Could Curcumin Modified Silver Nanoparticles Treat COVID-19?

Siukan Law1#, Chuiman Lo2#, Jie Han3#, Albert Wingnang Leung4, Chuanshan Xu4

1Department of Science, School of Science and Technology, Hong Kong Metropolitan University, Ho Man Tin, Kowloon, Hong Kong, China.
2Department of Chemistry, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong, China.
3School of Nursing, Tung Wah College, 31 Wylie Road, Ho Man Tin, Kowloon, Hong Kong.
4Key Laboratory of Molecular Target and Clinical Pharmacology, State Key Laboratory of Respiratory Disease, School of Pharmaceutical Sciences & Fifth Affiliated Hospital, Guangzhou Medical University, Guangzhou 511436, China.

Dear Editor,

Silver nanoparticles (AgNPs) have been widely used for diagnosis and therapy on wound healing, arthritic as well as infectious diseases. The size of AgNPs are extremely small ranged from 1 nm to 100 nm, which provides a large surface area to enhance their solubility, chemical stability, and catalytic activity for its functions.1 Anti-viral and anti-bacterial are the two common properties of AgNPs, which are attracting scientists' investigation.

AgNPs have an anti-viral potential against many types of viruses including human immunodeficiency virus, hepatitis B virus, herpes simplex virus, monkeypox virus, and respiratory syncytial virus.2 In 2008, Sun L et al. reported that the respiratory syncytial virus was inhibited by AgNPs capped with the poly(N-vinyl-2-pyrrolidone) (PVP), bovine serum albumin (BSA), and a recombinant F protein from RSV (RF 412). AgNPs could bind to the viral surface, block the interaction with G-protein, and distribute on the viral envelope to suppress its combination.3

Morris D et al. also proved that AgNPs had anti-viral and immunomodulatory activities in respiratory syncytial virus (RSV) infection of mice. It inhibited the virus replication and decreased the level of pro-inflammatory cytokines (i.e., IL-1α, IL-6, TNF-α) and pro-inflammatory chemokines (i.e., CCL2, CCL3, CCL5). They showed AgNPs was non-toxic when silver nanoparticles size was within 12 nm and dose below 50 mg/mL.4

Besides, AgNPs also have an anti-bacterial potential against methicillin-resistant Staphylococcus aureus (MRSA). Ip M et al. identified the release of silver ions in the wound dressings from the AgNPs. Silver ions interacted with the thiol groups of enzymes and proteins of bacteria to affect cell respiration and kill the bacteria.5 Another study from Duncan et al. demonstrated that the antibacterial activity of AgNPs on Gram-positive and Gram-negative bacteria. The AgNPs anchored on the bacterial cells to cause lysis and release of the silver ion into the cytoplasm to inhibit an electron transport chain in the cell, inactivate the bacterial protein synthesis, inhibit the DNA replication, and activate the generation of reactive oxygen species (ROS) to destroy the membrane protein, subsequently resulting in the bacterial cell death.6

Recently, Zachar O et al. reported that AgNPs were effective in the prevention and treatment of COVID-19. The concentration of AgNPs colloids are around 10 μg/mL and the particle sizes between 3 nm to 7 nm. However, these formulations were only investigated at the early stages for COVID-19. It’s required to work more before going on to the next stages.7 Basically, the pathogenesis of COVID-19 is caused by a SARS-CoV-2 virus. It binds to epithelial cells in the nasal cavity via the angiotensin-converting enzyme 2 (ACE-2) receptor. The SARS-CoV-2 virus migrates down the respiratory tract to induce infection in the airway and lung, causing damage, apoptosis of alveoli cells, and finally, lead to lung inflammation. If the continuous self-replication of SARS-CoV-2 virus in the tissues, it results in more severe scarring and fibrosis in the lung.8

Nowadays, traditional Chinese herb is widely used within the COVID-19 outbreak such as “Curcumin”. It possesses anti-viral and anti-bacterial properties. However, curcumin is lower solubility and absorption in the human body. AgNPs are the best tools for curcumin to improve its limitations and enhance the original function. A proposed pharmacological mechanism of AgNPs encapsulated with curcumin is the same as AgNPs itself. Curcumin blocks the active site of ACE-2 and attaches to the viral envelope lead to inhibit its replication, prevent the infection of the respiratory tract.

