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Antibacterial effects of iron oxide and silver nanoparticles synthesized by *Bacillus subtilis*: a comparative study

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ABSTRACT

The present study aimed to characterize silver and iron oxide nanoparticles (NPs) synthesized by *Bacillus subtilis* for their physicochemical properties and antibacterial activities. The antibacterial properties of NPs were evaluated using agar well diffusion method. In the following, zone of inhibition diameter, minimum inhibitory concentration (MIC), and minimum bactericidal concentration (MBC) were estimated against the standard bacteria of *Staphylococcus aureus* (PTCC 1112), *Bacillus cereus* (PTCC 1015), *Pseudomonas aeruginosa* (PTCC 1074), and *Escherichia coli* (O157:H7). According to the findings, the maximum optical density of Ag NPs and Fe_3O_4 NPs was read at 435 and 225 nm, respectively, which therefore verified the fabrication of NPs. The shape of Ag NPs was spherical with the size range of 25–45 nm, while the Fe_3O_4 NPs had cubic and spherical shapes and the size range of 55–80 nm. The results of antimicrobial potentials indicated that the Ag NPs were more active than the Fe_3O_4 NPs. Also, the biomass synthesis method for both NPs exhibited relatively better physicochemical properties and antimicrobial effects than the supernatant methods. There was a significant difference in antimicrobial effects between selected antibiotics and both synthesized NPs ($P < 0.05$). *S. aureus* and *P. aeruginosa* were the most sensitive and resistant bacteria for both NPs. The MIC values of Ag NPs for *S. aureus* and *P. aeruginosa* were 10 and 40 μg/mL, and the MBC values were 20 and 80 μg/mL, respectively. The obtained properties for the Fe_3O_4 NPs were weaker than for the Ag NPs, so that the MIC value was 20 μg/mL for *S. aureus* and *B. cereus*, and 40 μg/mL for *E. coli* and *P. aeruginosa*, in addition to, the MBC values were 40 and 80 μg/mL, respectively. Due to the antimicrobial potential of synthesized NPs, they can be used as antimicrobial agents in formulations of various disinfectants and antiseptics, because the used materials possess a very high reactivity due to nanoparticle nature and are able to inhibit unwanted microbial growth during a very short time.

Keywords: Silver nanoparticles; Iron oxide nanoparticles; *Bacillus subtilis*; Antibacterial properties; Microbial synthesis

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