Short Communication

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Bacteria–potential producers of nanoparticles

Resume

As result of screening conducted among microorganisms from the culture collection related to different physiological groups several strains capable to synthesis of nanoparticles of silver were identified. Microorganisms related to *Pseudomonas* species expressed the highest potential out of all studied groups. The highest activity was expressed by the strain *Pseudomonas stutzeri.* Nanoparticles produced by this strain expressed stability for 2 weeks and more.

Keywords: nanoparticles, biosynthesis, microorganisms

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Introduction

Nowadays the interest paid to synthesis of nanoparticles of metals, in particular of silver, constantly grows. This attention is stipulated mainly by the fact that today antibacterial silver-containing coating is the most commercialized product abroad.[1–3] Among many approaches of nanoparticles' production, there may be highlighted chemical and biological methods. Chemical methods are wider spread but, biological methods are more perspective since they are more environment friendly and do not demand on use of toxic reagents. Moreover, biological processes are conducted at aerobic conditions, whereas chemical methods quite often demand on anaerobic conditions, which considerably increase cost of nanoparticles' production. Microbiological formation of nanoparticles is one of essay, cheap and environment safe methods, allowing to obtain stable non-aggregating nanoparticles. Nevertheless, it has its own disadvantages: slow velocity and low mono dispersion of particles.[4–6]

Materials and methods

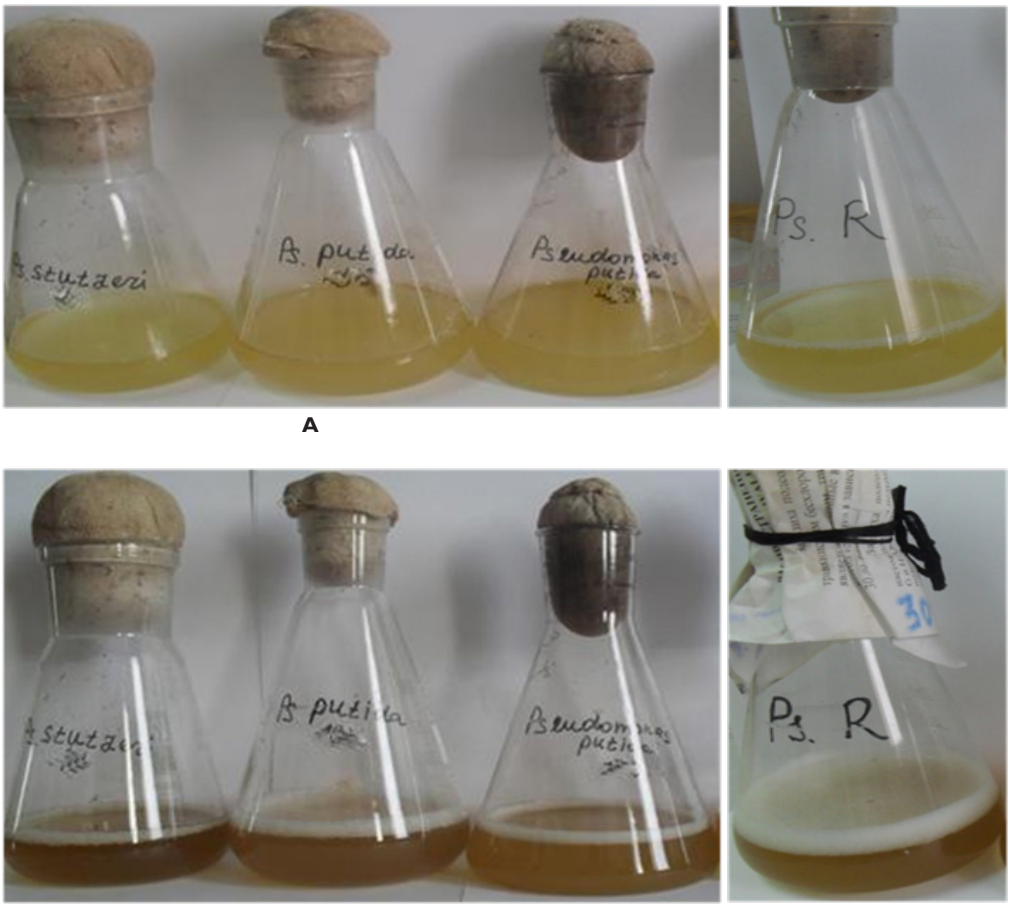
Objects of study were strains of different types of microorganisms preserved at the culture collection of the Institute of Microbiology. Selection of strains was determined by their resistance to different pollutants, including heavy metals, and ability to bio sorption of silver, since it is considered that ability to synthesis of nanoparticles of metals is protective function of microorganisms.[7] Cultivation of microorganisms was conducted on beef extract peptone broth (BEPB) nutrient medium. The subject of study was the receipt of silver nanoparticles. To do so the solution of silver ions $AgNO_3$ in distilled water was prepared. $AgNO_3$ equivalent is 169.89, respectively; 1 l of 0.1 N solution of silver nitrate should contain 16.989 g of reagent. To make a solution 17 g of reagent is dissolved in 1 l of distilled water. Titer of prepared solution is established after 7-10 days by chemically pure sodium chloride. The final concentration of test solution was 100 mg/l Ag^+. Experiments were conducted by addition of solution of silver salt into cultural broth. Mixture of cells and silver ions was incubated on rotary shaker at 150 rpm and 28°C during 3 days. Formation of silver particles was monitored visually: by staining solutions into yellow and brown colors characteristic for nanoparticles of silver and by precipitation of sediments of large silver particles.

