Synthesis, characterization and *in vitro* evaluation of cytotoxicity and antimicrobial activity of chitosan-metal nanocomposites

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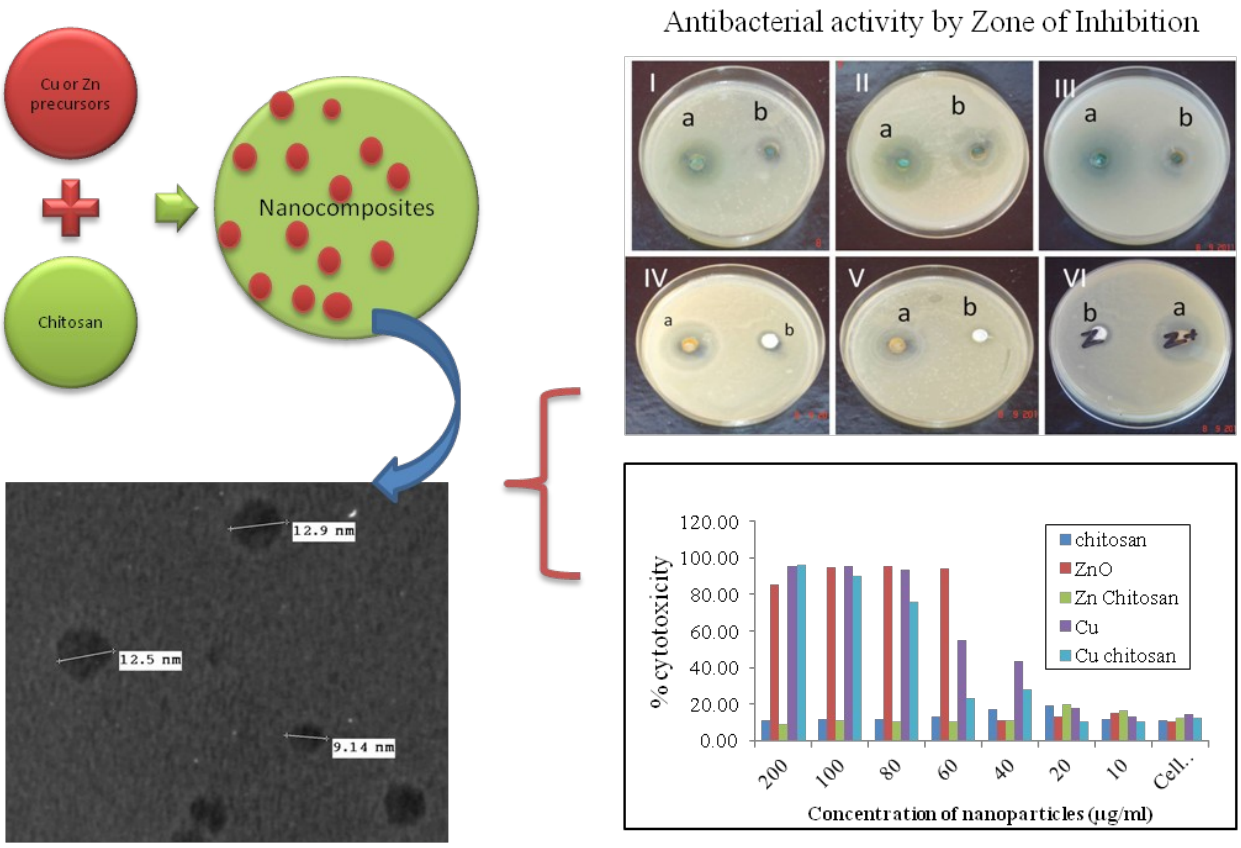
Abstract

Utilization of metallic nanoparticles in various biotechnological and medical applications represents one of the most extensively investigated areas of the current materials science and nanotechnology. Engineered multifunctional nanowires as novel biosensing tools for highly sensitive detection [1] and Biosensors as innovative tools for the detection of food borne pathogens and environmental virology have been well documented [2,3]. Advanced applications require appropriate chemical functionalization of the nanoparticles with organic molecules or their incorporation in suitable polymer matrices i.e. nanocomposites. The polymer nanocomposites material is an innovative product having nano fillers dispersed in the matrix of polymers. Polymer nanocomposites have gained much interest recently. Chitosan is a powerful chelating agent, which easily forms complexes with transition metals and heavy metals and shows antimicrobial activity [4]. In our previous work, we have synthesized chitosan/silver nanocomposites and evaluated their antimicrobial properties [5]. Composite was found to have significantly higher antimicrobial activity than its component particles at their respective concentrations. Although antibacterial action of nanocomposites has been reported [6-7] but a limited literature is available on the antifungal activity of nanocomposites [8]. Present study explores the *in situ* fabrication of chitosan-metal nanocomposites in view of their increasing applications as antimicrobial coating, wound dressing and antibacterial materials. Chitosan nanoparticles were prepared by ionic gelation between chitosan and sodium tripolyphosphate. Copper sulphate pentahydrate ($CuSO_4.7H_2O$) and zinc acetate were used as precursors for synthesis of chitosan-copper nanocomposites (Cu/Ch) and chitosan-zinc nanocomposites (Zn/Ch), respectively. Synthesis of nanocomposites was confirmed by Fourier Transform Infrared (FTIR) spectroscopy and Differential Scanning Calorimetry (DSC). Synthesized nanocomposites have an average particle size of ~ 15 nm as observed by Transmission Electron Microscopy (TEM). The chitosan-metal nanocomposites showed significant antibacterial activity against *Staphylococcus aureus* MTCC 1809, *Pseudomonas aeruginosa* MTCC 424 and *Salmonella enterica* MTCC 1253 *in vitro* than component nanoparticles individually. We also studied antifungal activity of chitosan-metal complex by percent inhibition of mycelia growth method. Surprisingly, our data showed excellent antifungal activity of all nanoformulations (chitosan, CuNPs, ZnNPs, Cu/Ch and Zn/Ch), specially nanocomposites (Cu/Ch and Zn/Ch). Cytotoxicity studies conducted on Vero cell line (African green monkey kidney cell line),

revealed good biocompatibility of nanocomposites as compared to metal nanoparticles. To date, this is the first report on cytotoxicity study of chitosan-copper and chitosan-ZnO nanocomposites. Therefore, results indicate that chitosan-metal complexes can be a very promising candidate for novel antimicrobial agents for application in cosmetic, food, health care and textile industry.



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