Antimicrobial polymer-clay composite films

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1. Introduction - A principal transmission route for hospital-acquired (nosocomial) infection is *via* contaminated intermediate vehicles such as equipment and medical devices [1]. Protective antimicrobial polymer coatings can provide some defence against this mode of communication of common hospital pathogens, such as *S. aureus*, *E. coli* and *P. aeruginosa*. Ag^+-, Cu^{2+}- and Zn^{2+}-exchanged mineral phases have been used in polymer composites to confer antimicrobial properties on a range of technical and biomedical materials [2]; however, to date, the incorporation of Ag^+-, Cu^{2+}- or Zn^{2+}-bearing smectite clay in antibacterial chitosan composites has not yet been investigated. Chitosan affords many advantages over petroleum-based polymers as it is readily abundant, renewable, biodegradable and non-toxic [2]. Accordingly, this research concerns a suite of antimicrobial chitosan composite films incorporating Ag^+-, Cu^{2+}- or Zn^{2+}-bearing smectite clay, with potential applications in the control of nosocomial infection.

2. Experimental - Labile Na^+ and Ca^{2+} ions of natural smectite clay (VEEGUM® F [3]) were exchanged for Ag^+, Cu^{2+} or Zn^{2+} ions by contacting 1 g of clay with 200 cm^3 of 5 mM metal nitrate solutions for up to 48 h at 25 °C [2]. The liquor and solids were separated by filtration and the recovered solutions were analysed by inductively coupled plasma spectroscopy (ICP). As-received smectite or Ag^+-, Cu^{2+}- or Zn^{2+}-bearing smectite and chitosan were blended at 5, 10 and 20 wt% in 1% aqueous acetic acid solution (to produce composite films - CS, CSAg, CSCu and CSZn). The films were characterised by scanning electron microscopy (SEM) with energy dispersive X-ray analysis (EDX). The solutions were cast on to polycarbonate surfaces and dried in air at 40 °C. Nutrient agar plates were spread with 0.2 cm^3 of *E. coli* (10^9 $CFUcm^{-3}$). In triplicate, 8 mm discs of each composite were placed in the centre of each plate and the samples were incubated at 37 °C for 24 hours, after which time the zone of inhibition was measured.

3. Results and Discussion - Maximum uptake values of Ag^+, Cu^{2+} and Zn^{2+} by the clay were found to be 0.72 ± 0.03, 1.90 ± 0.05 and 1.49 ± 0.06 mmol g^{-1}, respectively. Equilibrium was achieved within 6 h. SEM and EDX analysis confirmed that the smectite was uniformly distributed throughout the chitosan matrix and that the films had a fibrous texture (Image 1). Zone of inhibition data are listed in Table I and indicate that composites blended with as-received smectite failed to demonstrate antimicrobial activity against *E coli*. Conversely, composites containing the ion-exchanged clay showed clear zones, with CSAg and CSZn showing greater inhibitory behaviour than CSCu.

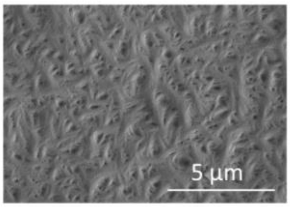

Image 1. SEM image of sample CS with 10% clay-content

Table I. Zone of inhibition data for chitosan-smectite composite films

Sample	CS			CSAg			CSCu			CSZn		
Clay-content	5%	10%	20%	5%	10%	20%	5%	10%	20%	5%	10%	20%
Zone (mm)	0	0	0	0.10 ±0.05	0.17 ±0.06	0.33 ±0.15	0	0	0.100 ±0.001	0.100 ±0.001	0.33 ±0.06	0.33 ±0.06

4. Conclusions - Antibacterial films can be prepared by solvent casting mixtures of chitosan and Ag^+-, Cu^{2+}- or Zn^{2+}-exchanged smectite. Ag^+ and Zn^{2+} were superior to Cu^{2+} at inhibiting the growth of *E. coli*.

5. References

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