

METALLIC NANOTOXICITY TO  
BACTERIA AND BACTERIOPHAGES

Jia You

Dr. Zhiqiang Hu, Thesis Supervisor

ABSTRACT

The inhibitory effort of two commonly used nanoparticles, silver nanoparticles (Ag NPs) and zinc oxide nanoparticles (ZnO NPs), on the growth of bacteria (*E. coli*) and bacteriophage (MS2) were evaluated using a turbidimetric microtiter assay and the standard double agar layer (DAL) assay. In the pure *E. coli* cultures, Ag NPs presented a greater degree of inhibition against bacteria than ZnO NPs. However, both nanoparticles did not deactivate MS2 at the highest nanoparticle concentrations tested (5 mg/L total Ag and 20 mg/L ZnO). Instead, exposure of MS2 to ZnO NPs at the concentration of 20 mg/L ZnO resulted in significantly higher plaque forming units (PFU) than the control. No bacteriophage inactivation was observed in the presence of nanosilver, nanosilver/Ag<sup>+</sup> mixture (50:50 of Ag<sup>+</sup> and nanosilver in mass ratios) or Ag<sup>+</sup> ions, all at the total Ag concentration of 5 mg/L. In a binary system containing bacteria and phages, both MS2 and Ag NPs reduced bacterial growth, but the degree of bacterial growth inhibition by nanosilver or a mixture of nanosilver/Ag<sup>+</sup> was phage concentration dependent. For Ag<sup>+</sup> ions at concentration of 5 mg/L Ag, complete bacterial growth inhibition was observed regardless of phage concentration. Results from the dynamic bacterial growth inferred from the turbidimetric microtiter assay and the parallel active bacterial and phage concentration measurements inferred from standard agar plate assay indicated that both Ag NPs and ZnO NPs facilitated MS2 to infect the *E. coli* host. The complex interactions among bacteria, phage and nanoparticles suggested that bacterial cell membrane disruption or structure change due to nanoparticle exposure might allow bacteriophage MS2 to enter bacterial host cells more easily and promote bacterial cell lysis.