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Antiviral potential of silver nanoparticles of the same size in various stabilizers

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Abstract

Introduction: Silver nanoparticles (NPs) are widely used in biomedicine and tissue engineering, for this reason, it is very important carefully to study biological activity of such NPs. The aim of this paper was to study the influence of Ag NPs of the same size (10 nm) but in various stabilizers on cell viability and reproduction of viruses.

Methodology: Ag NPs were stabilized in tryptophan or SDS. The toxicity of NPs was evaluated using changes in cell viability and metabolic activity. The antiviral activity against HSV-1, HAdV-2 and IAV was assessed using virus yield reduction assay.

Results: It was found that the metabolic activity of cells depended on the type of stabilizer of silver nanoparticles. The Ag in tryptophan are non-toxic for studied cells (BHK-21, Hep-2, and MDCK). In contrast, using of Ag NPs in SDS (1070-107 ng/ml) leads to a significant decrease of cell viability (99-60%). It was detected that Ag NPs in tryptophan in concentrations 1 - 1070 ng/ml significantly reduced the titer of the IAV (by 1.39-7.49 log). Whereas for HSV-1 and HAdV-2 such an effect was not observed. But Ag NPs in SDS showed better anti-adenovirus effect than in tryptophan, the decrease of virus titer was 1.15 - 1.28 log.

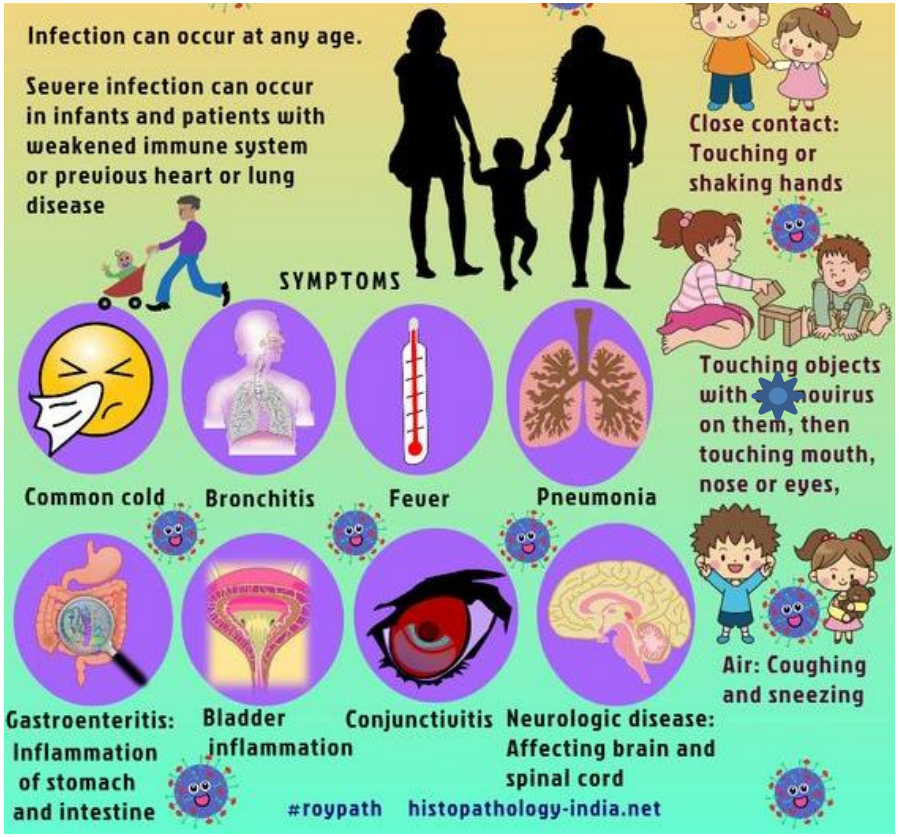
Conclusion: The results presented in this work demonstrate that the nature of the stabilizer of NPs also is the one of the factor governing their toxicity and antiviral activity.