Results and discussion

Early forty one strains belonging to different groups of microorganisms was screened. Majority of them expressed ability to synthesize nanoparticles to certain extent.[8] Microorganisms from the culture collection of the Institute of Microbiology, isolated from mixed community of soil borne microorganisms exposed to long term impact of chemical production and from soil polluted with different xenobiotics were studied. Results of microbiological study of industrially important non-spore bacteria after long term storage revealed that they preserve high viability, but differ by sensitivity towards different pollutants. Screening for active strains resulted in selection of the most active microorganisms belonging to Pseudomonas genus (Table 1). It should be noted that representatives of this genus along with representatives of genus Bacillus in stress conditions support structures of microbial communities and according to literature available are active producers of silver nanoparticles.[7–10] Strain *Pseudomonas stutzeri,* out of all studied *Pseudomonas* species, expressed the highest activity; it possessed high synthesizing capacity and, moreover, nanoparticles synthesized by this strain preserved stability up to two weeks and more (Figure 1). It is stipulated, possibly, by formation of smaller nanoparticles and by synthesis of compounds that coat nanoparticles thus preventing their aggregation and therefore stabilizing them. Difference in intensity of staining of different strains of *Pseudomonas putida* should also be noted. Possible reason may be the fact that *Pseudomonas putida* 2 was isolated from site polluted with heavy metals, whereas it is known that ability of microorganisms to form nanoparticles is a defensive function of the organism.[7]

Table 1 Nanoparticles production by *Pseudomonas* species

Strain	Color	Change of color					
		1 day	2 day	3 day	5 day	7 day	14 day
Pseudomonas stutzeri	Brown	+	3+	3+-	3+	3+	3+
Pseudomonas putida 1	Brown	+	+	-	-	-	-
Pseudomonas putida 2	Brown	+	2+	2+	2+	+	+
Pseudomonas sp. R	Light yellow	+	+	+	+	+	+



A

B

Figure 1 Formation of nanoparticles by different strains of *Pseudomonas*.

(A) Initial, **(B)** – after 48 h

Conclusion

As result of conducted study it was established that strains of *Pseudomonas* species preserved at the culture collection of the Institute of Microbiology are capable to synthesize nanoparticles of silver. Implementation of similar analysis at more extended range of different groups of microorganisms will promote to identification of the most efficient microorganisms. It is well known that quantitative change, increase or decrease, cannot last forever. At the certain moment it always leads to qualitative change that is to receipt of natural culture of microorganism with certain capacity to synthesis of nanoparticles.

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Conflict of interest

None.

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