Synthesis and evaluation of novel selenium nanoparticles for development of antibacterial healthcare textiles

Qiaoyi Wang*[1], Lara Barnes[1], Carol Howell[1], Matthew Illsley[1], Patrick Dyer[2], Irina Savina[1]

1: School of Pharmacy and Biomolecular Sciences, University of Brighton, Brighton, United Kingdom.
2: School of Art, University of Brighton, Brighton, United Kingdom
*Email: q.wang5@brighton.ac.uk

INTRODUCTION

It is estimated that 300,000 patients a year in England acquire a healthcare-associated infection as a result of care within the NHS and the related cost is approximately £1 billion a year[1]. In a hospital environment, textiles can provide ideal substrates for microorganisms to grow and become a vehicle for the transmission of pathogens[2]. In this study, selenium nanoparticles were investigated as novel antibacterial agents for the development of antibacterial textiles to control the growth and spread of pathogens in hospitals.

MATERIALS & METHODS

Firstly, a cation-generating agent, 3-chloro-2-hydroxypropyl trimethyl ammonium chloride (CHPTAC), was used to graft quaternary groups onto cotton surfaces. The cationic quaternary groups were able to attract anionic selenite groups and provide sites of reaction for the reduction of selenite into elemental selenium nanoparticles. The grafting of cationic groups and formation of selenium nanoparticles on cotton surfaces were confirmed by FTIR, SEM and EDX. The antibacterial activities of the selenium nanoparticle-coated cationic cotton textiles (Se-cotton) were then evaluated against Gram-positive and Gram-negative bacterial strains using a method based on the Absorption Method of ISO 20743:2013 standard. The fabrics were inoculated with 1 - 3 x 10^5 CFU/mL of bacteria in dilute Nutrient Broth. The number of viable bacteria recovered from the samples at 0 h and after 24 h incubation was determined by colony counting.

RESULTS & DISCUSSION

Selenium nanoparticles were successfully synthesised *in situ* on CHPTAC treated cotton surfaces. Antibacterial assessments indicated that cationic cotton had slight antibacterial activities primarily by the electrostatic interaction between quaternary groups and bacterial cells, while Se-cotton prepared with all 3 different concentrations of selenium precursor (0.2 mM, 0.5 mM and 1 mM) had strong antibacterial activity towards both *Staphylococcus aureus* and *Klebsiella pneumoniae* (Figure 1), indicating the excellent antibacterial efficacy of selenium nanoparticles with the presence of the cationic surface charge.

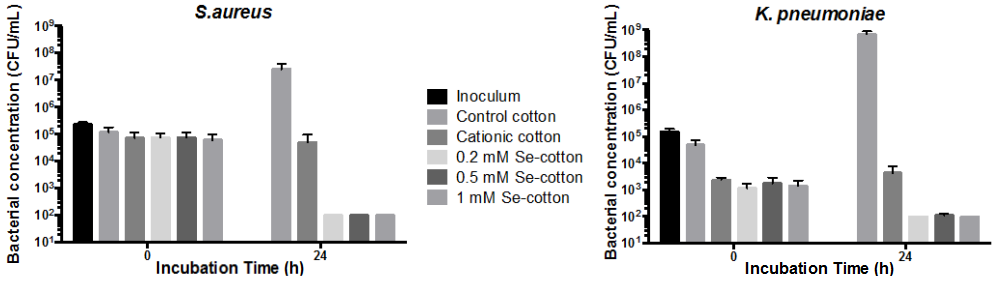

Figure 1 Antibacterial assessment of Se-cotton against *S. aureus* and *K. pneumoniae.* Mean ± SD, n = 3

CONCLUSION

Selenium nanoparticles were successfully prepared *in situ* on the surface of cationic cotton textiles. The cationic Se-cotton demonstrated excellent antibacterial performance towards both *S. aureus* and *K. pneumoniae* and has great potential to serve as an anti-infective material in hospital settings.

ACKNOWLEDGEMENTS

The author would like to thank University of Brighton for funding the PhD studentship.

REFERENCES

[1] NICE, Clinical Guideline 139:5, 2012. Available from: https://www.nice.org.uk/guidance/cg139

[2] Mitchell, A. *et al.*, J. Hosp. Infect., 90(4):285–292, 2015.