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# Biosynthesis of Zinc Oxide Nanoparticles from *Allium sativum* Extract: Characterization and Application

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Shahnaz Majeed, Noriz Syamil Bin Norshah, Mohammed Danish , M. N. Mohamad Ibrahim & Anima Nanda 198 Accesses  1 Citation [Explore all metrics](#) →[Cite this article](#)

## Abstract

Zinc oxide nanoparticles (ZnONPs) were synthesized from the aqueous extract of *Allium sativum* (*A. sativum*). The color change of the solution upon the addition of zinc sulfate indicated the formation of ZnONPs. Scanning spectra of UV-Vis spectroscopy in the wavelength range of 200 to 600 nm showed lambda max at 300 nm, which is a characteristic peak of ZnONPs. The Fourier transform infrared (FTIR) spectroscopy illustrated surface functional groups in synthesized nanoparticles. Transmission electron microscopy (TEM) analysis demonstrated particles of spherical shape mixed with some nanorods measured in the range of 5.95 to 15.66 nm were uniformly distributed in the sample. Field emission scanning electron microscopy (FESEM) surface images also confirmed the spherical-shaped nanoparticle mixed with evenly distributed nanorods. The zeta potential analysis of ZnONPs was -28.7 mV in colloidal suspension. The ZnONPs produced good antibacterial effects against various bacterial pathogens and were tested against *Staphylococcus aureus* (ATCC 33,591), *Staphylococcus epidermidis* (ATCC 35,984), *Salmonella typhi*, *Escherichia coli* (ATCC 25,922), and *Vibrio cholerae*. The size of the inhibition zone for 40 µg of ZnONPs against these bacteria was 15 mm, 19 mm, 19 mm, 15 mm, and 14 mm, respectively. The ZnONPs also showed remarkable antibacterial effect against methicillin-resistant *Staphylococcus aureus* (MRSA) (ATCC 4330) with a 15-mm inhibition zone. It has shown a synergistic effect with amoxicillin, gentamycin, and ceftriaxone antibiotics against the above-selected pathogens.