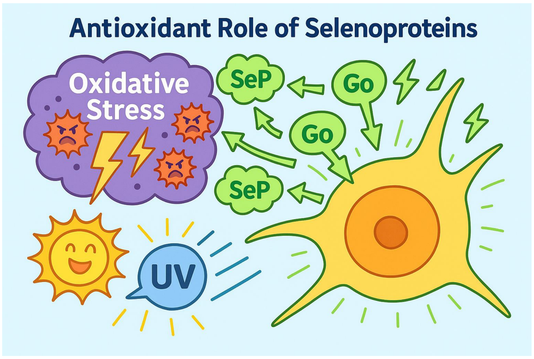
Conclusions

UV irradiation significantly modulated the optical and size properties of SeNPs without compromising colloidal stability. UVC exposure promoted mild aggregation, whereas UVA increased polydispersity, highlighting photonic modulation as a tunable strategy to optimize SeNPs for biomedical applications. However, the overall nanoparticle yield was low due to the use of a low SeMet concentration; therefore, further optimization is required to enhance yield while reducing particle size in future studies.



Future Work

- Further characterization with TEM/SEM for morphology validation.
- Assessment of SeNP stability under prolonged UV exposure.
- In vitro evaluation of antioxidant and cytoprotective effects



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