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Synthesis of hydride materials based on *Lactobacillus* cells and silver nanoparticles

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As known, silver is the strongest natural antibiotic from existing on the earth. It is well-proven that silver is able to kill or suppress more than 650 types of bacteria, that is why it is used by people during centuries, that testifies to his stable biocide effect. The nanoparticles (NPs) of silver have an extraordinarily large specific area of surface that increases the contact area of silver with bacteria or viruses, considerably improves an antimicrobial action. The application of silver as NP allows to bring down in hundred times the concentration of silver with maintenance of all bactericidal properties. In addition, it is known that bacteria of the genus *Lactobacillus* are salubrious for man. *Lactobacillus*-probiotics as living or killed bacteria, microcapsulated preparations, autolysates, noncellular products of metabolism, extracts and other forms used for a prophylaxis and treatment of diseases of digestive or respiratory tracts. They have an antitumor effect. The combination of natural probiotics and antibiotic can add to both objects the new properties. The mentioned cells can be used as natural templates for ultrafine silver formation (precipitation) due to a presence on the *Lactobacillus* surface of supramolecular layer consisting of regularly well-organized protein or glycoprotein that have pores the size of 2-8 nm. The aim of this investigation was to study the influence of bacteria-matrices and the method of silver NPs synthesis on the hybrid materials (GM) formation based on the cells of some *Lactobacillus* and ultrafine silver.

The hybrid materials based on *Lactococcus lactis*, *Lactobacillus acidophilus* and *Lactobacillus plantarum* cultures were synthesized by a chemical-microbiological method from silver nitrate solution using the reducing agent of sodium borohydride and by a method of biogenic reduction with active groups of a cellular wall. The ultrafine silver formation was controlling by the method of spectroscopy in UV-vis areas. The presence of silver particles was confirmed by means of energy-dispersive X-ray spectroscopy. The particles size distribution was estimated from TEM micrographs of cells impregnated with silver NPs using the ImageG program. The differences in physiology and surface structure properties of investigated cultures of *Lactobacillus* as well as the methods of silver NP formation exerted influence on the structural characteristics of silver particles and spectral properties of the hybrid materials.

The biogenic formed hydride materials had the yellow-brown colouring, the materials formed by chemical-microbiological method were dark-brown coloured. Bacteria *L.plantarum* and *L.acidophilus* appeared more effective for ultrafine silver forming by biogenic and chemical-microbiological methods. An average size of biogenic silver particles was 4±0,4 нм, 90% from them range in size from 2 to 6 nm. Particles appear to be reasonably monodisperse. Particles formed using $NaBH_4$ reagent had an average size of 6±0,5 нм. We observed that the biogenic silver NP plasmon resonance band occurs at 380-400 nm. Particles formed by chemical-microbiological method demonstrated a significant shift in the peak wavelength to 440-460 nm and shoulder at 400-440 nm.

Apparently, the biogenic silver NPs have a less size and achieve improvement in the monodispersity comparatively with particles precipitated in bacteria cell by sodium borohydride. Treatment of *Lactobacillus* biomass by an external low pulse electric field (20V, 2,0 KHz, 100 μsec) at the time of silver ions accumulation (30 min), as well as disintegration of surface S-layer lattice of a bacterial cell by guanidine hydrochloride or by acidic hydrolysis caused the shift of plasmon resonance band to the red region and additional peak appearance. Such changes can be related to a wide size distribution of the particles with different form of aggregates formed in the cell wall. Antibacterial properties of the biogenic formed GM appeared higher in comparison with the preparations formed by a chemical-microbiological method.