A-06

Synthesis of novel graphene oxide-iron nano-composite and comparison of its antimicrobial activity against selected medically important bacteria

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Nanomaterials are possible alternatives to antibiotics due to minimal microbial resistance. Owing to high biocompatibility and antimicrobial properties, iron oxide nanoparticles (Fe_3O_4) have high potential for using as an antimicrobial agent and their superparamagnetic properties could allow targeted delivery inside the body with a magnetic field. Graphene oxide (GO) possess excellent biocompatible, chemical and mechanical properties and so is often used to support and stabilize nanoparticles for preparation of novel antibacterial nanocomposites. In this study, we synthesized graphene oxide-iron oxide nanocomposite (GO-Fe) and compared antibacterial activity with GO and Fe_3O_4 on selected medically important bacteria. Fe_3O_4 was prepared using modified Massart method and GO-Fe synthesized via simple mixing after dispersing Fe_3O_4 in 1 M HNO_3. The nano-characterization was carried out using UV-Visible spectroscopy, Raman spectroscopy and Atomic force microscopy. The antibacterial activity was tested against *Escherichia coli* (ATCC-25922), *Pseudomonas aeruginosa* (ATCC-25853), *Acinetobacter baumannii* and *Staphylococcus aureus* (ATCC-25923). Absorbance at 630 nm of cultures treated with different concentrations of nanoparticles, 3.0 mg/ml to 23.4 μg/ml, was measured at 24 and 48 hours with appropriate controls in triplicate. Bacterial viability measured using the Resazurine reduction assay at 24 and 48 hours. Fe_3O_4 were well deposited onto GO sheets, with an average size of 84$\pm$9 nm. Percentage reduction of absorbance was directly correlated with the nanoparticle concentration. The GO-Fe nanocomposite resulted in the highest percentage reduction after 48 hours as 82.34% (*E. coli*), 84% (*P. aeruginosa*), 88.56% (*S. aureus*) and 82.55% (*A. baumannii*) at 3.0 mg/ml and it was significantly different from the percent reduction of GO and Fe_3O_4 nanoparticles. Antimicrobial activity based on bacterial viability was observed at concentrations above 375 μg/ml for all nanoparticles tested for both time intervals. Further GO-Fe composite demonstrated a significantly high antimicrobial property for all bacterial species compared to GO and Fe_3O_4 nanoparticles ($P<0.05$). Our results indicate that the GO-Fe nanocomposite is a potential antibacterial agent.

Keywords: graphene oxide, iron oxide nanoparticles, graphene oxide-iron nanocomposite, antibacterial agent, antimicrobial activity