In the past, it had several shreds of evidence about AgNPs encapsulating curcumin with increased anti-viral

*Corresponding Author: Siukan Law, Email: siukanlaw@hotmail.com
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and anti-bacterial activities. Yang XX et al. discovered that curcumin acted as reducing and capping agents in the synthetic route of AgNPs. AgNPs modified by curcumin with a stronger anti-viral property and higher efficient inhibition effect against respiratory syncytial virus (RSV) infection. Gupta A et al. also developed curcumin-cyclodextrins loaded into bacterial cellulose-base for wound dressing applications. These silver nanoparticle-loaded cellulose hydrogels had a strong anti-bacterial property with high cytocompatibility. It could inhibit three of the common wound-infecting pathogenic microbes including Staphylococcus aureus, Pseudomonas aeruginosa, and Candida auris.

All of the above information demonstrates that AgNPs or curcumin-loaded AgNPs might have potential in treating COVID-19. However, much more work needs to be done such as basic cell culture, cytotoxicity, animal models, clinical trials, and safety assessments in the human body.

Ethical Issues
Not applicable.

Conflict of Interest
Authors declare no conflict of interest in this study.

References
1. Sweet MJ, Singleton I. Silver nanoparticles: a microbial perspective. Adv Appl Microbiol 2011;77:115-33. doi: 10.1016/b978-0-12-387044-5.00005-4
2. Galdiero S, Falanga A, Vitiello M, Cantisani M, Marra V. Galdiero M. Silver nanoparticles as potential antiviral agents. Molecules 2011;16(10):8894-918. doi: 10.3390/molecules16108894
3. Sun L, Singh AK, Vig K, Pillai SR, Singh SR. Silver nanoparticles inhibit replication of respiratory syncytial virus. J Biomed Biotechnol 2008;4(2):149-58. doi: 10.1166/jbn.2008.012
4. Morris D, Ansar M, Speshock J, Ivanciuc T, Qu Y, Casola A, et al. Antiviral and immunomodulatory activity of silver nanoparticles in experimental RSV infection. Viruses 2019;11(8):732. doi: 10.3390/v11080732
5. Ip M, Lui SL, Poon VKM, Lung I, Burd A. Antimicrobial activities of silver dressings: an in vitro comparison. J Med Microbiol 2006;55(Pt 1):59-63. doi: 10.1099/jmm.0.46124-0
6. Duncan TV. Applications of nanotechnology in food packaging and food safety: barrier materials, antimicrobials and sensors. J Colloid Interface Sci 2011;363(1):1-24. doi: 10.1016/j.jcis.2011.07.017
7. Zachar O. Formulations for COVID-19 Early Stage Treatment via Silver Nanoparticles Inhalation Delivery at Home and Hospital. ScienceOpen Preprints; 2020. doi: 10.14293/S2199-1006.1.SOR-.PPHBJEO.v1
8. Mason RJ. Pathogenesis of COVID-19 from a cell biology perspective. Eur Respir J 2020;55(4):2000607. doi: 10.1183/13993003.00607-2020
9. Yang XX, Li CM, Huang CZ. Curcumin modified silver nanoparticles for highly efficient inhibition of respiratory syncytial virus infection. Nanoscale 2016;8(5):3040-8. doi: 10.1039/c5nr07918g
10. Gupta A, Briffa SM, Swingler S, Gibson H, Kannappan V, Adamus G, et al. Synthesis of silver nanoparticles using curcumin-cyclodextrins loaded into bacterial cellulose-based hydrogels for wound dressing applications. Biomacromolecules 2020;21(5):1802-11. doi: 10.1021/acs.biomac.9b01724