Abstract #113

Preparation and evaluation of selenium nanoparticles on cationized cotton fabrics for the development of antimicrobial healthcare textiles

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Introduction

It is estimated that over 4,000,000 patients in the EU acquire a healthcare-associated infection every year, resulting in approximately 37,000 deaths annually and significant financial burden on the healthcare systems[1]. Due to their large surface area, hospital textiles can provide an ideal substrate for microorganisms to grow and act as vehicles for the transmission of pathogens[2]. In this study, selenium nanoparticles (SeNPs) were prepared as novel antibacterial agents on cationized cotton fabrics for the development of antibacterial healthcare textiles.

Experimental Methods

Cotton fabrics were treated with a cationization agent, 3-chloro-2-hydroxypropyl trimethyl ammonium chloride (CHPTAC), to graft quaternary groups onto the cotton surface. The cationic quaternary groups attracted the anionic selenite groups to the fibre surface, and subsequently the selenite ions were reduced into elemental selenium nanoparticles *in situ* by ascorbic acid. The grafting of cationic groups and the formation of SeNPs on cotton surfaces were confirmed by SEM and EDX. Additionally, the loading efficiency and the durability of the nanoparticle coating following washing were determined by MP-AES.

The antibacterial activities of the SeNP-coated cationized cotton fabrics (Se-cotton) were evaluated using a method based on the Absorption Method of ISO 20743:2013. The fabrics were inoculated by pipetting 0.2 mL of bacterial suspension (1 – 3×10^5 CFU/mL) over the fabric surfaces, and the number of viable bacteria recovered from the samples at time 0 and after 24 h incubation was determined by colony counting to quantitatively analyse the antibacterial performance.

The cytotoxicity of the Se-cotton towards human bronchial epithelial cells (16HBE14o-) was evaluated using an extraction method as described in ISO 10993-12:2012. Fabric samples were incubated in tissue culture media for 72 h, and 16HBE14o- cells, seeded into 96-well plates, were exposed to the leachates for 24 h. A CellTiter-Glo® Luminescent Cell Viability Assay (Promega) and Pierce™ LDH Cytotoxicity Assay Kit were used to detect post-exposure ATP levels and LDH release, respectively.

Results and Discussion

Selenium nanoparticles were successfully synthesised *in situ* on CHPTAC treated cotton surfaces. The loading efficiency of selenium was 99%, 75%, and 69.9% respectively when the precursor concentration was 0.2 mM, 0.5 mM and 1 mM.

Antibacterial assessments indicated that cationized cotton had moderate antibacterial activities. This is

probably due to the electrostatic interaction between the cationic quaternary groups and bacterial cells. Se-cotton prepared with all 3 different precursor concentrations exhibited strong antibacterial activity towards both *Staphylococcus aureus* and *Klebsiella pneumoniae* (Figure 1).

Preliminary results from cytotoxicity tests (Figure 2) show that the cells exposed to the leachates from both the control cotton sample and the functionalised cotton samples were not as metabolically active as the cells exposed to the medium-only control. The reasons for this are not clear at present. However, the cationized cotton and Se-cotton (1 mM) did not result in ATP levels which were significantly different from the control cotton. Moreover, no significant difference was found on the LDH release between the medium-only control and the cotton samples, indicating no toxic effects of the cotton samples towards the 16HBE14o- cells.

Conclusion

Selenium nanoparticles were successfully prepared *in situ* on the surface of cationized cotton textiles. The cationic Se-cotton demonstrated excellent antibacterial performance towards both *S. aureus* and *K. pneumoniae* and did not show cytotoxicity towards 16HBE14o- cells, indicating its potential to serve as an infection control material in hospital settings.