Keywords: antiviral potential; cytotoxicity; silver nanoparticles; stabilization

Introduction

Adeno-, influenza and herpes viruses are causative agents of the high spectrum of diseases ranging from acute respiratory diseases to neoplastic symptoms. An increase in the levels of such infectious diseases among both adults and children causes a necessity of the development of effective methods for prevention and treatment of different forms of pathologies.

Ag NPs have been found to be a potential antiviral agent that acts against many deadly viruses. Ag NPs can generate free radicals and reactive oxygen species (ROS) leading to apoptosis-mediated cell death thereby inhibiting viral infection.



Size distribution of Ag NPs, surface chemistry, particle morphology, chemical composition, agglomeration, capping agent, particle response in media, ion release, and the reducing agents used during Ag NP synthesis plays an important role in their biomedical applications as alterations may result in variable biological interaction and activity.

Methodology

Objects:

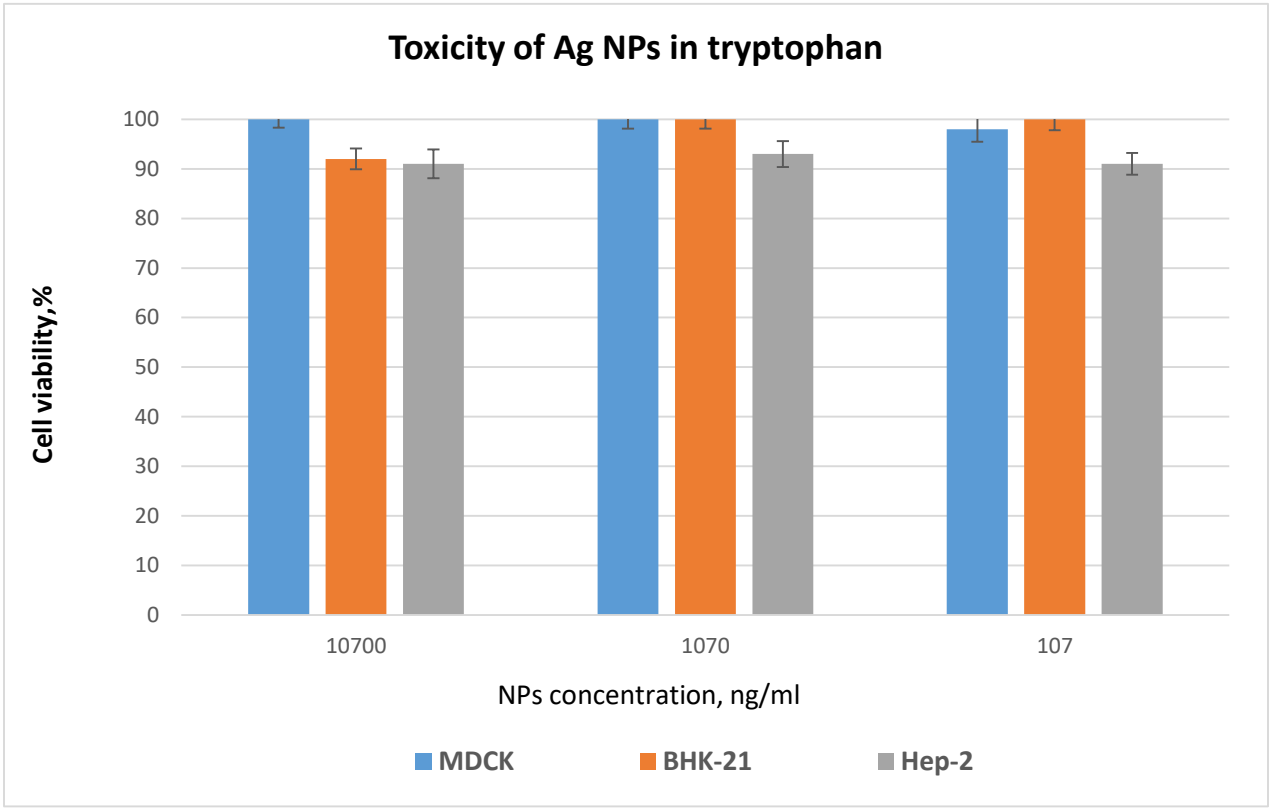
- Ag NPs of the same size (10 nm) stabilized in tryptophan or SDS
- Cell cultures: Syrian hamster kidney (BHK-21)
  human laryngeal carcinoma (Hep-2)
  Madin-Darby canine kidney (MDCK)
- Viruses: human herpes simplex virus type 1 (HSV-1)
  human adenovirus type 2 (HAdV-2)
  influenza virus type A (IAV)

