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Cu-containing bifunctional silica nanoparticles with antibacterial properties

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Copper ions and Cu-nanoparticles are supposed to be antibacterial in terms of different strains [1], which could be implemented for water disinfection. As well as aminogroups form stable complexes with copper ions, in this paper we represent silica nanoparticles, functionalized with amino and phenyl groups, derived by developed Stober's synthesis at different temperatures (0°C, 22°C, 45°C) [2] and reached particle's size 140-220 nm. The concentration of amino groups varied from 2,3 to 2,9 mmol/g. Sorption of copper ions from aqueous solution was performed, the ratio of Cu^{2+}/aminogroup on the surface is 1/1. Antibacterial properties were studied for functionalized silica sample with aminopropyl and phenyl groups (Fig.1 (2)) and the same sample with adsorbed Cu^{2+} (Fig. 1(3)) using *Staphylococcus aureus* ATCC 25923 and *Escherichia coli* ATCC 25922 strains (Fig.1). For inoculation were used standardized suspension of the cell of the test-cultures (0.5 McFarland standard), diluted in the normal saline up to $1{,}5 \cdot 10^6$ cells/ml. 1, 0.1, 0.001 and 0.0001% concentrations of silica nanoparticles were used. 100 µl of the suspension of the cell were put in the test-glass, containing 900 µl of the corresponding concentration of the nanoparticles and sustained there during 2 hours under average temperature and constant stirring. In 24 hours the number of colonies that had grown on a solid nutrient medium was calculated Thus, with the concentration of 1 and 0.1% of Cu-containing silica nanoparticles the growth *Staphylococcus aureus* was absent at all and the number of *E.coli* cells that had died, reached 99.8% (Fig.1). With the lower concentrations (0.01 and 0.001%) the number of *St. aureus* dead cells counted 93.3 and 77.9% and *E.coli* dead cells reached the number of 98.8 and 97.3% respectively.

To sum up, derived Cu-containing silica nanoparticles with aminopropyl and

phenyl groups showed antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* strains and acted in dose-dependent character.

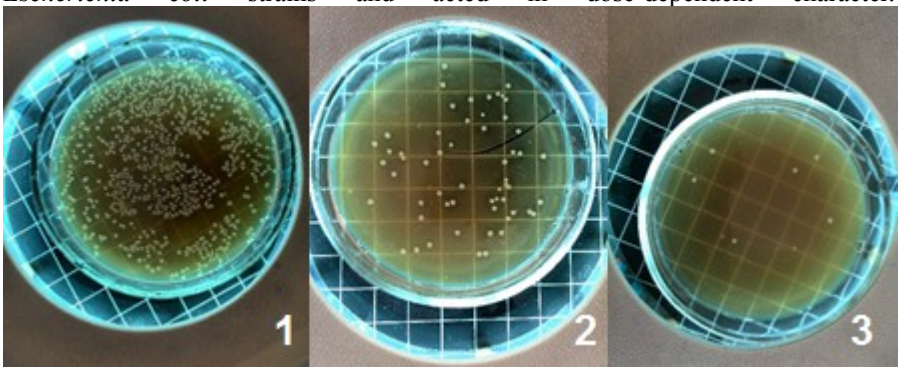

Fig. 1. Antibacterial activity of silica nanoparticles (0.1%) against *E. coli*: 1 – Control group *E. coli* ATCC 25922; 2 – with sample SiO_2/-$(CH_2)_3NH_2$/-C_6H_5; 3 – with sample SiO_2/-$(CH_2)_3NH_2$/-C_6H_5+Cu^{2+}.

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2. *Kotsyuda S.S., Melnyk I.V., Zub Yu. L.* Silica microspheres containing amino groups for biomolecules delivery // Ukrainian-Polish scientific conference “Membrane and Sorption Processes and Technologies” (December 1-3, 2014, Kyiv, Ukraine). -2014. – P.50-52.