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Silver-coated Magnetic Nanocomposite Induces Bacterial Growth Inhibition and Protein Changes

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Abstract:
Background: The persistent resistance of foodborne pathogenic bacteria to antibiotics remains a great concern in food production. Numerous studies have reported the antimicrobial properties of silver (ion) nanoparticles and associated nanocomposites on various pathogenic bacteria. However, the presence of such nanoparticles within the mixtures raises toxicity concerns, requiring their removal necessary. The possibility to coat iron oxide nanoparticles with silver ions (Ag) forms nanocomposites that may allow for such removal under a magnetic field. Here we evaluated the inhibitory effect of silver-coated magnetic nanocomposites on bacterial growth and induced protein changes.
Methods: Silver-coated magnetic nanoparticles (Ag-MN) were characterized by transmission electron microscopy (TEM), energy dispersive X-ray spectroscopy (EDS), and X-ray diffraction (XRD) analyses. The antibacterial effects of various concentrations of Ag-MN (0-200 µg/ml) were evaluated on *Escherichia coli*, *Salmonella enterica* serovar

Typhimurium and *S.* Anatum by hourly measurements of optical density (OD) and bioluminescence imaging (BLI), followed by colony forming unit counts (CFU) at the end of cultures. Proteomic analysis (2-DE; *LC-ESI-MS/*MS) was performed to examine the protein changes in *Escherichia coli* O157:H7 exposed or not (control) to Ag-MN (100 µg/ml). Data were assessed by Student's *t*-test with two-tailed nonparametric analysis or One-way ANOVA, with $P<0.05$ indicating significance.
Results: Analytic techniques (TEM, EDS, and XRD) revealed both longitudinal- and round-shaped Ag-MN nanocomposites. All bacteria showed dose-dependent growth inhibition in the presence of Ag-MN ($P<0.05$). The presence of Ag-MN was detected inside the bacteria (TEM micrographs), causing membrane degeneration and vacuole formation. The proteomic analysis indicated 15 up- and 10 down-regulated proteins after Ag-MN exposure ($P<0.05$).v
Conclusions: This study confirms the dose-dependent antibacterial property of silver-magnetic nanocomposites, with dysfunction of protein expression profiles that are crucial for bacterial survival and pathogenicity.
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