Interaction of silver nanoparticles with Tacaribe virus

Speshock JL, Murdock RC, Braydich-Stolle LK, Schrand AM, Hussain SM - J Nanobiotechnology (2010)

Bottom Line: ABSTRACT:Silver nanoparticles possess many unique properties that make them attractive for use in biological applications.An area that has been largely unexplored is the interaction of nanomaterials with viruses and the possible use of silver nanoparticles as an antiviral agent.This research focuses on evaluating the interaction of silver nanoparticles with a New World arenavirus, Tacaribe virus, to determine if they influence viral replication.This suggests that the mode of action of viral neutralization by silver nanoparticles occurs during the early phases of viral replication.

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Abstract: ABSTRACT:Silver nanoparticles possess many unique properties that make them attractive for use in biological applications. Recently they received attention when it was shown that 10 nm silver nanoparticles were bactericidal, which is promising in light of the growing number of antibiotic resistant bacteria. An area that has been largely unexplored is the interaction of nanomaterials with viruses and the possible use of silver nanoparticles as an antiviral agent.This research focuses on evaluating the interaction of silver nanoparticles with a New World arenavirus, Tacaribe virus, to determine if they influence viral replication. Surprisingly exposing the virus to silver nanoparticles prior to infection actually facilitated virus uptake into the host cells, but the silver-treated virus had a significant reduction in viral RNA production and progeny virus release, which indicates that silver nanoparticles are capable of inhibiting arenavirus infection in vitro. The inhibition of viral replication must occur during early replication since although pre-infection treatment with silver nanoparticles is very effective, the post-infection addition of silver nanoparticles is only effective if administered within the first 2-4 hours of virus replication.Silver nanoparticles are capable of inhibiting a prototype arenavirus at non-toxic concentrations and effectively inhibit arenavirus replication when administered prior to viral infection or early after initial virus exposure. This suggests that the mode of action of viral neutralization by silver nanoparticles occurs during the early phases of viral replication.

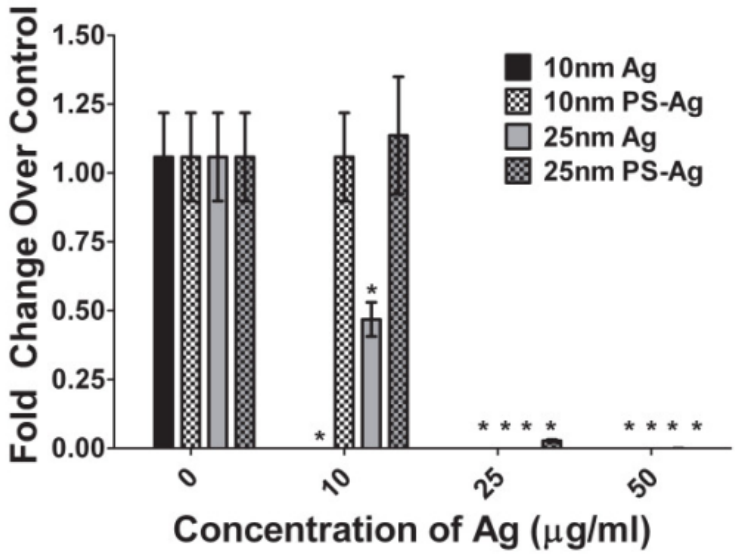

Figure 5: S segment quantitative real time PCR analysis. TCRV was treated with uncoated and PS-coated 10 and 25 nm Ag-NPs for 1 hour. Treated or control virus was used to infect Vero cells for 4 days. The supernatant was removed and the cells were washed 2 times with PBS to remove non-adherent virus. RNA was isolated from the Vero cells and S segment gene expression was determined using qRT-PCR with Sybr green. Changes in S segment gene expression are expressed as fold change over untreated TCRV infection with error bars representing the S.E.M. and statistical analysis comparing the untreated control to each of the treatment groups. (*$p < 0.05$; student's t test; $n = 6$).

Mentions: Since we determined that the virus is entering the cell but progeny virus production is impaired following pre-treatment with Ag-NPs, we wanted to determine whether the Ag-NPs inhibited viral RNA replication. Therefore we examined the amount of S segment gene expression in TCRV-infected Vero cells with and without Ag-NP treatment. Arenaviruses have 2 strands of RNA, the S and L segments. The S segment is the segment that encodes the nucleoprotein and GP1 and 2 proteins, which are early proteins and therefore are detectable early in viral replication. At 25 and 50 μg/ml, all 4 Ag-NPs tested had a dramatic reduction in the amount of S segment expression as compared to the untreated TCRV control (Fig 5). This correlated with the significant reduction in progeny virus produced following the Ag-NP treatments. There was also a significant decrease in the S segment gene expression of the Vero cells infected with TCRV treated with 10 μg/ml of 10 and 25 nm uncoated Ag-NPs (Fig 5).