
# An *in vitro* assessment of the potential toxicity of Cadmium Selenide nanoparticles

A thesis presented by

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Submitted in fulfilment for the award of the degree of

**Master's (MSc) in Biochemistry**

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**Abstract**

Nanotechnology is steadily finding its application in all aspects of the consumer industry, science and engineering. At a relative pace Cadmium Selenide (CdSe) nanoparticles are gaining increased attention for their potential use in biomedical applications such as bio-imaging of tissues, disease diagnosis and biological labelling due to its unique optical and electronic properties. Exposure of these particles to humans and other biological systems raise huge concerns with regards to their safety. In this study, water soluble cysteine capped CdSe nanocrystals, were prepared through a one pot green route method. The prepared CdSe nanocrystals were characterized using Transmission electron microscopy (TEM), High resolution transmission electron microscopy (HRTEM), Ultra violet spectroscopy (UV) and Photoluminescence (PL) analysis to establish the size, shape, dispersion, aggregation state, crystalline nature and optical properties of CdSe nanoparticles. The *in vitro* effects of CdSe nanoparticles on DNA stability, red blood cells (RBC's) and blood platelets were evaluated. DNA was exposed to CdSe nanoparticles and its assessment on DNA stability was confirmed by agarose gel electrophoresis and spectrophotometry. Damage to DNA structure was observed at 200 µg/ml of CdSe. *In vitro* assays carried out on RBC damage included reducing power and chelating activity of iron. The results showed that the CdSe nanocrystals exhibited high reducing power and sufficient chelating activity, which would be able to impair the function of haemoglobin. CdSe nanoparticles promoted platelet aggregation in a dose dependent manner. Based on the findings of this study the biosafety of CdSe nanoparticles is not guaranteed and further studies need to be conducted to ascertain the safety of CdSe nanoparticles for possible use in biological systems.

**Dedication**

This study is dedicated to my late Gurudev, Sri Saathiya Sai Baba. I am blessed everyday just knowing that you live forever in my heart. Thank you for always guiding me.

**Declaration**

I declare that this dissertation is my own, unaided work. It has been submitted for the degree of Master's in Science at the University of Zululand. It has not been submitted before for any degree or examination at any other University. I also state that all the sources that I have used have been duly acknowledged.

This _____ day of _____ 2012.

**Acknowledgement**

I wish to thank my Supervisor Dr A. Shonhai, and co-supervisors Prof A. R. Opoku and Prof N. Revaprasadu for all the support, motivation, guidance and encouragement throughout the project. From all of you, I have gained many skills that will add endless value to my life and career. Thank you to Dr Shonhai for always pushing me to realize my potential and never giving up on me. Thank you to Prof N Revaprasadu (Chair of Nanotechnology, South Africa) and DST/NRF for the award of a scholarship that funded this project. It was a great honor for me to have been supervised by you all, I have learnt that hard work, determination and passion for research are the key to a promising academic career.

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I wish to thank you God and my parents, for always believing in me and standing by my side throughout the years. Without you I would never have made it this far your efforts to provide me with amazing opportunities in life have not gone unnoticed and is highly appreciated.

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**List of Abbreviations and symbols**

| | |
|---|---|
| **CdSe** | Cadmium selenide |
| **RBC's** | Red blood cells |
| **$NaBH_4$** | Sodium borohydride |
| **TEM** | Transmission electron microscope |
| **HRTEM** | High resolution transmission electron microscope |
| **UV** | Ultra- violet |
| **PL** | Photoluminescence |
| **DNA** | Deoxyribonucleic acid |
| **EDTA** | Ethylenediaminetetra-acetic acid |
| **$TiO_2$** | Titanium dioxide |
| **TAE** | Tris-acetic EDTA |
| **TCA** | Trichloro acetic acid |
| **ADA** | Acid dextrose anti-coagulant |

**List of symbols**

| | |
|---|---|
| **°C** | Degrees Celsius |
| **µg** | microgram |
| **ng** | nano gram |
| **bp** | base pairs |
| **nm** | nanometers |
| **ml** | microliters |
| $\mathbf{A_{260}}$ | Absorbance at 260 nm |
| $\mathbf{A_{415}}$ | Absorbance at 415 nm |
| $\mathbf{A_{700}}$ | Absorbance at 700 nm |

**List of research outputs**

**Dunpall, R.**, Opoku, A. R., Nejo A. A., Revaprasadu, N. and Shonhai A.
An *in vitro* assessment of the potential toxicity of Cadmium selenide quantum dots. "Rejuvenating Science in Zimbabwe." Harare, Zimbabwe, 26 October 2011. (Oral presentation)

**Dunpall, R.**, Opoku A. R., Nejo A. A., Revaprasadu, N. and Shonhai A.
The *in vitro* assessment of the interaction of CdSe nanoparticles on DNA, iron haemoglobin and blood platelets. (Manuscript currently in preparation)

**Dunpall, R.**, Opoku A. R., Nejo A. A., Revaprasadu, N. and Shonhai A.
The synthesis, characterization and *in vitro* assessment of the potential toxicity of cadmium selenide nanoparticles. NanoAfrica 2012. 4th International conference and nanotechnology, Bloemfontein 1-4 April 2012. (Oral presentation)

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