References

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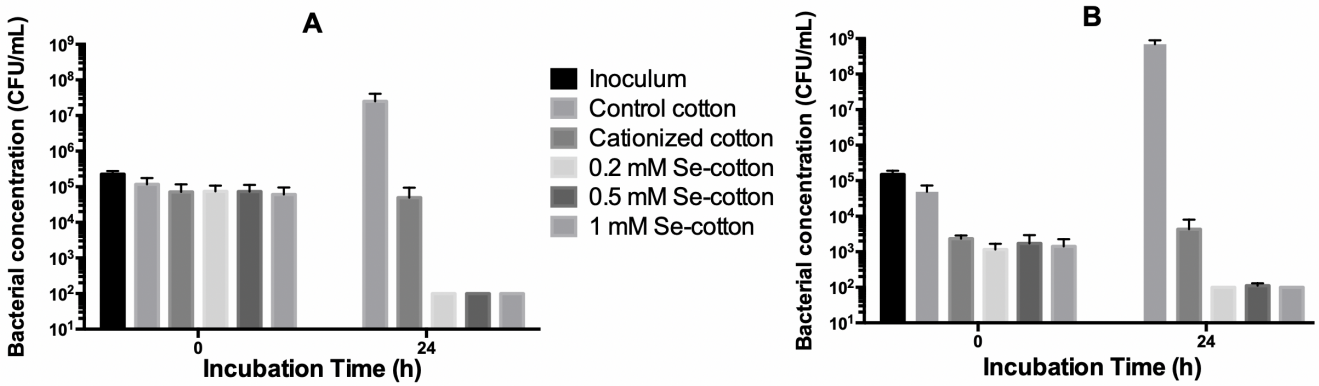

Figure 1 Antibacterial assessment of Se-cotton against (A) S. aureus and (B) K. pneumoniae.

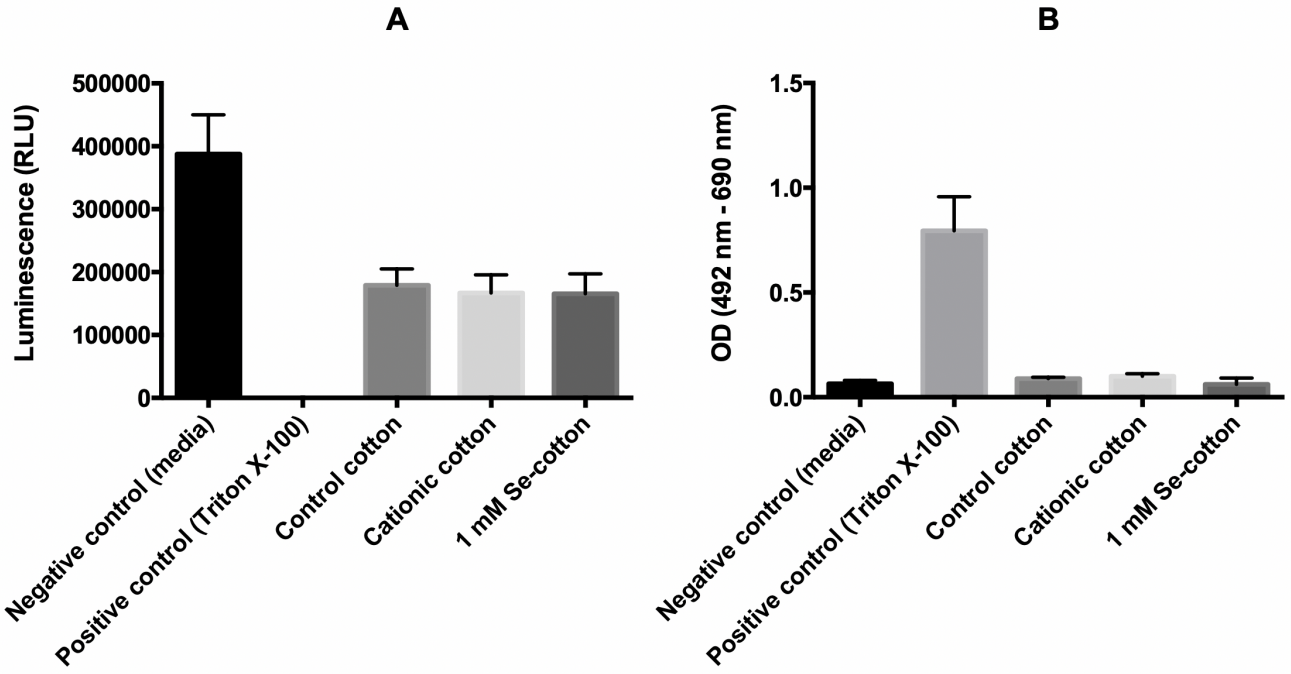

Figure 2 Cytotoxicity evaluation of Se-cotton: (A) ATP assay and (B) LDH assay.