Methods:

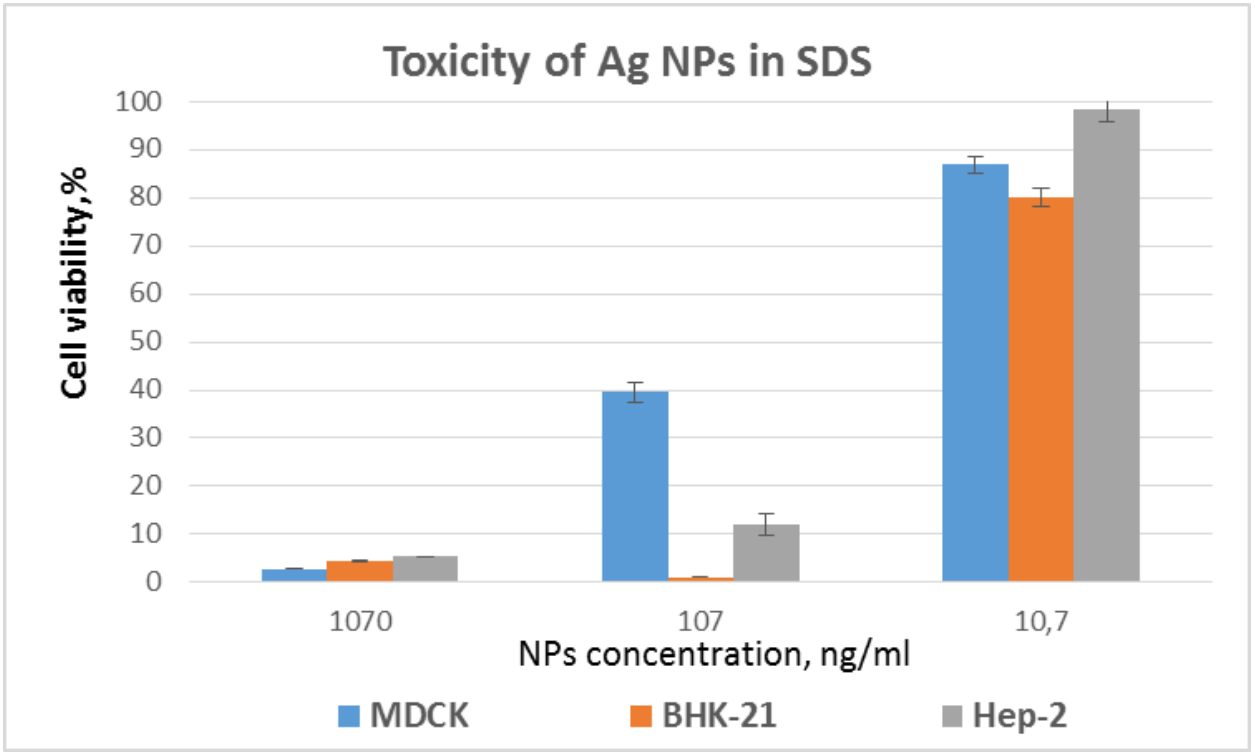
- Cell metabolic activity of NPs was tested *in vitro* using MTT-assay. The concentrations of NPs that inhibit 50% of cell viability compared to control cells (value CC_{50}) were measured.
- The antiviral potential of NPs was assessed using virus yield reduction assay. The titer of the virus synthesized *de novo* was studied.

