

Effect of ZnO nanoparticles and illumination on growth inhibition of *Escherichia coli* and *Staphylococcus aureus* bacteria in cultivation medium.

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This is a study of antibacterial effects of the ZnO nanoparticles in cultivation medium (Mueller-Hinton broth) on the two basic representatives of gram-negative (*Escherichia coli*) and gram-positive (*Staphylococcus aureus*) bacteria. The broth was chosen to be able to study bacteria and antibacterial effects in bacterial natural environment.

We used three types of the ZnO nanoparticles in our experiments. There was our synthesized ZnO sample and two commercial ZnO samples for comparison - a sample with 50 nm particles and a sample with 20 μm particles. These materials were characterized by the DLS, zeta potential and SEM. The experiments were performed with two different concentrations of the ZnO (1 mg/mL and 0.1 mg/mL). The incubation was performed for 24 hours in the incubator with presence of fluorescent light or in the dark. Samples were taken at given times to be able to obtain the growth curve.

Our results show that the *E. coli* bacteria are more sensitive to the ZnO presence in the cultivation media than the *S. aureus*. We observed the reduction of viable bacteria in time during treatment compared to the reference and after 24 hours there was up to the six order decrease of colony forming units (CFU) number compared to the reference in case of the *E. coli*. The highest sensitivity of the *E. coli* was observed at the sample with our ZnO. In case of the *S. aureus* we observed approximately four order decrease of the CFU number at all samples with higher ZnO concentration. We also tested influence of light to the antibacterial effect. The fluorescent light presence had no significant effect compared to the dark cultivation.

From all possible antibacterial mechanisms of the ZnO particles (reactive oxygen species, releasing of the Zn^{2+} ions, electrostatic interaction and mechanical disruption) we estimate that the most important one is the mechanical factor, which strongly depends on the particle size and shape, which could explain the bacteria inhibition differences between used ZnO samples at the gram-negative *E. coli* with thin outer membrane and small differences at the gram-positive *S. aureus* with thick membrane.