Results and discussion

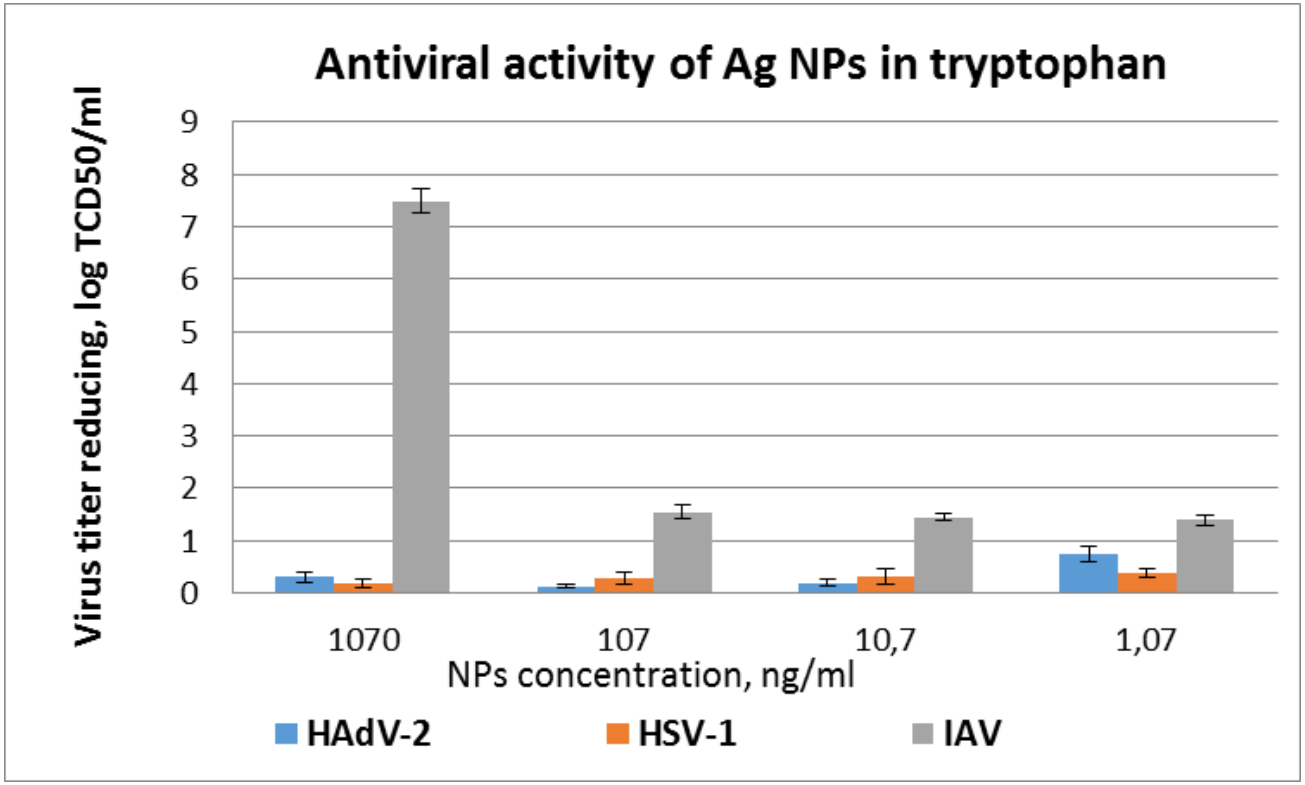
It was found that the toxicity of Ag NPs depended on the type of their stabilizer.



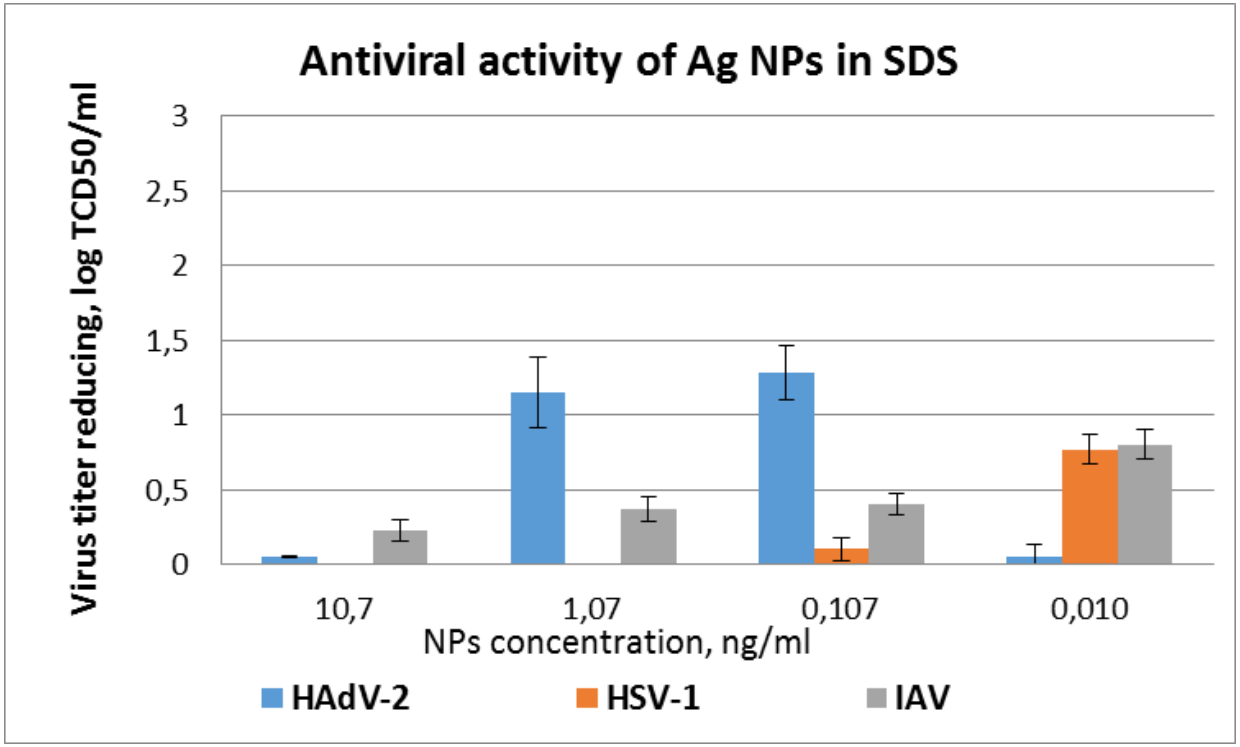
Ag NPs in tryptophan exhibited little cytotoxic effect for studied cells, as their metabolic activity was in the range of 90-100%. CC_{50} values were > 10.7 µg/ml.



Using of Ag NPs stabilized SDS (1070-107 ng/ml) leads to a significant decrease of cell viability (99-60%). CC_{50} values were 87, 47 and 65 ng/ml, respectively, for MDCK, BHK-21 and Hep-2.



It was founded, that Ag NPs tryptophan stabilized significantly inhibited IAV reproduction. In concentrations, 1 - 1070 ng/ml NPs reduced the titer of the influenza virus obtained *de novo* by 1.39-7.49 log. Effect of the NPs on the titer of the virus synthesized *de novo* indicates that the nanoparticles affect the formation of infectious virus progeny. Although virus offspring are formed, virus particles are not complete, and they are not able to cause an infection process. Whereas for HSV-1 and HAdV-2 such an effect was not detected, as the decreasing of infectious titer of viruses did not exceed 0.75 log.



It should be noted that relative to adenovirus, silver nanoparticles showed better antiviral effect in SDS than in tryptophan, the decrease of virus titer was in range 1.15 - 1.28 log.

Conclusions:
The results presented in this work demonstrate that the nature of the stabilizer of NPs also is the one of the factor governing their toxicity and antiviral activity.

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